



HUMECOAL
PROJECT



VOLUME 1

Hume Coal Project and Berrima Rail Project

Response to Submissions
Main Report

Prepared for Hume Coal Pty Limited
June 2018



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Hume Coal Project and Berrima Rail Project

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Hume Coal Project and Berrima Rail Project

Final

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Executive Summary

ES1 Background

Hume Coal Pty Limited (Hume Coal) proposes to construct and operate an underground coal mine and associated mine infrastructure in the Southern Coalfield of New South Wales (NSW) (the Hume Coal Project). The mine will produce metallurgical coal with a secondary thermal coal product. Around 50 million tonnes (Mt) of run-of-mine coal will be extracted from the Wongawilli Seam via a non-caving mining system, resulting in approximately 39 Mt of saleable coal over a project life of about 23 years, including construction and rehabilitation. The Hume Coal Project area is located to the west of Moss Vale, in the Wingecarribee local government area (LGA).

Hume Coal is also seeking approval in a separate development application for the construction and operation of a new rail spur and loop, known as the Berrima Rail Project. Coal produced by the Hume Coal Project will be transported by rail to port for export or to domestic markets via this new rail spur and loop. Approval for both the Hume Coal Project and the Berrima Rail Project is being sought under Part 4 Division 4.1 (State significant development) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

Hume Coal is a wholly-owned subsidiary of POSCO Australia Pty Limited (POSA), the Australian subsidiary of POSCO. POSCO is a leading steel manufacturer and one of the largest buyers of Australian coal and iron ore.

This Response to Submission (RTS) report responds to submissions received on the Hume Coal Project and the Berrima Rail Project, following public exhibition of the Environmental Impact Statement for each project.

ES2 Submissions received

The Environmental Impact Statements for the Hume Coal Project and the Berrima Rail Project were publically exhibited over a 90 day period, from the 31 March 2017 to 30 June 2017.

A total of 12,666 submissions were received on the two projects, of which 11,241 were form letter submissions. 1,354 unique submissions were received from individual community members. 23 submissions were received from special interest groups, and 36 from businesses. The remaining 12 submissions were from government agencies. A summary of the submissions received, including the number that objected and those that were in support, is provided in Table E.1.

Table E.1 Summary of submissions

Source/type	Object	Support	Comment	Total
Form letter	11,241			11,241
Community (unique)	929	419	6	1,354
Special Interest group	21	2		23
Business	21	15		36
Government			12	12
Total	12,212	436	18	12,666

The most commonly raised technical issue in submissions on the Hume Coal Project related to water resources, and in particular the potential impacts to groundwater and privately owned bores. Impacts to surface water resources were also commonly raised, as well as matters related to the local economy, potential noise impacts, social impacts, and the potential impacts to the tourism industry in the region. General objections to the coal industry in general and climate change related impacts were also broadly raised.

The most common issue raised in submissions on the Berrima Rail Project related to traffic and transport. The concerns in this regard mostly related to the proposed additional train movements and the implications of this increase on waiting times at rail/road crossings. Dust and noise emissions were the next most common technical aspect raised, followed by health, generally also related to dust and noise emissions.

ES3 Actions since EIS exhibition

Additional technical investigations were commissioned by the Hume Coal Project team in response to both submissions received on the project after the public exhibition of the EIS, and questions from technical experts engaged by the NSW Department of Planning and Environment (DPE) to review the aspects of mine design, noise and vibration, economics and groundwater.

Importantly, the additional work undertaken to respond to submissions did not result in the need to make any changes to the project design, nor did any of the overall findings as presented in the EIS with regard to potential impacts significantly change. The project description as described in Chapter 2 of the Hume Coal Project EIS and Chapter 2 of the Berrima Rail Project EIS remain an accurate description of the two projects, as does the project evaluation and justification.

The additional investigations included the following:

1. **Mine design:** two and three dimensional numerical modelling of the mine layout, to provide a complementary and independent method of analysing mine stability and subsidence predictions. This included back analysis of key parameters to local observational data, parameter sensitivity analysis and scenario analysis.
2. **Water resources:**
 - a) revision of the groundwater model, surface water balance, and subsequent production of an updated water impact assessment (included as Appendix 2 of this report); and
 - b) the purchase of additional groundwater licences (548 ML) on the open market and via controlled allocation. Hume Coal has now secured 93% of the peak water licence volume required over the life of the project.
3. **Aboriginal heritage:** additional test excavation of two potential archaeological deposits (HC_179 and HC_146).
4. **Biodiversity:** completion of an additional floristic plot to confirm plant community types (PCTs).
5. **Visual amenity and historic heritage:** production of additional photomontages relating to Mereworth House and Garden, as requested by the Heritage Council of NSW.
6. **Tourism:** preparation of a report on the tourism industry in the Wingecarribee LGA by Judith Stubbs and Associates (JSA) (JSA 2017a), including an investigation into the potential impact of the Hume Coal Project on this industry; and
7. **Property values:** similar to tourism, a report was prepared by JSA (2017b) on property values in the Wingecarribee LGA, including an investigation into the potential impact of the Hume Coal Project on these values.

The most extensive amount of additional work undertaken was in the areas of groundwater and the mine design. The additional numerical modelling of the mine layout confirmed the predictions of the original subsidence assessment (ie that negligible subsidence will occur). The additional groundwater modelling resulted in a change to the predicted number of privately owned bores to be influenced by the project (ie greater than 2 m drawdown) by one, from 93 to 94 bores.

In addition to these technical investigations, Hume Coal continued to engage with stakeholders after the development application and accompanying EIS was submitted to the DPE, particularly during the public exhibition period to facilitate effective communication of the EIS with stakeholder groups. These engagement activities included holding eight community information sessions during the exhibition period, which were held across weekends and week days (two at the Mittagong RSL and the remainder at the Mereworth property). A total of approximately 200 community members attended these sessions. A number of meetings have also been held with government agencies to discuss their submissions on the Hume Coal Project and the Berrima Rail Project.

Hume Coal also continues to engage with potentially affected bore owners. In May 2017 (during the exhibition period) personalised information packages were sent via registered post to all potentially affected landowners. Included in this package were the modelled impacts to the landowner's groundwater bore, a copy of the groundwater baseline assessment form, the NSW aquifer interference policy, a plan detailing the company's understanding of the bores location and schematics of the proposed mitigation measure specific to the landowner's bore. Face-to-face meetings have also been held with several landowners throughout the consultation process.

ES4 Water resources and revised impact assessment

Given the focus on groundwater in the submissions, as described above, substantial additional groundwater modelling and impact assessment work has been undertaken. This included the preparation of a detailed make good strategy (refer to Appendix 2) to address the issues and concerns raised in this regard, and to demonstrate that a credible pathway exists to 'make good' each bore that is predicted to be influenced by the project. The strategy outlines the proposed staged approach to the implementation of make good measures. Ultimately, consultation will be required on an individual level with each landowner in order to agree on suitable, appropriate and tailored make good measures based on individual circumstances and technical details.

Dr Noel Merrick of HydroSimulations performed a detailed audit of the EIS groundwater model originally developed by Coffey, followed by a range of additional modelling work including: a model revision using upgraded software and solvers; a range of additional sensitivity analyses; and a detailed uncertainty analysis. The numerical model was designed in accordance with the Australian Modelling Guidelines (Barnett et. al 2012). The NSW Government independent peer reviewer, Hugh Middlemis, concluded that the model software, design, extent, grid, boundaries and parameters form a good example of best practice in design and execution.

The additional groundwater modelling work generally provides support to the predictions of water impacts presented in the EIS. The number of privately owned bores that are predicted to experience drawdown as a result of the project by more than 2 m is now 94 (compared with 93 bores reported in the EIS) on 72 properties.

The revised aspects of the surface water assessment demonstrate that the project will meet the Neutral or Beneficial Effect criteria for surface water quality across all aspects of the project.

A revised Water Assessment for the Hume Coal Project (EMM 2018a) has been produced to reflect the outcomes of the updated groundwater modelling, and is presented in Appendix 2 of this RTS report. This revised assessment replaces the Water Assessment presented in the EIS (EMM 2017c). Whilst there has not been a significant change in the findings of this assessment, for simplicity the entire Water Assessment presented in the Hume Coal Project EIS is replaced by this revised assessment in Appendix 2.

ES5 Evaluation and conclusion

Extensive work has been undertaken to respond to the submissions received on the Hume Coal Project EIS and the associated Berrima Rail Project EIS. The overall outcome is that no major changes to the two projects were required as a result of any of the submissions or the additional groundwater modelling work undertaken. In addition, the peer reviews conducted by the independent expert reviewers on behalf of DPE in the key areas of groundwater, economics, noise and the mine design have resulted in responses and additional work by Hume Coal that have broadly reaffirmed the overall outcomes of the EIS. Therefore, the description of the project, and project evaluation and justification, as presented in the EIS, remains a true and accurate reflection of the project for which approval is sought.

The Hume Coal Project and the Berrima Rail Project, if approved, would provide a number of benefits including:

- **Provision of a high quality coking coal:** The Southern Coalfield is the only significant source of quality hard metallurgical or coking coal in NSW. Within the project area, coal deposits have been extensively explored by Hume Coal since 2011, showing the coal has all the necessary characteristics to produce a product that generally meets export coking coal specifications, and contains some highly attractive qualities such as ultra-low phosphorous.
- **Employment generation:** At its peak the mine will employ about 300 workers. This will provide substantial flow-on benefits to the region, particularly during the 19 year operational phase of the project as the workforce will be a residential workforce, from within a 45 minute commute to the mine site. The employment benefits have particular significance given that the Southern Highlands currently has the highest youth unemployment rate in NSW (Brotherhood of St Laurence 2018).
- **Economic benefits:** The proposed mine will generate direct economic benefits of \$316 million for NSW in net present value terms at a real discount rate of 7% (or nominally around 9%). Royalty payments to the NSW government will total around \$266 million over the life of the project in real 2016 dollars, or \$114 million in net present value terms at a real discount rate of 7%. Payroll tax and other state government duties, taxes and levies are additional benefits to NSW. Locally, the net direct benefits of the project to the Wingecarribee LGA are expected to amount to approximately \$84 million in NPV terms.

Great care has been taken in planning the project so that its design minimises and mitigates potential environmental impacts. The project's design includes features that exceed the normal practices used in Australian coal mines and go beyond minimum regulatory standards, particularly:

- A low impact underground coal mine that employs a mining method resulting in negligible subsidence. This has the dual benefits of avoiding both surface disturbance and impacts to the groundwater system that are typically associated with underground mining systems that induce caving of the overburden. It thus greatly reduces surface impacts and the volumes of groundwater that would otherwise be intercepted in the active mine workings.
- Sealing panels with bulkheads after extraction and reject backfilling, which allows the early recovery of groundwater levels.
- Rejects will be placed underground, removing the need for a permanent surface emplacement.
- Full and empty coal wagons travelling to and from the mine will be covered.

A range of physical, economic and environmental attributes combine to make the project area suitable for the proposed underground mine. The project area is close to rail infrastructure that links directly to the Port Kembla coal terminal, currently an under-utilised asset that is ready to accept coal from the Hume Coal Project. It is also in close proximity to the Moss Vale Enterprise Corridor, an area established by the local council to encourage an increase in industrial, employment generating land uses in the area. The surface infrastructure area has been carefully situated on predominantly cleared land so as to avoid sensitive environmental features, and is in an area with limited neighbouring sensitive receivers. Due to the underground, non-caving nature of the mine, existing land uses will continue across 98% of the project area, without impacts from mine-induced subsidence.

The Hume Coal Project and associated Berrima Rail Project will enable the orderly and efficient development of a dormant publically owned resource – Wongawilli Seam coal – which will be of significant benefit to the local and broader NSW communities. While the two projects have the potential to cause some adverse impacts, mitigation and/or compensation measures have been developed to address all of these and the net result is that residual impacts are considered to be minor. With all relevant factors considered, the associated benefits are considered to outweigh costs and the proposed Hume Coal Project and Berrima Rail Project are strongly justified.



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Part A

Submissions received and response approach

Chapter 1: Introduction

Chapter 2: Overview of the exhibited project

Chapter 3: Analysis of submissions

Chapter 4: Actions undertaken since EIS exhibition



1 Introduction

1.1 Background

Hume Coal Pty Limited (Hume Coal) proposes to construct and operate an underground coal mine and associated mine infrastructure in the Southern Coalfield of New South Wales (NSW) (the Hume Coal Project). The mine will produce metallurgical coal with a secondary thermal coal product. Around 50 million tonnes (Mt) of run-of-mine coal will be extracted from the Wongawilli Seam via a non-caving mining system, resulting in approximately 39 Mt of saleable coal over a project life of about 23 years, including construction and rehabilitation. The Hume Coal Project area is located to the west of Moss Vale, in the Wingecarribee local government area (LGA). Figure 1.1 illustrates the location of the project at a regional scale.

Hume Coal is also seeking approval in a separate development application for the construction and operation of a new rail spur and loop, known as the Berrima Rail Project. Coal produced by the Hume Coal Project will be transported to port by rail for export or to domestic markets also by rail via this new rail spur and loop. The project areas for the Hume Coal Project and the Berrima Rail Project are shown on Figure 1.2.

Hume Coal is a wholly-owned subsidiary of POSCO Australia Pty Limited (POSA), the Australian subsidiary of POSCO. POSCO is a leading steel manufacturer and one of the largest buyers of Australian coal and iron ore. Hume Coal began exploration drilling in the Hume Coal Project area in May 2011. The Hume Coal Project and Berrima Rail Project have subsequently evolved progressively following detailed geological, engineering, environmental, financial and other technical investigations to define the mineable resource, and to address identified environmental and technical constraints. The two projects have been designed to extract coal efficiently and transport the coal to market within the identified constraints, while minimising adverse environmental impacts.

1.2 Approval process

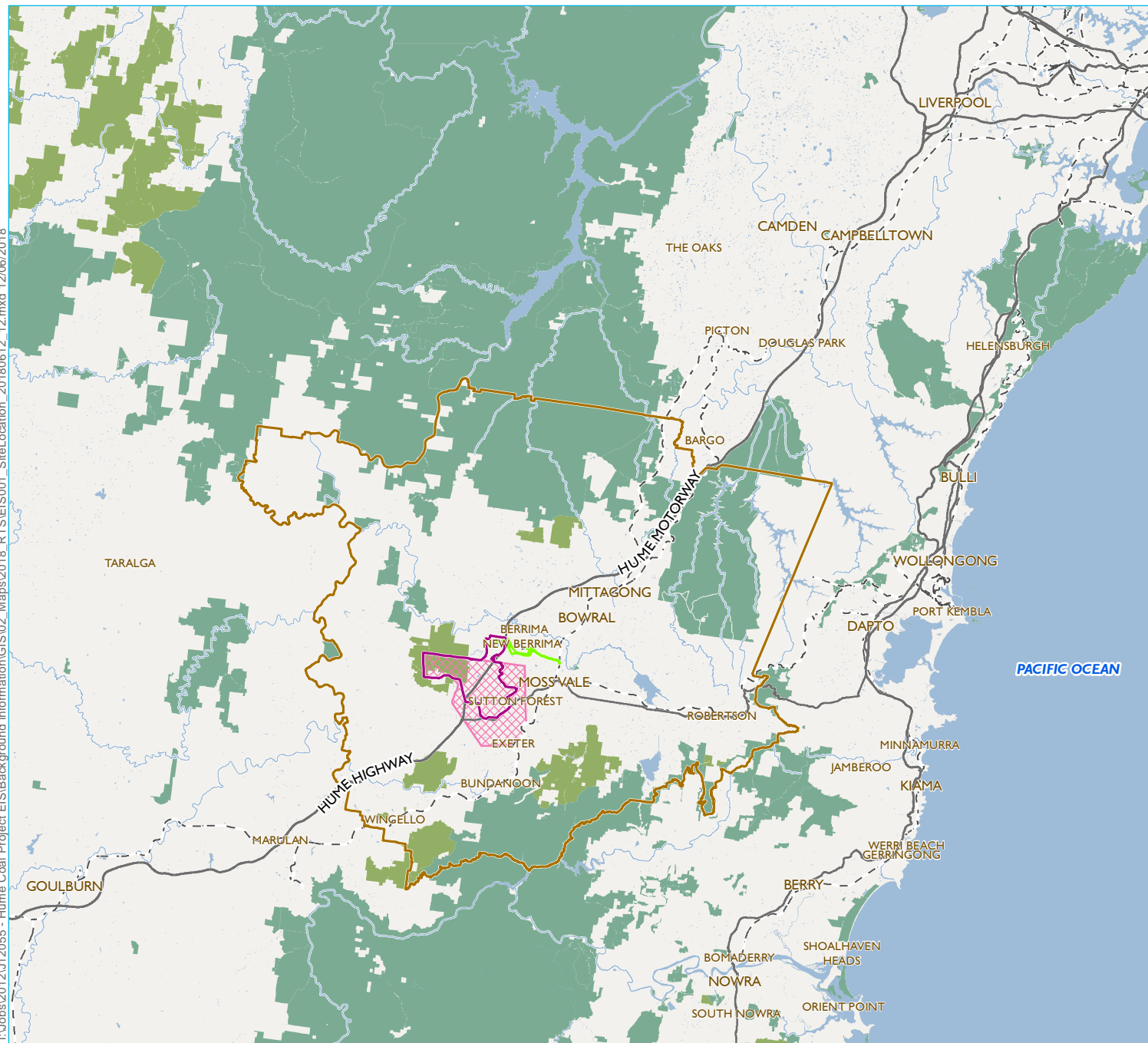
Approval for both the Hume Coal Project and the Berrima Rail Project is being sought under Part 4 Division 4.1 (State significant development) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The Secretary's Environmental Assessment Requirements (SEARs) for the two projects were issued by the NSW Department of Planning and Environment (DPE) on 20 August 2015.

Approval for the Hume Coal Project is also sought under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The coal project was declared a controlled action on 1 December 2015 requiring assessment and approval under the EPBC Act. Supplementary environmental assessment requirements (to the SEARs) were subsequently issued on 18 January 2016 by the then Department of the Environment (DoE) (now the Department of Environment and Energy (DoEE)). The Hume Coal Project will be assessed under the bilateral agreement between the Commonwealth and NSW governments in accordance with Part 5 of the EPBC Act.

In correspondence dated 5 November 2015, the DoEE confirmed that the Department is satisfied the Berrima Rail Project does not need to be included in the referred action for the Hume Coal Project. Therefore, the rail project is not a controlled action and approval is not required under the EPBC Act.

The development applications and accompanying environmental impact statements (EIS) for the Hume Coal Project (EMM 2017a) and the Berrima Rail Project (EMM 2017b) were submitted to the DPE on 29 November 2016 for adequacy review. Following feedback and some modification, the two EISs were deemed adequate for exhibition, which occurred between 31 March 2017 and 30 June 2017. A total of 12,666 submissions were received on both projects, the majority of which (89%) were form letter submissions, totalling 11,241. 1,354 unique submissions were received from individual community members, of which 419 were in support and 929 objected. 23 submissions were received from special interest groups, and 36 from businesses. The remaining 12 submissions were from government agencies. Of the total submissions received (including form letters), 12,212 objected to the project, 436 were in support and 18 provided comment. Further details on the submissions received are provided in Chapter 3 and a register of submitters is included in Appendix 1.

T:\Jobs\2012\12055 - Hume Coal Project EIS\Background information\GIS\02_Maps\2018_RTSE\IS001_SiteLocation_20180612_12.mxd 12/06/2018



- KEY**
- Hume Coal Project area
 - Berrima Rail Project boundary
 - Wingecarribee Shire LGA
 - A349
 - Main road
 - Rail line
 - Drainage line
 - NPWS reserve
 - State forest
 - Waterbody

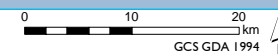
Regional context

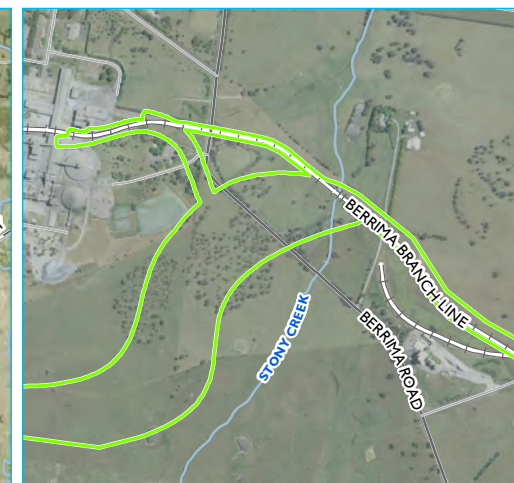
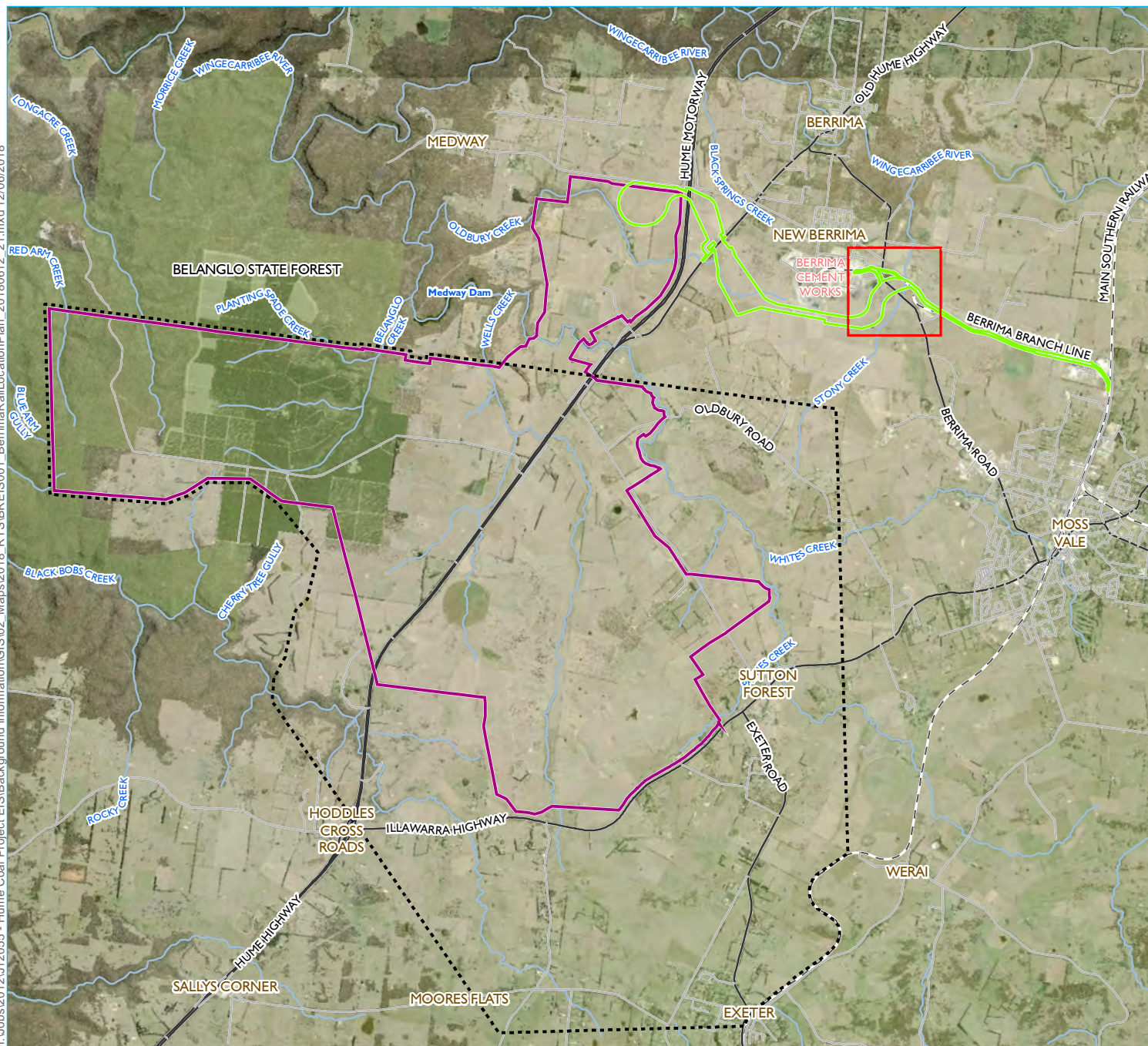
Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 1.1



Source: EMM (2018); DFSI (2017); Hume Coal (2017)





KEY

- Hume Coal Project area (5,051 ha, 44,740 m perimeter)
- Berrima Rail Project area (181 ha, 23,201 m perimeter)
- A349
- Main road
- Local road
- Rail line
- Drainage line
- State forest

Note: Hume Coal Project Area, Berrima Rail Project Area and A349 boundaries have been offset for clarity.

Local context

Hume Coal Project and Berrima Rail Project
Response to submissions
Figure 1.2



1.3 Expert reviewers

The DPE engaged expert reviewers to review and provide comment on the EIS on a number of aspects of the project; the proposed mine design, noise and vibration, economics, and groundwater. The experts engaged are listed below:

- Mine design: Emeritus Professor Jim Galvin and Professor Ismet Canbulat;
- Noise and vibration: Renzo Tonin & Associates;
- Economics: BIS Oxford Economics; and
- Groundwater: Hugh Middlemis.

A series of meetings were held between these reviewers, the Hume Coal project team, and the technical specialists who prepared the impact assessment on each aspect for the EIS. In particular, in relation to groundwater, meetings were held between DPE's reviewer Hugh Middlemis and Dr Noel Merrick, who subsequently updated the Hume Coal Project numerical groundwater model. For the mine design and subsidence aspects, a session was held between DPE's reviewers, members of the Hume Coal Project team and Mine Advice, who prepared the original subsidence assessment for the EIS. The expert reviewers prepared review reports, and Hume Coal provided formal responses to these reviews.

Additional work has been undertaken by the Hume Coal project team and technical specialists as part of the RTS process to respond to questions raised by the peer reviewers, particularly in the areas of groundwater, with a revision of the groundwater numerical model undertaken; and the mine design, with two and three-dimensional numerical modelling commissioned. The additional work undertaken on these two aspects is discussed in Chapters 8-10 (groundwater, surface water and licensing) and 16 (mine design and subsidence). No re-modelling was required in the areas of noise and economics.

The overall outcome of the reviews is that none resulted in the requirement to make any changes to the project. The project description as described in Chapter 2 of the Hume Coal Project EIS remains an accurate description of the project, as does the project evaluation and justification.

1.4 Purpose of this report

This response to submissions report (RTS) responds to submissions received on both the Hume Coal Project EIS and Berrima Rail Project EIS. This report will be submitted to the DPE who will distribute it to relevant government agencies and the Independent Planning Commission (IPC) for consideration in the proposal's assessment and determination.

In responding to submissions received, the submissions have been categorised, grouped and addressed by issue, rather than on an individual or stakeholder basis. This approach is consistent with Guideline 5 of the *Draft Environmental Impact Assessment Guidance Series* (DPE 2017), which was released for public comment by the DPE in 2017. A summary of the analysis of submissions is provided in Chapter 3.

This report also describes the further technical studies undertaken since exhibition of the Hume Coal Project EIS and Berrima Rail Project EIS, particularly in relation to groundwater and surface water, as well as the additional stakeholder and community engagement activities that Hume Coal carried out during the exhibition period, and which the company continues to undertake.

1.5 Document structure

This RTS comprises three volumes, made up of the main report and supporting technical reports in the appendices.

Volume 1 contains the main RTS report and is structured as follows:

- **Chapters 1 and 2** provide a background of the approvals process to date and a summary of the exhibited projects;
- **Chapter 3** provides a detailed summary of the submissions received on the two projects, including where the submissions were received from and the key issues raised;
- **Chapter 4** describes the activities undertaken by Hume Coal since exhibition of the two EIS', including the additional technical studies and stakeholder engagement activities undertaken;
- **Chapter 5** provides a revised water impact assessment for the Hume Coal Project, reflecting the additional work completed on the groundwater model;
- **Chapters 6-26** respond to matters raised in the submissions on the technical studies undertaken for the two projects;
- **Chapter 27** responds to other matters raised in the submissions not directly related to the technical study areas, such as project justification and general objections to the coal industry;
- **Chapter 28** provides an updated summary of project commitments; and
- **Chapter 29** provides an updated project evaluation and conclusion.

Volume 2 comprises:

- **Volume 2a**
 - Appendix 1 Register of submitters
 - Appendix 2 (Part 1) Hume Coal Project Revised Water Assessment
- **Volume 2b** - Appendix 2 (Part 2) Hume Coal Project Revised Water Assessment
- **Volume 2c** - Appendix 2 (Part 3) Hume Coal Project Revised Water Assessment
- **Volume 2d** - Appendix 2 (Part 4) Hume Coal Project Revised Water Assessment
- **Volume 2e** - Appendix 2 (Part 5) Hume Coal Project Revised Water Assessment

Volume 3 comprises:

- **Appendix 3** - Aboriginal cultural heritage - additional information
- **Appendix 4** - Biodiversity - additional information
- **Appendix 5** - Hume Coal Project - Response to community concerns regarding impacts on tourism (Judith Stubbs & Associates 2017)
- **Appendix 6** - Hume Coal Project - Response to community concerns regarding impacts on land values (Judith Stubbs & Associates 2017)
- **Appendix 7** - Mine design additional information - 3D numerical modelling

2 Overview of the exhibited projects

2.1 Hume Coal Project

Hume Coal holds exploration Authorisation 349 (A349), located to the west of Moss Vale in the Wingecarribee LGA. Hume Coal is seeking development consent to construct and operate an underground coal mine and associated mine infrastructure within A349 in the Hume Coal Project area shown in Figure 2.1. Up to 3.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal will be extracted from the Wongawilli Seam within the project life of 23 years. The product split will be about 55% metallurgical coal and 45% thermal coal.

A349 covers approximately 8,900 hectares (ha), although mining is not proposed across its full extent. The proposed underground mining area is approximately 3,474 ha. The Hume Coal Project area boundary is illustrated in Figure 2.1, and covers the combined Mining Lease Application (MLA) areas for the project that have been submitted under the *NSW Mining Act 1992* (MLA 527, MLA 528 and MLA 529; totalling 4,811 ha), as well as the parts of the project that do not require a mining lease. The Hume Coal Project area is therefore larger than the combined MLA area, at 5,051 ha. Within the project area, the surface infrastructure area is limited to approximately 117 ha.

Product coal will be transported by rail to Port Kembla for shipment to export markets and by rail to domestic customers. Rail works and rail use are covered by a separate development application for the Berrima Rail Project, which is described further in Section 2.2.

The indicative project layout, including surface infrastructure locations and the underground mine, is shown in Figure 2.1. The mine surface infrastructure area is shown in further detail in Figures 2.2 and 2.3.

The key components of the Hume Coal Project are:

- Establishment of temporary construction offices and a temporary construction accommodation village.
- Development and operation of an underground coal mine, comprising of approximately two years of construction and 19 years of mining, followed by a closure and rehabilitation phase of up to two years, leading to a total project life of 23 years. Coal extraction will commence during the second year of construction following excavation of the drifts, and hence there will be some overlap between the construction and operational phases.
- Extraction of approximately 50 Mt of ROM coal from the Wongawilli Seam, at a rate of up to 3.5 Mtpa. Low impact mining methods will be used, which will have negligible subsidence impacts.
- Following processing of ROM coal in the coal preparation plant (CPP), production of up to 3 Mtpa of metallurgical and thermal coal for sale to international and domestic markets.
- Construction and operation of associated mine infrastructure, mostly on cleared land, including:
 - one personnel and materials drift access and one conveyor drift access from the surface to the coal seam;
 - ventilation shafts, comprising one upcast ventilation shaft and fans, and up to two downcast shafts installed over the life of the mine, depending on ventilation requirements as the mine progresses;
 - a surface infrastructure area, including administration, bathhouse, washdown and workshop facilities, fuel and lubrication storage, warehouses, laydown areas, and other facilities. The surface infrastructure area will also comprise the CPP and ROM coal, product coal and temporary emergency reject stockpiles;

- surface and groundwater management and treatment facilities, including storages, pipelines, pumps and associated infrastructure;
 - overland conveyors;
 - rail load-out facilities;
 - a small explosives magazine;
 - ancillary facilities, including fences, access roads, car parking areas, helipad and communications infrastructure; and
 - environmental management and monitoring equipment.
- Establishment of site access from Mereworth Road, and construction or upgrade of minor internal roads.
 - Relocation of some existing utilities, such as part of the existing Wingecarribee Shire Council easement that traverses the project area containing power and water infrastructure associated with Medway Dam.
 - Coal reject emplacement underground, in the mined-out voids.
 - Ongoing resource definition activities, along with geotechnical and engineering testing and other fieldwork to facilitate detailed design.
 - Peak workforces of approximately 414 full-time equivalent employees during construction and approximately 300 full-time equivalent employees during operations.
 - Decommissioning of mine infrastructure and rehabilitating the area once mining is complete, so that it can support land uses similar to current land uses.

The Hume Coal Project incorporates design elements that are leading practice; some of which set a new benchmark for underground coal mining in NSW. For example, the rail wagons that will transport product coal will be covered, both when full of coal and on the return route when empty. All coal reject material (the stone that is separated out of the coal during processing) will be returned underground to partially backfill the mined-out void, reducing potential visual and other environmental impacts that could be associated with a permanent surface emplacement area. A mining system will be used which leaves pillars of coal in place so that the overlying strata is supported, rather than collapsing into the mined-out void, and therefore surface subsidence impacts will be negligible. By minimising disruption to the overlying strata, associated groundwater impacts will also be minimised.

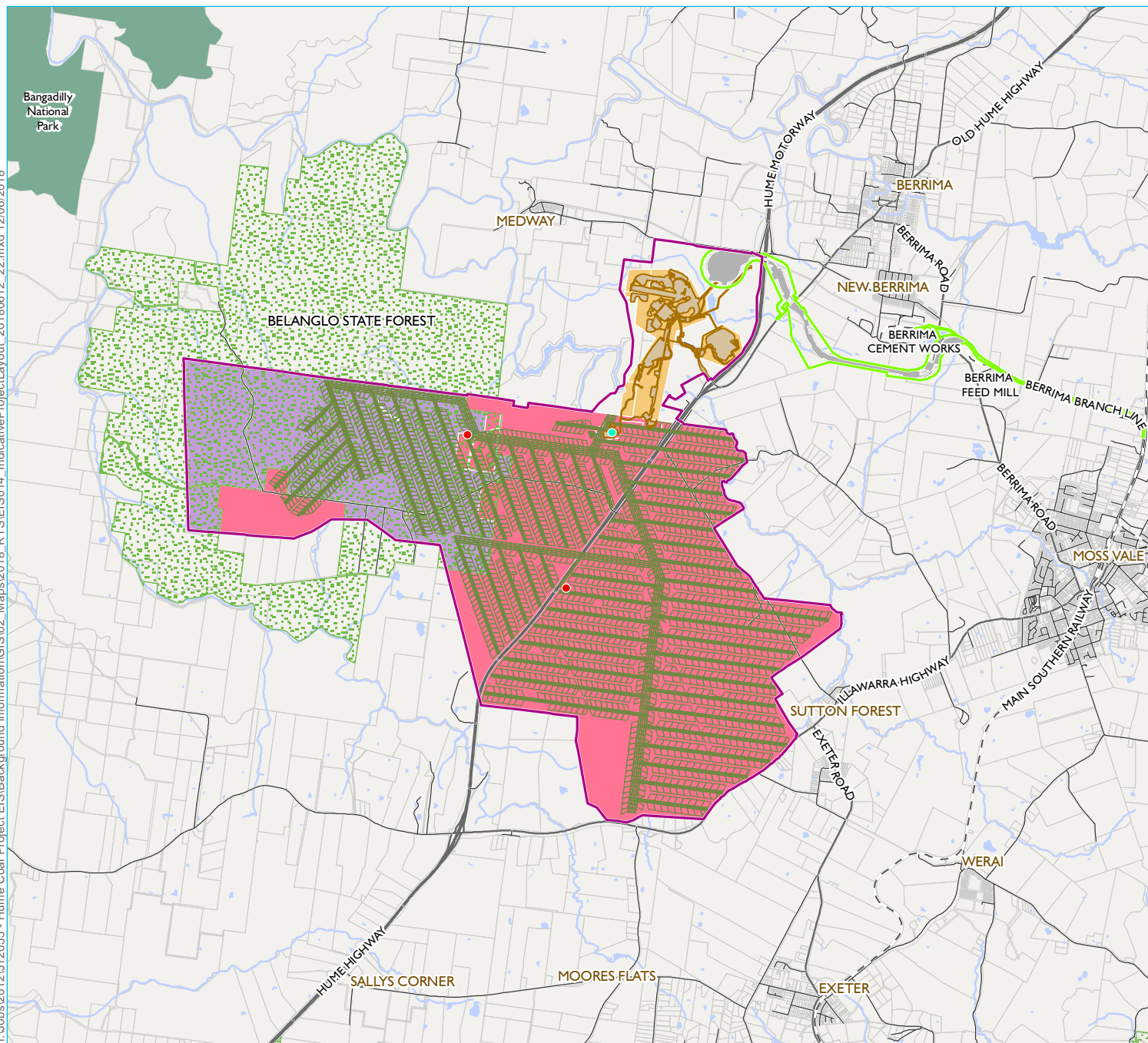
2.2 Berrima Rail Project

Hume Coal is also seeking approval for the Berrima Rail Project, which will enable coal produced by the Hume Coal Project to be transported to market. The Hume Coal Project seeks approval for all activities associated with the excavation and processing of coal, and construction and operation of the required coal loading facilities to load the coal into train wagons. The Berrima Rail Project comprises the construction and operation of the new rail line and loop.

In addition to the construction and operation of a new rail spur and loop that will connect to the existing Berrima Branch Line, the Berrima Rail Project also involves:

- associated upgrades at the existing Berrima Junction sidings;
- construction of a basic rail maintenance and provisioning facility;
- use of the upgraded rail infrastructure; and
- the ongoing use of the Berrima Branch Line, and the regular maintenance and associated shunting activities by existing users and other future users as may change from time to time.

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KEY

- Hume Coal Project area
- Berrima Rail Project area
- Berrima Rail Project construction disturbance footprint
- Underground mine workings (indicative)
- Hume Coal Project indicative surface infrastructure footprint
- Downcast ventilation shaft location
- Upcast ventilation shaft location
- MLA 527
- MLA 528
- MLA 529
- Existing features
- Main road
- Local road
- Rail line
- Drainage line
- Cadastral boundary
- Waterbody
- NPWS reserve
- State forest

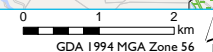
Indicative project layout

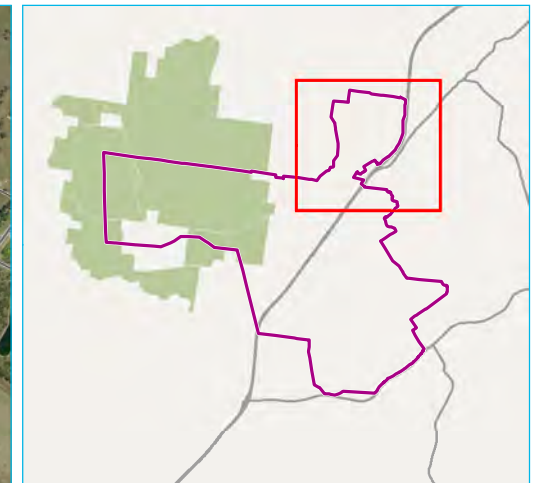
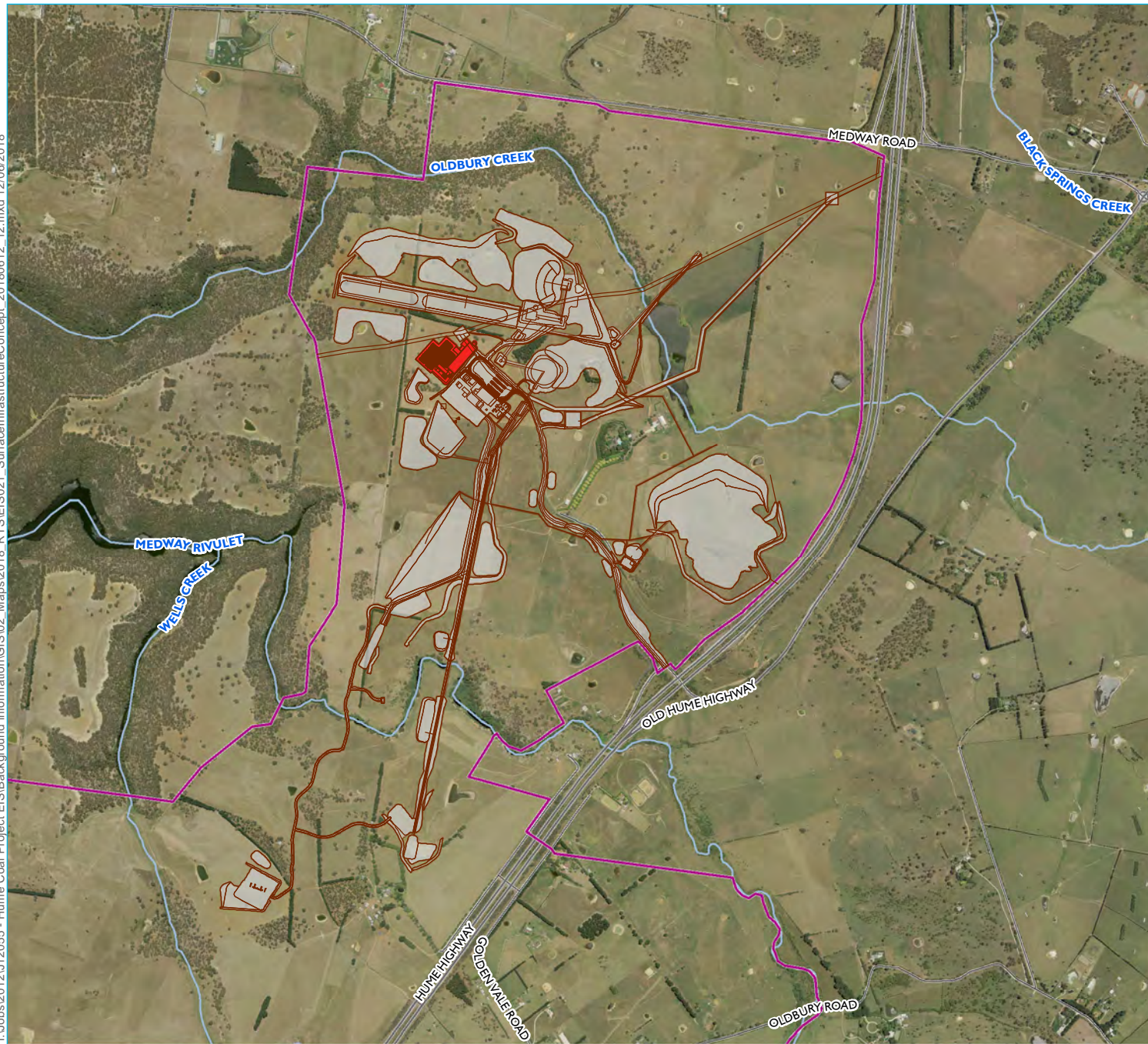
Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 2.1



Source: EMM (2018); DFSI (2017); Hume Coal (2017)





- KEY**
- Project area
 - Surface infrastructure footprint
 - Temporary construction accommodation village
- Existing features
- Main road
 - Local road
 - Drainage line

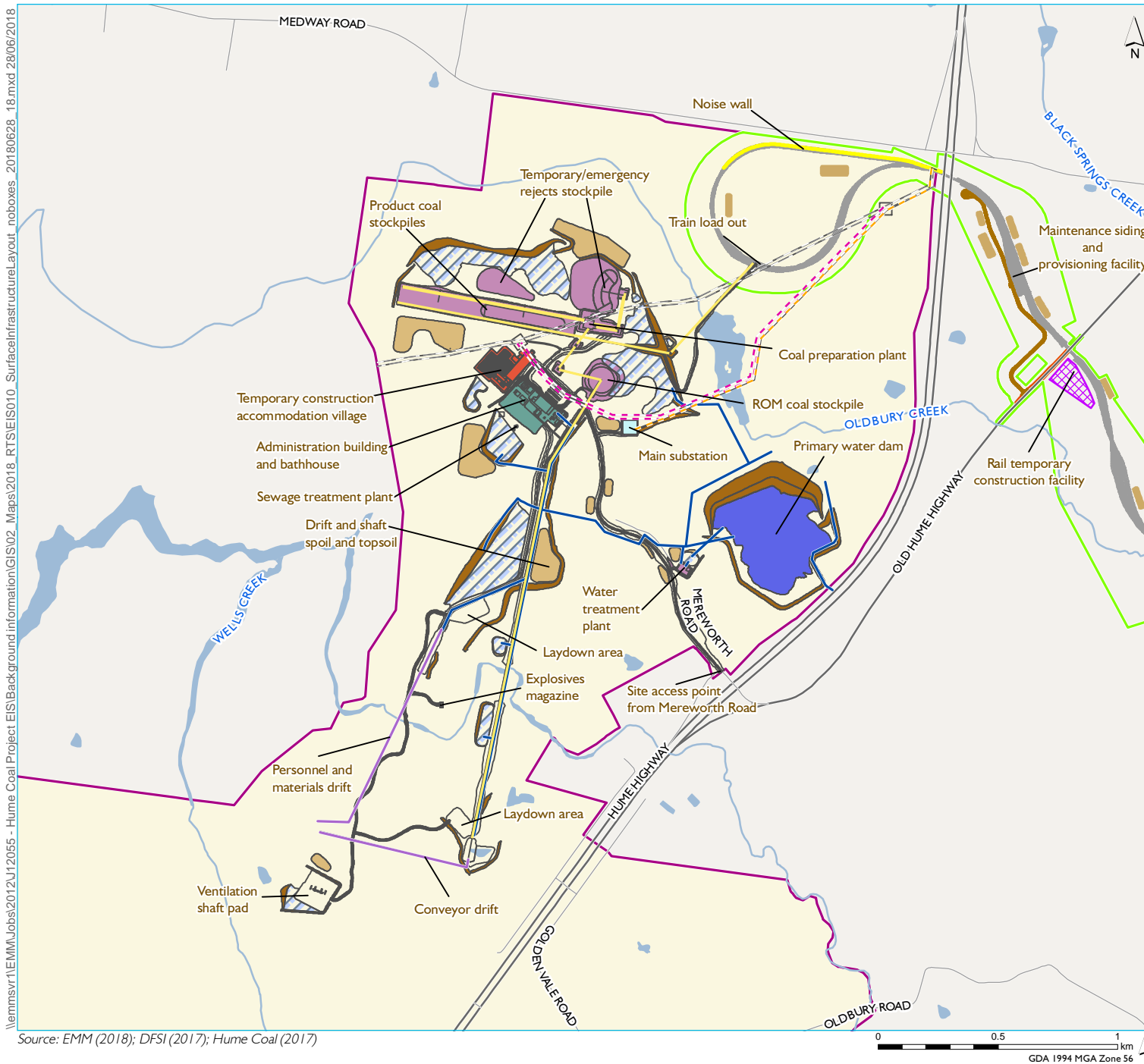
Hume Coal Project - Surface infrastructure footprint

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 2.2



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- KEY**
- Hume Coal Project area
 - Berrima Rail Project area
 - Indicative surface infrastructure features
 - Temporary construction accommodation village
 - Administration/bathhouse/workshop
 - CPP and stockpiles
 - Topsoil stockpiles
 - Stormwater management earthworks
 - Water management area
 - Top water level
 - Existing WSC easement
 - Proposed powerline and pipeline easement
 - Powerline route
 - Conveyor
 - Water pipeline
 - Internal road
 - Indicative Berrima Rail Project components
 - New rail line
 - Rail maintenance facility access road
 - Noise wall
 - Turning lane/shoulder
 - Rail temporary construction facility
 - Topsoil stockpiles
 - Existing features
 - Main road
 - Local road
 - Drainage line
 - Existing waterbodies

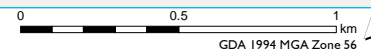
Surface infrastructure layout

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 2.3



Source: EMM (2018); DFSI (2017); Hume Coal (2017)



The conceptual layout of the Berrima Rail Project is illustrated in Figure 2.4. As shown, approval is sought for two alignments of the new rail line where it will cross Berrima Road. The preferred option presented in the Berrima Rail Project EIS was the blue rail alignment, which includes construction of a railway bridge over Berrima Road. This preferred project design was developed in consultation with Boral Cement Limited (Boral) as the owner of the Berrima Branch Line. The alternative option presented in the EIS (the orange alignment in Figure 2.4) accounts for a proposal by Wingecarribee Shire Council (WSC) to realign approximately 700 m of Berrima Road between Taylor Avenue and Stony Creek. This proposal would replace the T-intersection at Berrima Road and Taylor Avenue with a roundabout, and replace the existing rail level crossing into the Berrima Cement Works with a grade separated (road over rail) crossing.

Since submission of the Berrima Rail Project EIS, WSC has commenced construction of the Berrima Road realignment. If this is completed, the 'alternative' Berrima Rail Project alignment would be constructed by Hume Coal.

A summary of the key components of the Berrima Rail Project ('alternative' alignment) are:

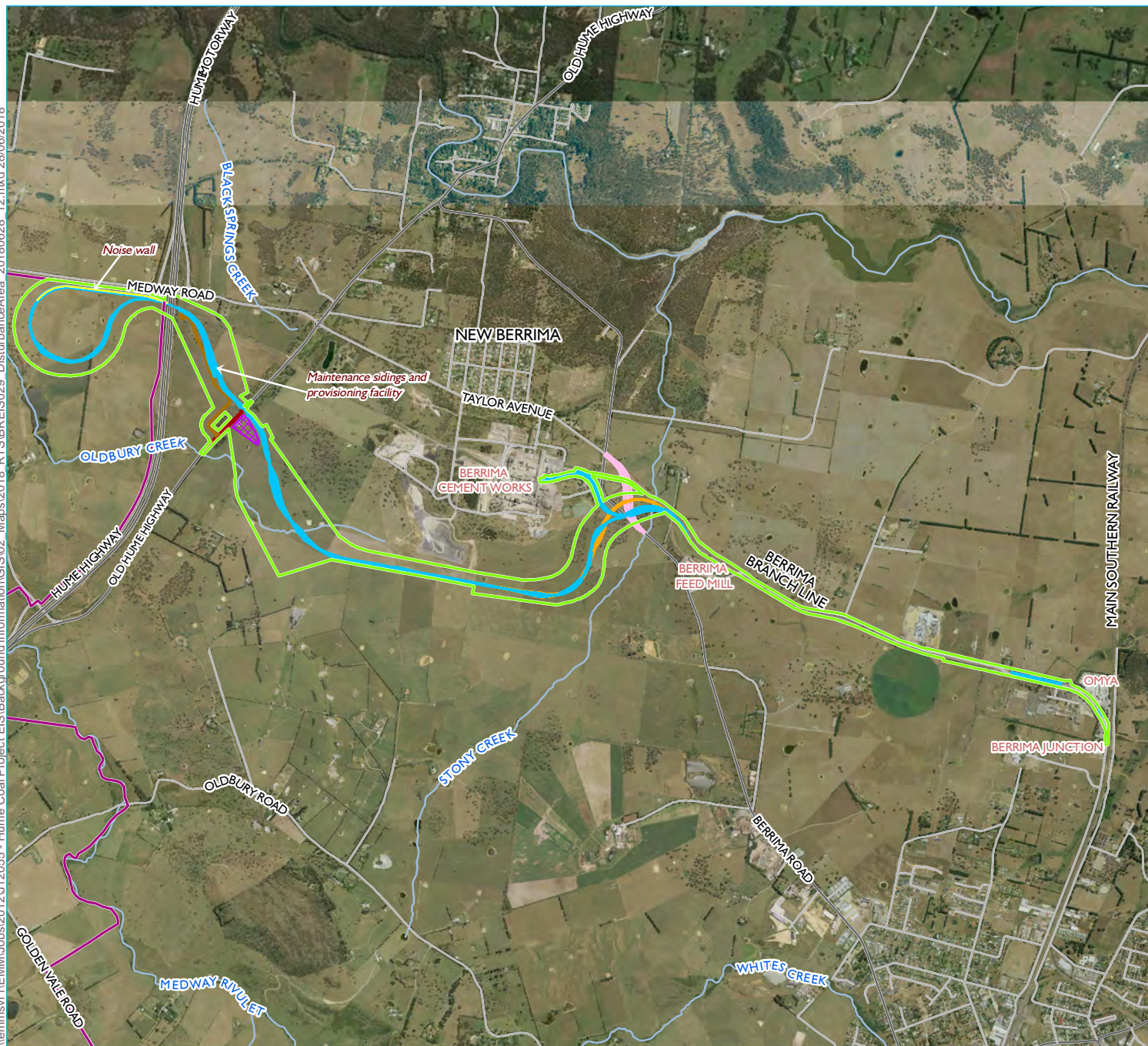
- Upgrades to Berrima Junction (at the eastern end of the Berrima Branch Line) to improve the operational functionality of the junction, including extending the number 1 siding, installation of new turnouts and associated signalling on the branch line. This does not involve any work at or beyond the interface with the Australian Rail Track Corporation (ARTC) - controlled track.
- Installation of a turnout for the new spur line to service the Hume Coal Project on the existing Berrima Branch Line, approximately 1,000 m east of the Berrima Cement Works. A short section of the existing Berrima Branch Line would be shifted north, within the rail corridor on Boral-owned land, to accommodate the spur line.
- The construction of a railway underpass beneath the realigned Berrima Road, constructed through the elevated embankment for the road. No changes would be required to the existing rail connection into the cement works.
- Construction and operation of a new rail spur line from the Berrima Branch Line connection to the Hume Coal Project coal loading facility.
- Construction and operation of a grade separated crossing (railway bridge) over the Old Hume Highway.
- Construction and operation of maintenance sidings, a passing loop and basic provisioning facilities on the western side of the Old Hume Highway, including an associated access road, car parking and buildings.
- Construction and operation of the Hume Coal rail loop within the Hume Coal Project area, adjacent to Medway Road.
- Construction and operation of associated signalling, services (including water and sewerage), access tracks, power and other ancillary infrastructure.

Without the road re-alignment in place, the following project components would vary (ie the preferred option presented in the Berrima Rail Project EIS):

- Construction and operation of a railway bridge over Berrima Road.
- Construction and operation of a new rail connection into the Berrima Cement Works from the railway bridge, including realignment of various tracks inside the works to suit the new connection.
- Decommissioning of the existing rail connection into the Berrima Cement Works including the Berrima Road level crossing.

The new rail track will involve construction of approximately 7.6 km if the alternative option is constructed, or approximately 8.2 km of new railway track (excluding sidings) under the preferred option. The track will be constructed to accommodate a 30 tonne (t) axle load.

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KEY

□ Berrima Rail Project area

□ Hume Coal Project area

Project elements

— New rail line - preferred option

— New rail line - alternative option

— Noise wall

— Rail maintenance facility access road

— Turning lane/shoulder

— Berrima Road relocation (works by Wingecarribee Shire Council)

▣ Rail temporary construction facility

■ Topsoil stockpiles

Existing features

— Drainage line

— Main road

— Local road

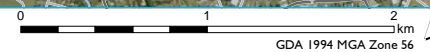
Berrima Rail Project
indicative project layout

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 2.4



Source: EMM (2018); DFSI (2017); Hume Coal (2017)



2.3 The applicant

Hume Coal is a wholly-owned subsidiary of POSA, the Australian subsidiary of POSCO. POSCO is a leading multi-national steel manufacturer and one of the largest buyers of Australian coal and iron ore, purchasing an average of US\$6.2 billion per annum in the period 2012 to 2014. The shares in Hume Coal were acquired from Anglo Coal in December 2010, as a joint venture between POSA and Cockatoo Coal Limited (ASX: COK) that was formed in 2010. POSA subsequently acquired Cockatoo Coal's stake and now owns 100% of the project.

POSCO, through POSA, has already invested around \$2.2 billion in coal and iron ore projects in NSW, Queensland and Western Australia. POSCO is set to make a substantial investment in the Hume Coal Project and Berrima Rail Project if approved, making it an important part of the company's plans to increase its Australian investment portfolio.

Hume Coal's headquarters are in Moss Vale and a project community office is located in Berrima. Hume Coal is an active member of the local community and supports and participates in various groups including the Southern Highlands Chamber of Commerce and Industry, Moss Vale Manufacturing Cluster, Goulburn Chamber of Commerce and the Illawarra First group. The Hume Coal Project and Berrima Rail Project will last over two decades and the company is committed to making a significant and lasting contribution to the region's prosperity. Hume Coal also owns around 1,306 ha of land within and in the vicinity of the Hume Coal Project area, making it one of the largest landholders in the area. The company has leased the properties to a pastoral company that is now running a productive agricultural business on these properties and is currently investing in pasture improvement, weed control and other initiatives to improve the land's agricultural productivity. In keeping with the current land use, it is the current intention that most of this land will continue to be farmed during and following mining.

3 Analysis of submissions

3.1 Exhibition details

The Hume Coal Project EIS and the Berrima Rail Project EIS were publicly exhibited from 31 March to 30 June 2017 at the following locations:

- WSC office in Moss Vale;
- Mittagong Library;
- Bowral Library;
- Moss Vale Library;
- Hume Coal Office (Clarence Street, Moss Vale);
- Hume Coal Project community office (Berrima);
- Nature Conservation Council office (14/338 Pitt Street, Sydney); and
- DPE office in Sydney (320 Pitt Street, Sydney).

Each EIS was also available for review on DPE's online Major Projects register and copies were sent to a number of NSW government agencies nominated by the DPE. In addition, 115 electronic copies of the EIS were handed out to persons requesting copies of the documentation.

3.2 Overview of submissions received

Following public exhibition of the two environmental impact statements, over 12,600 submissions were received by the DPE. The majority of submissions (approximately 89%) adopted the format of a form letter submission, which is a pre-written submission that is distributed and then signed and submitted by a large number of individuals.

Submissions are available to view on the DPE's website at:

- Berrima Rail Project: http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=7171
- Hume Coal Project: http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=7172

A breakdown of the submissions received for each project is provided in Table 3.1.

Table 3.1 Summary of submissions received

Source/type	Object	Support	Comment	Total
Form letter	11,241			11,241
Community (unique)	929	419	6	1,354
Special Interest group	21	2		23
Business	21	15		36
Government			12	12
Total	12,212	436	18	12,666

A further breakdown of the community submissions by project is provided in Table 3.2.

Table 3.2 **Summary of submissions received**

Source/type	Number of submissions	Breakdown
Community - Form letter	11,241	6,084 (Hume Coal Project)
		4,911 (Berrima Rail Project)
		246 (Both projects)
- Unique	1,354	1,059 (Hume Coal Project)
		295 (Berrima Rail Project)
Total	12,595	

The following NSW Government agencies provided submissions:

- DPE Division of Resources and Geoscience (DRG);
- Department of Primary Industries (DPI), including;
 - DPI – Agriculture;
 - DPI – Water; and
 - DPI – Fisheries.
- Environment Protection Authority (EPA);
- Forestry Corporation of NSW (FCNSW);
- Office of Environment and Heritage (OEH);
- NSW Health – South Western Sydney Local Health District;
- Roads and Maritime Services (RMS);
- Heritage Council of NSW;
- Subsidence Advisory NSW;
- Transport for NSW (TfNSW);
- Water NSW; and
- Wingecarribee Shire Council.

Special interest groups that provided submissions were:

- 350 Australia;
- Aurora Southern Highlands Steiner School;
- Australian Garden History Society - Southern Highlands Branch;
- The Australia Institute;
- Australian Stock Horse Society - Moss Vale Branch;
- Battle for Berrima Inc;
- Berrima District Acclimatisation Society;
- Berrima Residents Association;
- Climate Action Now Wingecarribee;
- CFEMU (The United Mineworkers South Western District);
- Coal Free Southern Highlands (this submission included a number of supporting reports, as listed further below);
- Exeter Village Association;
- Farmers for Climate Action;
- Groundswell Gloucester;
- Institute for Energy Economics and Financial Analysis (IEFFA);
- Lock the Gate Alliance;
- National Trust – Southern Highlands Branch;
- The National Trust of Australia;
- Nature Conservation Council of NSW;
- Quit Coal;
- Regional Development Australia - Southern Inland;
- Southern Highlands Food and Wine Association; and
- Southern Highland Greens.

The Coal Free Southern Highlands Group commissioned a number of studies in support of their submission:

1. Pells and Pan (May 2017) *Groundwater modelling of the Hume Coal Project*, Pells Consulting technical report #S025.R1;
2. UNSW Water Research Laboratory (June 2017) *Hume Coal Project peer review of conceptual and numerical modelling that predicted likely groundwater impacts*;
3. C. M. Jewell and Associates Pty Ltd (May 2017) *Potential groundwater contamination issues associated with the placement of washery fines material into mine voids, review of Appendix K Hydro-geochemical assessment*;
4. The Australia Institute (May 2017) *For Hume the bell tolls – local economic impacts of the Hume Coal Project*;
5. The Australia Institute (June 2017) *Hume Coal Project - Submission on Environmental Impact Statement*;
6. Marylou Potts Pty Ltd and Robert White (June 2017) *Water regulations and the Hume Coal Project*;
7. John Lee, geoscientist, Hydroliex Pty Ltd (June 2017);
8. Colleen Morris and Christine Hay (May 2017) *Cultural landscape assessment, Berrima, Sutton Forest and Exeter*;
9. Colleen Morris and Christine Hay (June 2017) *Statement of Heritage Impact for Berrima, Sutton Forest and Exeter Cultural Landscape of Hume Coal proposal for an underground coal mine and Berrima Rail line extension*; and
10. Macquarie University, Department of Environmental Sciences, Faculty of Science & Engineering (June 2017) *Report on the predicted off-site impacts of the proposed Hume Coal and Berrima Rail Projects – Southern Highlands, NSW*.

3.3 Response methodology

All submissions received were collated and categorised based on who they were from, in accordance with the following categories:

- government;
- unique community submission;
- form letter;
- business; and
- special interest/political group.

The submissions were reviewed and the key issues raised in each submission identified.

Responses were prepared to each issue by EMM and Hume Coal, with input from the technical specialists who prepared the relevant impact assessment for the EIS. The study team was the same team that prepared the Hume Coal Project EIS and Berrima Rail Project EIS, with the addition of:

- **Dr Keith Heasley**, who was commissioned to undertake two and three-dimensional numerical modelling of the mine design. Dr Heasley's report is attached in Appendix 7 and the outcomes are discussed in Chapter 16;

- **HydroSimulations (Dr Noel Merrick)**, who moved from a groundwater modelling peer review role into the role of groundwater modeller. Dr Merrick undertook a detailed EIS groundwater model audit in response to submissions received from government agencies on the groundwater assessment. This audit evolved into a model revision using upgraded software and solvers, and a detailed uncertainty analysis. HydroSimulations are one of the few companies within Australia that can undertake comprehensive uncertainty analysis. The resulting Revised Water Assessment is attached in Appendix 2, and the outcomes summarised in Chapter 5 of this report. HydroSimulations undertook the peer review of the original groundwater model prepared for the Hume Coal Project EIS (EMM 2017a);
- **Harris Environmental**, who prepared a waste water assessment; and
- **Judith Stubbs and Associates**, who were commissioned to prepare a report on the potential impacts of the project on tourism (refer to Appendix 5) and property values (attached as Appendix 6), and discussed in Chapters 23 and 20 respectively.

3.4 Origin of submissions

Figure 3.1 and Figure 3.2 show the source of unique community submissions, and all community submissions (including form letters) respectively, by LGA in NSW, indicating the number that objected and supported the project/s. Also shown is the number of submissions received from other Australian states and overseas.

3.4.1 Unique community submissions

The majority of unique community submissions came from the Wingecarribee LGA (66%), where the Hume Coal and Berrima Rail Projects are located. As shown in the inset in Figure 3.1, most of the unique community submissions (95%) came from NSW, with a small number from other states; 3% from Queensland, 1% from Victoria, and less than 1% from the remaining states and the ACT. A small number of submissions (4, or 0.3%) were received from overseas.

Approximately 31% of the unique community submissions were in support of the projects, and 69% objected.

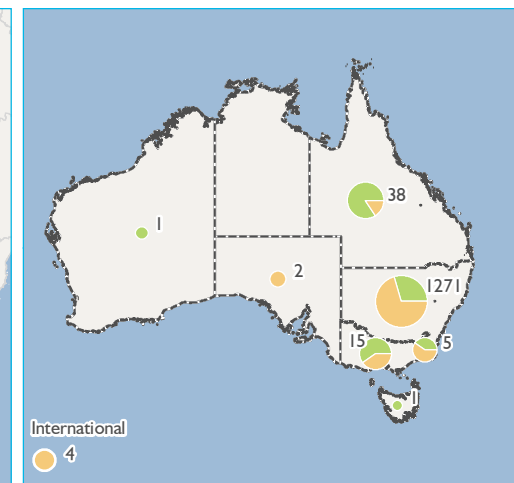
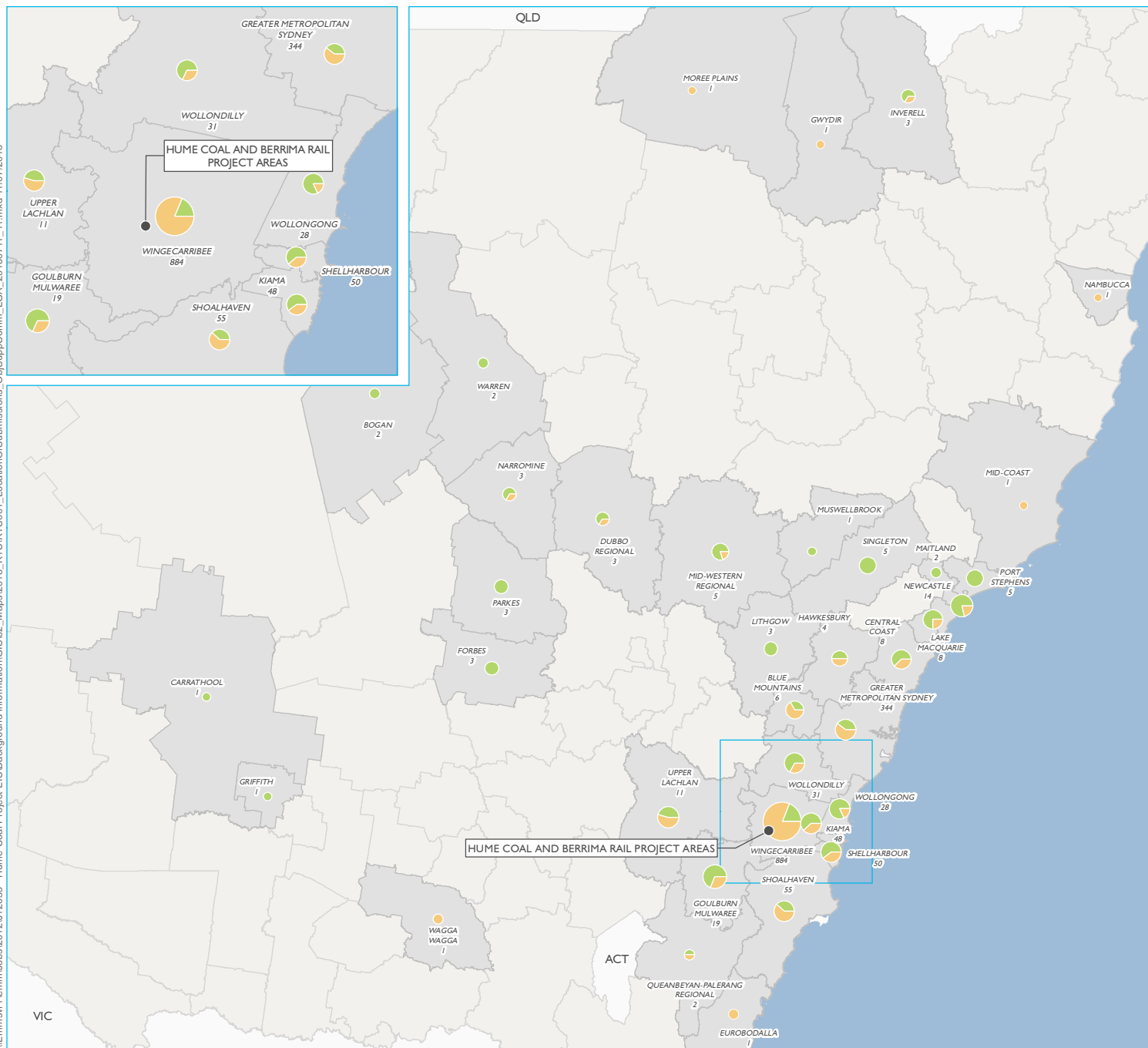
The majority of the unique community submissions from the Wingecarribee LGA opposed the two projects. However, most of the submissions received from the neighbouring local government areas of Wollongong, Shellharbour, Kiama, Goulburn Mulwaree and Wollondilly were in support of the project, as can be seen in Figure 3.1. These areas have a long industrial and mining history, with a number of mines continuing to operate today. Mining provides employment in the region, and many of the submissions from these LGAs cited support of the Hume Coal Project and Berrima Rail Project on the basis of the significant employment and economic benefits they will provide.

A similar story can be seen in Figure 3.1 around the areas of the Central Coast, Newcastle, Lake Macquarie, Singleton, Muswellbrook, Lithgow and Mid-western regional LGAs, from which a majority of submissions also supported the project. Once again, these areas all have a significant industrial history and source of employment from the mining industry.

3.4.2 Form submissions

Form letters were received relating to the Hume Coal Project, the Berrima Rail Project and some relating to both projects. There were seven main variations of the form letters received on the Hume Coal Project, and five variations on the Berrima Rail Project (two of which were the same as two form letters received on the Hume Coal Project). All of the form letters opposed the proposed mine and rail project. The total number of community submissions including form letters, is shown in Figure 3.2, which also shows the number of submissions received in support and those that objected.

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KEY

Submission type

4 Total number of submissions in area

Support

Object

Local government area

Submission provided

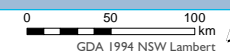
Origin of unique community submissions

Hume Coal Project and Berrima Rail Project
Response to submissions

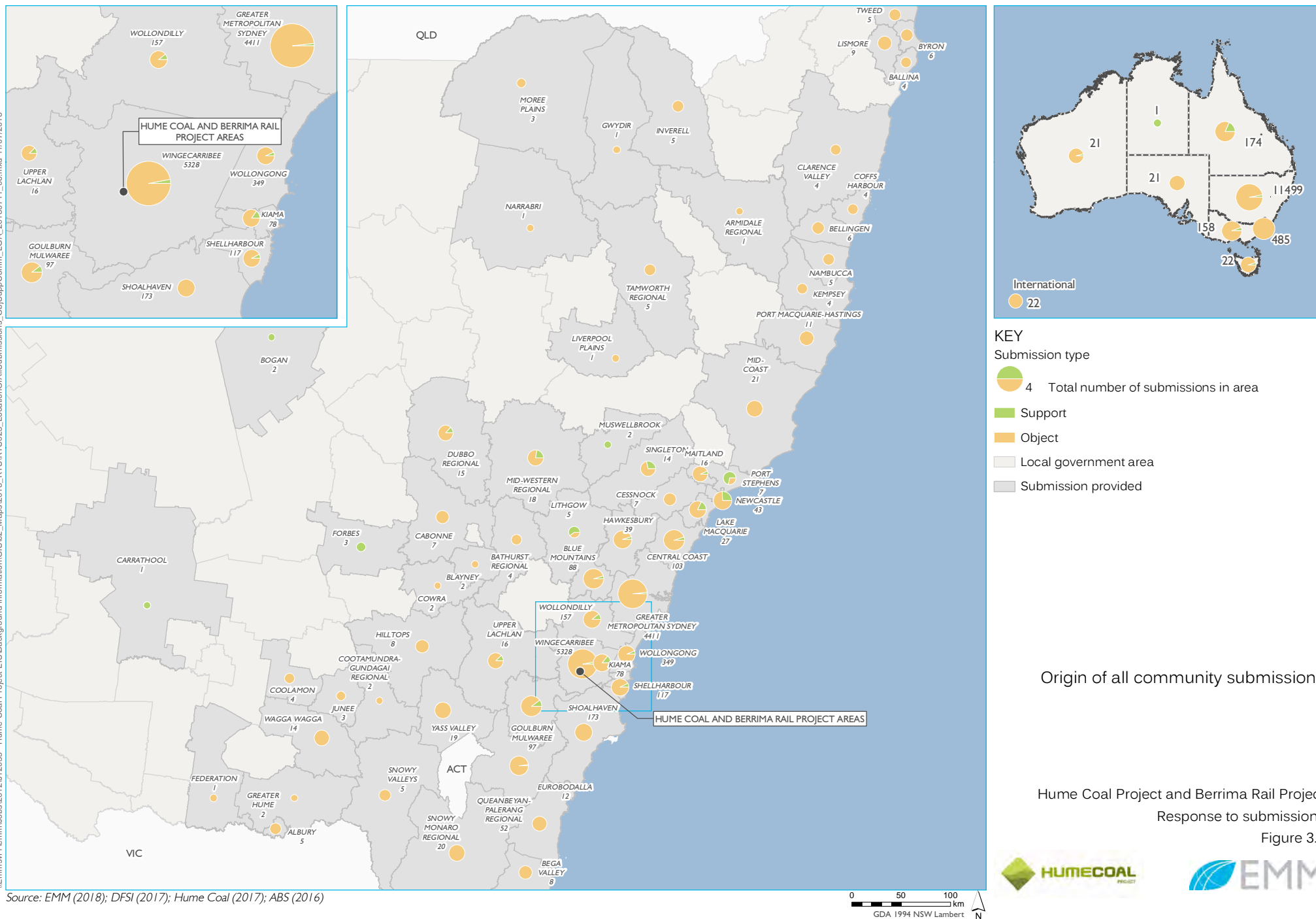
Figure 3.1



Source: EMM (2018); DFSI (2017); Hume Coal (2017); ABS (2016)



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3.5 Summary of matters raised

3.5.1 Objections

A summary of the matters raised in submissions objecting to the Hume Coal Project is provided in Table 3.3. The table shows the percentage of submissions in which each aspect was raised. The sum of the percentage column is greater than 100% because almost all of the submissions raised more than one matter. To show the influence of form submissions, statistics are presented for both the unique community submissions only, and with the form submissions included. The categories of matters raised are based broadly on the chapters in the EIS.

Table 3.3 Summary of matters raised by objectors – Hume Coal Project

Aspect	Unique community submissions		All community submissions	
	Quantity	Percentage	Quantity	Percentage
Other matters	520	66.84%	2273	33.12%
Groundwater	485	62.34%	5614	81.81%
Economic assessment	348	44.73%	4745	69.15%
Noise and vibration	314	40.36%	2624	38.24%
Surface water	312	40.10%	2709	39.48%
Social	263	33.80%	985	14.35%
Tourism	246	31.62%	567	8.26%
Legislation, planning instruments and policies	207	26.61%	528	7.69%
Health	162	20.82%	1014	14.78%
Visual amenity	156	20.05%	477	6.95%
Traffic and transport	151	19.41%	1904	27.75%
Greenhouse gas	149	19.15%	149	2.17%
Air quality	145	18.64%	2155	31.40%
Agriculture, land and soil resources	123	15.81%	2864	41.74%
Biodiversity	121	15.55%	121	1.76%
Mine design, subsidence and geology	113	14.52%	747	10.89%
Rejects management	94	12.08%	1760	25.65%
European heritage	80	10.28%	1132	16.50%
Closure and rehabilitation	55	7.07%	777	11.32%
Stakeholder engagement and community outreach	18	2.31%	18	0.26%
Aboriginal heritage	14	1.80%	14	0.20%
Water licensing	9	1.16%	9	0.13%

As shown, the most common category of issues raised in the unique submissions were classified as 'other matters', which included general objections to the project, broad objections to the coal industry in general, as well as corporate governance and the corporate reputation of Hume Coal/POSCO. The most commonly raised technical issues were potential impacts to groundwater, followed by matters related to the economic assessment, noise and vibration, and surface water. Matters relating to the social impacts of the project and potential impacts to the tourism industry were also commonly raised.

Once form submission are added, the most commonly raised issue was impacts to groundwater, followed by economic related matters, potential impacts to agriculture and soils, surface water, and noise.

A summary of the matters raised in submissions objecting to the Berrima Rail Project is provided in Table 3.4.

Table 3.4 Summary of matters raised by objectors – Berrima Rail Project

Aspect	Unique community submissions		All community submissions	
	Quantity	Percentage	Quantity	Percentage
Traffic and transport	115	76.16%	4743	93.70%
Other matters	84	55.63%	4337	85.68%
Air quality	77	50.99%	4043	79.87%
Noise and vibration	73	48.34%	4330	85.54%
Health	42	27.81%	325	6.42%
Legislation, planning instruments and policies	36	23.84%	319	6.30%
Economic assessment	35	23.18%	35	0.69%
Social	30	19.87%	30	0.59%
Visual amenity	29	19.21%	29	0.57%
Tourism	22	14.57%	305	6.03%
Groundwater	20	13.25%	20	0.40%
Surface water	19	12.58%	19	0.38%
Greenhouse gas	12	7.95%	12	0.24%
Biodiversity	10	6.62%	10	0.20%
Agriculture, land and soil resources	6	3.97%	6	0.12%
European heritage	6	3.97%	289	5.71%
Closure and rehabilitation	4	2.65%	4	0.08%
Stakeholder engagement and community outreach	1	0.66%	1	0.02%
Aboriginal heritage	0	0.00%	0	0.00%

As shown in Table 3.4, the most common issue raised relating to the Berrima Rail Project in the unique community submissions, as well as in the form submissions, were matters relating to traffic and transport (in particular the potential for increased waiting times at level crossings). Air quality and noise emissions were the next most commonly raised technical aspects, followed by health (generally relating to dust and noise emissions).

Over 11,000 form letter submissions were received on the Hume Coal Project and the Berrima Rail Project. The issues raised in each of the variations of form letters are broadly summarised in Table 3.5.

Table 3.5 Matters raised in the form letter submissions

Form letter	Number of submissions	Aspect raised
Hume Coal Project		
1	634	<u>Economics</u> : viability of the project and adequacy of the economic assessment <u>Rejects</u> : concerns over the proposed methodology of underground reject emplacement
2	2,010	<u>Economics</u> : potential impacts of the mine on the Southern Highlands economy, and economic return to NSW <u>Noise</u> : potential impacts locally on the villages of Berrima and Medway <u>Air quality</u> : dust from trains, coal handling equipment and diesel emissions <u>Visual amenity</u> : light spill
3	1,366	<u>Water resources</u> : impacts on groundwater (bores) and surface water (potential for release to Oldbury creek, and more broadly on the Sydney water catchment and achieving a neutral or beneficial effect), return of water underground
4	722	<u>Alternatives</u> : benefits of the 'do nothing' alternative relating to avoidance of

Table 3.5 **Matters raised in the form letter submissions**

Form letter	Number of submissions	Aspect raised
		<u>impacts</u> <u>Rehabilitation</u> : concerns around who will bear the costs of rehabilitation <u>Water resources</u> : maintaining security of resources <u>Health risks</u> : associated with dust and noise
5	300	<u>Water resources</u> : potential impacts on groundwater, privately owned bores and the Sydney drinking water catchment <u>Reject emplacement</u> : concerns over the proposed methodology of underground reject emplacement <u>Social</u> : claims relating to lack of community support for the project <u>Train movements</u> : concerns relating to coal dust and diesel emissions, and additional delays to vehicles at level crossings <u>POSCO's reputation</u> : claims relating to POSCO's international track record <u>Social</u> : impacts to health relating to uncertainty over the proposed mine <u>Economics</u> : potential impacts to the local economy
6	552	<u>Water resources</u> : potential impacts to the Sydney water catchment, and risks to groundwater and privately owned bores <u>Social</u> : claims relating to lack of community support for the project, and concerns relating to impacts to health due to uncertainty over the proposed mine <u>Health</u> : potential impacts from coal dust and diesel emissions <u>Train movements</u> : concerns relating additional delays to vehicles at level crossings <u>POSCO's reputation</u> : claims relating to POSCO's international track record <u>Heritage</u> : potential impacts to heritage areas <u>Agriculture</u> : potential impacts to local farm land <u>Economics</u> : potential impacts to the local economy
7	321	<u>Heritage</u> : potential impacts to the cultural landscape and heritage values of Berrima Sutton Forest and Exeter <u>Tourism</u> : concerns that the mine would deter visitors <u>Zoning</u> : compatibility with local zoning <u>Visual amenity</u> : concerns around potential impacts of surface infrastructure to public and private views
Form letter with comment	179	A number of the above form letters were provided with additional comments added
Berrima Rail Project		
1	2,259	<u>Scope of assessment</u> : inadequacy of the scope of the EIS in assessing the branch line and the Unanderra to Port Kembla line <u>Road over rail crossings</u> : risk associated with these crossings <u>Pedestrians</u> : risks to pedestrian traffic at road and pedestrian crossings <u>Noise and dust</u> : associated with train movements
2	1,543	<u>Train movements</u> : concerns relating additional traffic delays at level crossings
3	1,109	<u>Heritage</u> : impacts of the rail infrastructure on the cultural landscape <u>Zoning</u> : inconsistency with the E3 zone <u>Visual</u> : impacts on the visual landscape due to the rail bridge over the Old Hume Highway <u>Noise</u> : from elevated trains on the rail bridge over the Old Hume Highway <u>Health risks</u> : associated with noise and dust from train movements
Both projects		

Table 3.5 Matters raised in the form letter submissions

Form letter	Number of submissions	Aspect raised
5	17	Issues as per form letter 5 above (Hume Coal Project)
6	229	Issues as per form letter 6 above (Hume Coal Project)

3.5.2 Support

The individual community submissions received in support of the Hume Coal Project and the Berrima Rail Project predominantly raised the job creation and flow on economic benefits associated with the two projects as reason for support. In relation to the Hume Coal Project, approximately 64% raised the social benefits of the mine such as employment, as reason for support. Around 45% raised the economic benefits of the project. 35% of all supportive individual community submissions raised the low impact mine design as another reason for supporting the project.

A summary of the matters raised in submissions supporting the Hume Coal Project is provided in Table 3.6.

Table 3.6 Summary of matters raised by supporters – Hume Coal Project

Primary classification	Community submissions	
	Quantity	Percentage
Social	176	64.00%
Economic	126	45.82%
Mine design and geology	98	35.64%
Other matters	73	26.55%
Groundwater	41	14.91%
Legislation, planning instruments and policies	32	11.64%
Traffic and transport	22	8.00%
Visual amenity	21	7.64%
Air quality	19	6.91%
Noise and vibration	18	6.55%
Surface water	13	4.73%
Agriculture, land and soil resources	13	4.73%
Stakeholder engagement and community outreach	12	4.36%
Greenhouse gas	11	4.00%
Water licensing	6	2.18%
Closure and rehabilitation	6	2.18%
Tourism	6	2.18%
European heritage	6	2.18%
Biodiversity	5	1.82%
Aboriginal heritage	4	1.45%
Health	3	1.09%
Rejects management	1	0.36%

Submissions in support of the Berrima Rail Project also raised the economic and social benefits of the project as reason for support. The key matters raised in support of the Berrima Rail Project are summarised in Table 3.7.

Table 3.7 **Summary of matters raised by supporters – Berrima Rail Project**

Primary classification	Submissions (form and unique)	
	Quantity	Percentage
Economic assessment	35	24.31%
Traffic and transport	34	23.61%
Social assessment	28	19.44%
Other matters	20	13.89%
Mine design and geology	11	7.64%
Noise and vibration	9	6.25%
Legislation, planning instruments and policies	8	5.56%
Groundwater	6	4.17%
Air quality	6	4.17%
Biodiversity	5	3.47%
Visual amenity	2	1.39%
Surface water	1	0.69%
Agriculture, land and soil resources	1	0.69%
Closure and rehabilitation	1	0.69%
Tourism	1	0.69%
Aboriginal heritage	1	0.69%
Greenhouse gas	1	0.69%
Stakeholder engagement and community outreach	0	0.00%
Rejects management	0	0.00%
Water licensing	0	0.00%
Health	0	0.00%
European heritage	0	0.00%

4 Actions taken during and after EIS exhibition

4.1 Overview

This chapter describes the additional technical investigations commissioned by the Hume Coal Project team in response to both submissions received on the project after the public exhibition of the EIS, and questions from technical experts engaged by the DPE to review certain technical aspects (as described in Chapter 1). Stakeholder engagement activities that Hume Coal continued to undertake throughout and following the public exhibition period are also described.

The additional investigations undertaken included:

1. **Mine design** – two and three dimensional numerical modelling of the mine layout to provide a complementary and independent method of analysing mine stability and subsidence predictions. This included back analysis of key parameters to local observational data, parameter sensitivity analysis and scenario analysis.
2. **Water resources** –
 - c) revision of the groundwater model, surface water balance, and subsequent production of an updated water impact assessment (included as Appendix 2); and
 - d) purchase of additional groundwater licences (548 ML) on the open market and via controlled allocation.
3. **Aboriginal heritage** – additional test excavation of two potential archaeological deposits (HC_179 and HC_146).
4. **Biodiversity** – completion of an additional floristic plot to confirm plant community types (PCTs).
5. **Visual amenity and historic heritage** – production of additional photomontages relating to Mereworth House and Garden, as requested by the Heritage Council of NSW.
6. **Tourism** – preparation of a report on the tourism industry in the Wingecarribee LGA by Judith Stubbs and Associates (JSA) (JSA 2017a), including an investigation into the potential impact of the Hume Coal Project on this industry; and
7. **Property values** – similar to tourism, a report was prepared by JSA (2017b) on property values in the Wingecarribee LGA, including an investigation into the potential impact of the Hume Coal Project on these values.

The additional work undertaken on each of these aspects is summarised in the sub-sections below.

4.2 Mine design

The DPE engaged two technical experts in the field of mining engineering; Emeritus Professor Jim Galvin and Professor Ismet Canbulat, to review and provide comment on the underground mine design of the Hume Coal Project. As a result of these reviews, Hume Coal brought forward numerical modelling work that was planned to be undertaken in the pre-production planning phase of the project. This modelling provides a supplementary assessment of mine pillar stability and potential subsidence outcomes already contained in the EIS (EMM 2017a).

Dr Keith Heasley was engaged by MineAdvice (who completed the original subsidence assessment of the project) on behalf of Hume Coal to undertake this work using the numerical modelling software “LaModel”. Dr. Heasley was the developer, and is the primary proponent, of the LaModel program, and is therefore the pre-eminent expert in developing and analysing numerical models of coal mines using the LaModel program.

Dr Heasley is an Emeritus Professor at the University of West Virginia in the United States, and his CV is appended to his report.

Hume Coal has also continued to utilise the expertise of Professor Bruce Hebblewhite of the University of New South Wales for advice and guidance on geotechnical and mining-related matters throughout this process. Professor Hebblewhite first became involved with the project during risk assessment workshops of the mining system and bulkheads conducted in early 2015, and peer reviewed the EIS subsidence impact assessment and pillar stability assessment, which was authored by Dr Russell Frith of MineAdvice. It was Professor Hebblewhite that originally recommended undertaking 3D numerical modelling during pre-production planning, in order to understand the benefits that the third dimension may bring to the layout design.

The numerical modelling work for the Hume Coal Project was undertaken in five phases by Dr Heasley, as described below.

1. Confirmation of the model's characterisation of coal pillars: An exercise was conducted to confirm the validity of using the "coal wizard" model tool to characterise the pillars according to Mark-Bieniawski pillar strength formula. This involved comparing results from pillars characterised using this modelling tool to pillars characterised manually, according to pillar stress-strain curves based on observational data, prepared independently by MineAdvice. The results were practically indistinguishable.
2. Back analysis of key model parameters to observational data from the adjacent Berrima Colliery: The second stage involved a back analysis of the subsidence observations at Berrima Colliery to determine reasonable values for the overburden parameter.
3. 2D parameter sensitivity analysis: The third and fourth stages involved undertaking parameter sensitivity studies to understand the impact on mine stability of varying the overburden stiffness across three representative mining depths (80 m, 120 m, and 160 m).
4. 3D parameter sensitivity analysis: Similar to step 3, parameter sensitivity studies were conducted to understand the impact on mine stability of varying the overburden stiffness across three representative mining depths (80 m, 120 m, and 160 m). The results support the overall conclusions of the original pillar stability assessment in the EIS.
5. 3D scenario analysis: The scenario analysis was undertaken in order to understand the impact of potential localised instability on global mine stability. Two scenarios were analysed: the removal of the centre web pillar from the model; and the removal of all web pillars between a pair of intra-panel barrier pillars, to remove any stabilising influence that these pillars have on the broader pillar system.

The results of the numerical modelling work support the original assessment and demonstrate that even under extreme conditions, the mine design results in global stability and subsidence levels that are generally in accordance with the original EIS assessment criteria.

The outcomes of this work are discussed in more detail in Chapter 16.

4.3 Water resources

4.3.1 Overview

The DPE appointed Hugh Middlemis as the independent expert peer reviewer for the groundwater model. The review involved consultation between the regulator, the peer reviewer and the Hume Coal Project team, and subsequent audits and updates to the groundwater model.

In response to submissions received and the results of the expert review, the groundwater model was revised. Subsequently, the site water balance and surface water quality models and assessments were also revised. These revisions were undertaken following additional consultation with Water NSW. Also as a result of submissions, additional geochemical modelling was undertaken.

The revised modelling confirmed that changes were not required to the project, nor do the predicted impacts on water resources vary significantly, and in many cases not at all, from that presented in the EIS. The outcome is that the Hume Coal Project remains consistent with that described in the EIS, although there have been some modifications to how the impacts were assessed following receipt of submissions and consultation with relevant government agencies. The assessment modifications have been incorporated to provide a greater level of confidence in the model results and with consideration of ongoing Government consultation and expert independent peer review.

Minor changes were also made to the Berrima Rail surface water assessment as a result of submissions. Unless otherwise mentioned, all matters discussed with respect to the water assessment relate to the Hume Coal Project.

4.3.2 Consultation

Consultation on water related aspects following submission of the Hume Coal Project EIS are shown in Table 4.1.

Table 4.1 Water related consultation

Date	Objective	Attendees	Outcome
4 July 2017	Make good concept discussion	DPE: (David Kitto, Clay Preshaw and Paul Freeman) DPI: Mitchell Isaacs Hume Coal: Greig Duncan, Ben Anderson, EMM: Liz Webb	Hume and EMM confirmed groundwater would remain available for the licensed purpose of the relevant water bore. More detail about make good strategies has been included in this RTS report.
25 August 2017	DI Water submission discussion	DI Water: Mitchell Isaacs, Tim Baker, Greg Russell, Graeme White, Fabienne d'Hautefeuille, Andrew Drusneski, Hume Coal: Greig Duncan, Ben Anderson, Luke Edminson, EMM: Liz Webb Noel Merrick, Frans Kalf Posco: Patrick Yeou	Open discussion and clarification of issues raised by DI Water in their submission. Hume committed to undertaking a model audit and rework as per discussion and agreement at this meeting.
9 October 2017	Consultation and discussion on model details	Hugh Middlemis and Noel Merrick	Revised model subsequently tailored to ensure Middlemis' outstanding concerns could be addressed.
24 October 2017	Water NSW submission discussion	Hume: Luke Edminson, Ben Anderson, Alex Pauza, WSP: Rob Leslie, Leigh Doleman, EMM Coal: Liz Webb, Nicola Fry, WaterNSW: Girja Sharma, Neil Cowley, Malcolm Hughes, Maria Dubikova, Peter Dupen, Hemantha DeSilva	Focused on surface water quality and water management in dams (including the first flush). Hume to provide further details around potential water quality offsetting measures and black water treatment.
2 November 2017	Water NSW submission discussion	Hume Coal: Luke Edminson, Alex Pauza WaterNSW: Girja Sharma, Neil Cowley	Discussion on surface water quality and water management in dams

4.3.3 Summarised changes

The specific steps taken in response to the submissions and consultation as outlined above are summarised below:

- water risk assessment;
- additional presentation of baseline data;
- detailed audit of the numerical groundwater model;
- upgrade of numerical groundwater model software and coding package to provide more elaborate mathematical solutions;
- consideration and alterations made to the groundwater model based on relevant concerns raised by the NSW Government appointed independent peer reviewer and relevant government agencies;
- more detailed sensitivity analysis;
- detailed *Monte Carlo* uncertainty analysis (generally in accordance with the IESC guidelines (Middlemis & Peeters 2018));
- updated 'make good' landholder bore assessment (using revised groundwater model results);
- updated site water balance (using revised groundwater model results);
- updated surface water flow assessment (using revised groundwater model results and revised site water balance);
- black water treatment and irrigation concept prepared;
- potential offset areas for surface water quality identified;
- updated surface water quality assessment (using revised groundwater model results and revised site water balance); and
- additional geochemical modelling on potential groundwater quality impacts and pathways.

4.3.4 Groundwater modelling

The alterations to the groundwater model are described in detail in Chapter 8.6 of Appendix 2 (Revised Water Assessment Report). The additional modelling work was undertaken by Noel Merrick of HydroSimulations, and involved:

- a detailed model audit/verification;
- a model revision using a later version of MODFLOW-SURFACT with improved solvers;
- conversion to MODFLOW-USG (ie upgraded software and solvers, allowing use of time varying materials and pseudo-soil functions);
- additional sensitivity analysis (including wet and dry climate sensitivity); and
- detailed uncertainty analysis.

These model revisions and upgrades provided for a more realistic simulation of inflow to the mine and recovery of water levels following the completion of the Hume Coal Project.

Additional sensitivity analysis was conducted on;

- specific storages and specific yield;
- adoption of pseudo-soil function;
- drain conductance (1 order of magnitude); and
- vertical basalt barrier (effect of its presence/absence).

The Hume Coal Project EIS model predictions were based on average climate into the future. This is a defensible, standard and proper approach for predictive modelling to ascertain mining effects exclusive of potential climate effects. A groundwater model sensitivity was run as part of the groundwater model revision using cloud computing to allow multiple simultaneous processors to model a large number of climate sequences aligned to the surface water assessment, based on historical climate records. Model runs were also completed that used the 'wettest' and 'driest' climate scenarios, based on maximum and minimum average daily rainfall.

An extensive and detailed uncertainty analysis was conducted that is generally in accordance with the recently released draft IESC Explanatory Note for Uncertainty Analysis in Groundwater Modelling (Middlemis & Peeters 2018). This was undertaken using *Monte Carlo* simulation techniques and cloud computing to allow a large number of model runs to be completed in a reasonable timeframe. This work required new computer code to be written to allow the modelling and interpretation of results.

4.3.5 Make good assessment

The impact to landholder bores and the make good assessment was a key concern raised during the submissions process, by both the NSW Government, interest groups and the community. The focus of the concerns was the question on the ability for a project to be approved that resulted in 'more than minimal impact' (as defined in the NSW *Aquifer Interference Policy* 2012 (the AIP) (NOW 2012). The logistics of being able to physically 'make good' on groundwater level changes in bores was a key community concern.

The updated make good assessment (included as Appendix M of Appendix 2) is based on the results of the revised groundwater model, which has lead to minimal changes in the total number of landholder bores (from 93 to 94) predicted to experience drawdown . The updated assessment is more comprehensive than the original EIS *Hume Coal Project Water Assessment* report (EMM 2017c). It provides a staged approach to make good, and the level of detail provided for stage 1 is increased. All bores predicted to experience drawdown of 2 m or greater are assessed individually. Potential make good options specific to each individual bore are discussed, including timeframes for implementation of each stage. Ultimately, consultation will be required on an individual level with each landowner in order to agree on suitable, appropriate and tailored make-good measures based on individual circumstances and technical details.

The revised make good assessment considers:

- historical context for make good;
- the AIP guidance for assessment;
- revised groundwater model results from the uncertainty analysis;
- legal precedent; and

- NSW Government recommendations for additional detail at each individual bore, as outlined during consultation with DPE.

4.3.6 Revised site water balance

The water balance modelling undertaken for the Hume Coal Project EIS has been updated to include the revised groundwater inflow estimates from post-EIS numerical groundwater modelling undertaken by HydroSimulations. The groundwater inflows predicted by the revised numerical groundwater modelling are key inputs to the water balance. No other changes were made to the water balance model developed for the Hume Coal Project EIS (EMM 2017a). The water balance model base case adopts groundwater inflow estimates from the revised groundwater model.

Additional sensitivity analysis was also assessed relating to predictions of groundwater inflows based on average, wet and dry climate scenarios output from the groundwater model. This sensitivity analysis was undertaken to address matters raised in submissions from government agencies and demonstrates how insensitive the water balance model is with respect to the impact of changes in climate on groundwater inflows.

Details regarding the revisions of the site water balance model and the outputs are presented in Section 8.2 and Chapter 10 of Appendix 2.

4.3.7 Revised surface water flow assessment

The surface water flow assessment undertaken for the Hume Coal Project EIS has been updated to address matters raised in the submissions from government agencies and other stakeholders. The surface water flow assessment has also been updated to reflect post-EIS numerical groundwater modelling undertaken by HydroSimulations (2018).

The estimate of reductions to baseflow predicted by the revised numerical groundwater modelling is a key input to the surface water flow assessment. In addition, revised water balance model predictions of releases from stormwater basins (SB) 03 and SB04 to Oldbury Creek, following first flush, have been included in the surface water flow assessment.

Additional sensitivity analysis was also conducted for surface water flows, taking into account predictions of baseflow reduction during average, wet and dry climate scenarios output from the groundwater model. This sensitivity analysis was undertaken to address matters raised in submissions from government agencies to understand how sensitive the water balance model is with respect to changing climate.

Details regarding the revisions of the surface water flow assessment and the outputs are presented in Sections 8.3 and 10.1 of Appendix 2.

4.3.8 Revised surface water quality assessment

Work undertaken to update the water quality assessment is based on the result of the amended groundwater model and subsequent water balance and flow impact assessment changes, as well as modifications to the MUSIC (Model for Urban Stormwater Improvement Conceptualisation) modelling following suggestions raised during the submissions process for assessment of the project against the neutral or beneficial effect (NorBE) principles.

The following revisions have been made to the MUSIC modelling for the NorBE assessment of releases from stormwater basins to Oldbury Creek, of mine access roads, and the Berrima Rail Project railway line:

- altered time-series releases from SB03 and SB04 to Oldbury Creek to reflect the revised water balance model results;
- existing flows modelled as a combination of baseflow and storm flow;
- MUSIC model timestep changed from daily to 6-minutes; and

- alterations of MUSIC model parameters and proposed water quality treatment measures for the mine access roads assessment and the Berrima Rail Project railway line assessment.

An additional GoldSim mass balance analysis has been undertaken to allow for quantitative assessment of potential water quality changes associated with baseflow reduction, building on the baseflow reduction water quality assessment presented in the EIS.

Additional management measures of vegetation protection zones are included to offset potential water quality impacts associated with baseflow reduction.

An additional analysis has also been undertaken to assess potential water quality changes associated with coal dust deposition in surface water catchments.

Details regarding the revisions of the surface water quality assessment and the outputs are presented in Section 8.4 and 10.1.5 of Appendix 2.

4.3.9 Groundwater quality impacts and pathways

Additional geochemical modelling has been undertaken for the Hume Coal Project to address two issues raised in several submissions regarding predicting water quality evolution in the primary water dam (PWD) and the groundwater response to underground placement of rejects.

Several hydrogeochemical models were constructed in Geochemist's Workbench and PHREEQC to ultimately estimate the range of water qualities likely to exist in the PWD over the life of the mine and to determine the likely water qualities resulting from the placement of co-disposed reject (reject porewater and PWD water) into mined-out voids (panels) and the effect on groundwater systems.

Details regarding the additional geochemical modelling and the outputs are presented in Section 8.7 and 11.2 of Appendix 2.

4.3.10 Water licensing

The Hume Coal Project EIS (EMM 2017a) reported that the maximum volume of water licences required for the project would be 2,290.5ML/yr. At the time the EIS was completed in early 2017, Hume Coal had secured approximately 60% of this requirement. Since that time the numerical groundwater model has been revised, as described in Section 4.3.1, and the project's licence requirement has been updated accordingly. The total volume of water licences required for the project has subsequently reduced slightly as a result of the groundwater model revision and detailed uncertainty analysis, to 2,093 ML.

Hume Coal has continued to acquire water licences for the project on the open market and via controlled allocation, and has now secured in excess of 90% of the total project peak requirement. The groundwater licences contain a carryover provision for unused allocation equal to 10 percent of the licensable volume. The majority of water licences are required for the Sydney Basin Nepean Groundwater Source - Management Zone 1. Since the EIS was submitted, Hume Coal and its subsidiaries have secured an additional 518 ML in this water source, bringing the total to 1,909 ML, or 93% of the required component for this water source. In addition, 5 ML and 25 ML have been purchased in the Sydney Basin Nepean Groundwater Source - Management Zone 2 and the Sydney Basin South Groundwater Source, respectively. This demonstrates the capability to acquire all of the remaining necessary water licences on the open market.

Current licence volumes and required volumes are outlined in Table 4.2, including a comparison with the licences held at the time the EIS was submitted to the DPE in early 2017.

Table 4.2 Water access licence (WAL) requirements and Hume Coal owned licensed volumes

Water Source	WAL required (ML)	Volume of Hume Coal owned licence as at March 2017 (ML)	Volume of Hume Coal secured licence as at June 2018 (ML)	Required additional volume (ML)
Sydney Basin Nepean Groundwater Source - Management Zone 1	2,059	1,391	1,909	150
Sydney Basin Nepean Groundwater Source - Management Zone 2	8	0	5	3
Sydney Basin South Groundwater Source	7	0	25	-
Upper Nepean and Upstream Warragamba Unregulated River Water Source - Medway Rivulet Zone	19	31	31	-
Total	2,093	1,422	1,970	153

4.4 Aboriginal heritage

OEH's submission on the Hume Coal Project and the Berrima Rail Project recommended that additional archaeological test excavations be undertaken in an area of potential archaeological deposit (PAD), identified as HC_179. This site was identified during Aboriginal heritage surveys within the Hume Coal Project proposed disturbance footprint. The submission recommended that the test excavation be completed prior to project approval.

Additionally, OEH suggested that another PAD (HC_146) be considered for test excavation to "add rigour to the archaeological sensitivity model presented by EMM and also to mitigate the loss of the sites through contributions to further research". Site HC_146 was recorded as an area of PAD during Aboriginal heritage surveys for the Berrima Rail Project and was predicted to have low archaeological potential.

In response to OEH's submission, EMM completed a test excavation program covering the PADs HC_179 and HC_146. The overall aims of the test excavation program and reporting were to:

- determine whether Aboriginal objects occur at sites HC_179 and HC_146;
- characterise the archaeological deposits with reference to previous excavations completed for the Aboriginal Cultural Heritage Assessment;
- revise the assessments of significance for each site;
- revise the impact assessment for each site; and
- determine whether the previously proposed management measures presented in the Aboriginal Cultural Heritage Assessment (ACHA) (EMM 2017d and 2017q) were still appropriate for each site.

Aboriginal stone artefacts were recovered from each of the PADs, verifying the areas as archaeological sites. HC_179 is within an area of moderate archaeological sensitivity that was predicted to have an average artefact density of up to 14 artefacts/m². The test excavation results were in accordance with this prediction, finding an average artefact density of 13 artefacts/m². The recommendations for the management of this PAD therefore remain the same as was made in the ACHA prepared for the EIS (EMM 2017d), which is to undertake salvage excavation of the area because it will be impacted by the construction of a conveyor and storm management earthworks.

HC_146 is within an area of low archaeological sensitivity that was predicted to have an average artefact density of up to 2.7 artefacts/m². This artefact density was confirmed by the test excavation.

The full test excavation report is provided in Appendix 3.1.

4.5 Biodiversity

A meeting was held during the EIS exhibition period onsite in the Hume Coal Project area, between representatives of OEH, the Hume Coal Project team and the primary author of the Biodiversity Assessment Report for the Hume Coal Project (EMM 2017e). Following this meeting, OEH provided their submission on the Hume Coal and Berrima Rail projects.

In their submission, OEH requested clarification on the PCTs to be impacted by the Hume Coal Project. In response, an additional floristic plot was completed on 16 November 2017 by EMM ecologists in accordance with Section 5.3.2 of the *Framework for Biodiversity Assessment: NSW Offsets Policy for Major Projects* (OEH 2014). The vegetation mapping for patch 3 was also refined on this date. The purpose of the additional survey was to address OEH's comment regarding the re-classification of patch 3 (refer to Figure 5.2 of the Biodiversity Assessment Report (EMM 2017e)) to PCT 1191. Plot data collected during the survey is provided in Appendix 4.1 and a response to OEH's submission is provided in Section 13.1.1 of this report.

OEH's submission also referred to some minor miscellaneous inputs into the offset calculations that required rectification. These inputs related to the classification of PCTs mentioned above, minor updates to maps and calculator inputs and the re-classification of patches in low condition to moderate to good condition. The requested changes were made to the offset calculations for the Hume Coal Project and Berrima Rail Project, with revised calculations and credit reports provided in Appendix 4.2 and 4.3 respectively.

As described above in Section 4.3, the groundwater model was revised following the EIS exhibition period in response to queries from the technical experts engaged by the DPE to review the Hume Coal Project EIS and associated technical studies, as well as submissions received on the project. Accordingly; the assessment of potential impacts to groundwater dependent ecosystems (GDEs) was revised, finding no significant changes to the impacts predicted on GDEs to that predicted in the Hume Coal Project EIS (EMM 2017a). The revised GDE impact assessment is presented in Section 13.3.

4.6 Visual amenity and historic heritage

Mereworth House and Garden, which is listed in the *Wingecarribee Local Environmental Plan 2010* (LEP) as a local heritage item, is in the Hume Coal Project area. The garden is an intact work of renowned landscape architect Paul Sorensen. The Heritage Council of NSW raised concerns in their submission about the potential adverse impact of the Hume Coal Project surface infrastructure area on the view from the garden to the north and east. The Heritage Council therefore recommended that a number of views in and around Mereworth be accurately rendered and presented at least at A4 size as follows:

- the view from within Sorensen's Garden out to the north and east;
- the view to Mereworth House and Garden from the highest point on the original Mereworth drive; and
- the view to Mereworth House and Garden from the Old Hume Hwy parallel to the original drive, now disused.

Photomontages were produced for all of these views, with the exception of the view from within Sorensen's garden out to the east; because of the dense vegetation in place which provides an effective screen blocking views.

The additional photomontages supported the findings of the EIS. A similar view from the Old Hume Highway was assessed in the EIS (viewpoint 7), finding that the tree screen already planted along the highway will substantially screen the infrastructure from this viewpoint, reducing the significance of the potential visual impact from moderate to low, to low. In relation to the view from within the garden at Mereworth, the EIS identified that the construction of the surface infrastructure area will change some aspects of the Mereworth landscape and immediate surrounds (refer to Section 25.7.2) to the north and north-east. However, views from the house to the surrounding landscape are generally constrained by the perimeter plantings of Bhutan cypress and notably, the design of the garden is deliberately inward-looking.

The additional photomontages are presented and discussed further in Chapter 25, Section 25.7.

4.7 Tourism and property values

A number of submissions on the Hume Coal Project raised matters relating to the potential impact of the project on the tourism industry and/or property values in the region. In response, Hume Coal commissioned JSA to prepare two reports; one on the potential impacts of the project on tourism (JSA 2017a) and one on property values (JSA 2017b). The full technical reports are included in Appendix 5 and 6 respectively. Responses to key issues relating to property and tourism raised in submissions, using the outcomes of these two reports, are provided in Chapter 20 (economics – property values) and Chapter 23 (tourism).

4.7.1 Tourism

The JSA (2017a) report investigated four aspects relating to the tourism industry within the Wingecarribee LGA and the Hume Coal Project, as follows:

1. The extent of tourism related employment in the Southern Highlands compared to other relevant industry sectors, and the implications for the locality *should* there be significant negative impacts upon tourism and related employment. This involved an analysis of net impacts on tourism activity under a range of different scenarios.
2. The extent to which existing industrial uses are currently compatible with tourism in the locality surrounding the project area. This involved an analysis of the existing character and amenity of the Moss Vale-Berrima locality, including existing features of the 'industrial landscape' and land uses, their proximity and visibility from sensitive tourism receptors, and the level of current co-existence of these sectors.
3. The extent to which tourism-related activities are likely to be incompatible with the Hume Coal Project in the future. This involved consideration of the likely future amenity impacts in the locality as a result of the proposed mine on sensitive tourist receivers, such as visual, noise and air quality impacts.
4. The statistical relationship between mining and tourism employment more generally in NSW was also investigated, as well as observations from a relevant case study area, to supplement and test the conclusions from the above analysis.

Overall, JSA found that it was highly unlikely that the Hume Coal Project would have significant adverse impacts on tourism due to conflicts in land use considering the existing amenity of the Moss Vale-Berrima area, the proposed location of the surface infrastructure area, the current co-existence of general and heavy industrial uses and tourism uses in the New Berrima-Berrima locality, as well as statistical testing of this relationship at the NSW State level. JSA (2017a) found no statistically significant relationship between the presence of coal mining and either increases or decreases in tourism industries, both nationally and more locally across NSW LGAs.

4.7.2 Property values

The investigation by JSA (2017b) into property values in the region considered two primary questions:

1. The broad relationship between coal mining and property values, and whether increased levels of coal mining is associated with a decline in property values.
2. The impact of the Hume Coal Project on property values to date, and whether there has been a decrease in property values in the locality in recent times.

The full report by JSA is included as Appendix 6 with a summary of the key findings and the response to submissions relating to property values provided in Chapter 20 of this report. Broadly, the results of an analysis of median house prices across LGAs in NSW with an active coal mining industry, as well as locally around the project area, did not support claims of an adverse impact of coal mining on property values.

4.8 Stakeholder engagement

Chapter 4 of the Hume Coal Project EIS described the comprehensive stakeholder engagement program undertaken by Hume Coal throughout the preparation of the EIS. Hume Coal has been actively engaging with stakeholders since 2011 when its exploration program began. This engagement continued after the development application and accompanying EIS was submitted to the DPE, particularly during the public exhibition period, to facilitate effective communication of the EIS with stakeholder groups. A description of these engagement activities is provided below. Responses to submissions on stakeholder engagement are also provided in Chapter 7.

Hume Coal has continued to engage with local businesses and other non-government stakeholders, including through meetings with Austral Bricks, the Port Kembla Coal Terminal and Boral.

4.8.1 Community stakeholders

i Website

Hume Coal continues to maintain an informative and up-to-date website. The purpose of the website is to make information readily available in a format that is easily accessible, and to provide a means by which interested parties can make enquiries on the project and/or provide feedback. A selection of the information listed on the website includes information about Hume Coal's parent company POSCO, Hume Coal's charitable foundation, the assessment process the project is subject to, copies of media releases, community bulletins, key topic summaries and fact sheets, expression of interest for employment form, a 'frequently asked questions' section and answers, and copies of key applications and approvals received to date for the project, including the Site Verification Certificate application and the certificate issued by the DPE, mining lease applications, the Hume Coal Project EIS and the Berrima Rail Project EIS.

ii Radio Advertising

Hume Coal invested in local commercial radio advertising during the exhibition period with Radio 2ST Southern Highlands (102.9 FM), accompanied by advertising on Macarthur/Wollondilly C91.3 (91.3 FM) during the later stages of exhibition. Live interviews were held every Thursday on Radio 2ST to update the community on the project and the upcoming discussion forum on www.yoursay.humecoal.com.au, as well as to discuss any queries or issues regarding the project as they arose.

iii Engagement HQ (EHQ) 'Your Say'

This engagement tool was used during the public exhibition period to communicate key topics from the EIS; including groundwater, visual impact, noise and air quality, and could be accessed at yoursay.humecoal.com.au. Online discussion forums were also available through the platform. This form of communication allowed for communication of the technical components of the EIS throughout exhibition period. This platform was selected as it has been used by a range of government organisations in a number of community consultation programs.

iv Community office

The Berrima community office opened in May 2016 and operated four days per week, generally from 9 am to 5 pm. From 31 March 2017, it was opened five days per week throughout the exhibition period. It was also opened for the first few Saturdays during the exhibition period to allow additional opportunity for community members to drop in. Post exhibition of the EIS, the Berrima community office was open by appointment only, due to the limited demand for the facility. It re-opened five days a week in May 2018, ahead of lodgement of this Response to Submissions report.

v Fact Sheets

A series of factsheets, case studies and topic summaries were produced to provide simple summary information of key EIS findings. Over 100 copies of each fact sheet were printed and handed out at information sessions, as well as being provided to community groups and media outlets. Electronic versions are also available online through the Hume Coal website and the 'Your Say' website.

vi Social Media

Hume Coal's social media accounts are monitored and administered by Hume Coal staff. These social media platforms, particularly Facebook, receive a lot of traffic, and automatic moderation settings are employed to ensure explicit language is captured and hidden from public comment trails. Hume Coal staff continued to actively engage with the community on Facebook during the exhibition period, aiming to respond to messages within 48 hours and on a case by case basis.

vii Information Sessions

Hume Coal held community information sessions at both the Mittagong RSL Club and at the Mereworth property during the EIS exhibition period. Eight information sessions were held across weekends and week days (two at Mittagong RSL and the remainder at Mereworth), with a total of approximately 200 community members attending these sessions. The information sessions were attended by Hume Coal staff as well as some of the EIS technical experts to answer questions about technical aspects of the project and the impact assessments.

4.8.2 Government stakeholders

A number of meetings have been with government agencies to discuss their submissions on the Hume Coal Project and the Berrima Rail Project and related matters. Engagement has been undertaken with:

- NSW Department of Planning and Environment
- NSW Office of Environment and Heritage
- NSW Department of Industry – Lands and Water
- WaterNSW
- Wingecarribee Shire Council

In addition, Hume Coal has contacted Transport for NSW (TfNSW) and Sydney Trains by phone in response to the submission by TfNSW.

Dr. Gang Li (Principal Subsidence Engineer and Senior Inspector, Mine Safety Operations at DRE) also conducted a site visit on 13th September 2017. This site inspection included an inspection of selected surface and subsurface features. Hume Coal also provided a briefing on the following aspects of the project:

1. Proposed mine design (ie method of extraction, mine layout and dimension).
2. Site conditions (such as the cover depths, lithological and geotechnical characteristics of the overburden, roof and floor, geological complexities and old workings).
3. Surface and sub-surface features.



Part B

Revised Water Assessment

Chapter 5: Revised water assessment



5 Revised water assessment

As described in Chapter 4, a revised water assessment has been prepared for the project based on the updated groundwater model and other minor revisions and/or additions to the surface water assessment and groundwater quality assessment. The results of the revised assessment are not substantially different to what was presented in the EIS. This chapter provides a summary of the revised water assessment report, which is attached in Appendix 2. The technical studies prepared as input to the overarching water assessment are appended to that report. Minor changes to the Berrima Rail Project Water Assessment (relating to the water quality assessment) are also discussed. Unless otherwise mentioned, all matters discussed in this chapter relate to the Hume Coal Project.

5.1 Assessment overview

The Revised Water Assessment (Appendix 2) replaces the Water Impact Assessment prepared for the Hume Coal Project EIS (EMM 2017a). The revised water assessment is required as it addresses rework associated as a result of submissions on the original EIS.

The Revised Water Assessment documents the groundwater and surface water assessment methods and results, the initiatives built into the project design to avoid and minimise water associated impacts, and the additional mitigation and management measures proposed to address residual effects. The assessment also considered in great detail the uncertainty associated with the water resources of the greater area, and natural climatic variability. The assessment has been made in accordance with relevant NSW and Commonwealth guidelines and the Environmental Assessment Requirements (SEARs) issued by the Secretary of the DPE for the Hume Coal Project (the project) and supplementary SEARs both issued on 20 August 2015.

The water assessment was undertaken by a team of leading specialists and a number of technical reports that have been appended to Appendix 2 for reference, namely:

- the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018), which contains:
 - the revised water balance and the EIS *Hume Coal Project Water Balance* report (WSP PB 2016a);
 - the revised flow assessment and the EIS *Hume Coal Project Surface Water Flow and Geomorphology Assessment* report (WSP PB 2016c);
 - the revised surface water quality assessment and the EIS *Hume Coal Project Surface Water Quality Assessment* report (WSP PB 2016b);
 - the EIS *Hume Coal Project Flooding Assessment* report (WSP PB 2016d); and
 - the *Berrima Rail Project EIS Surface Water Assessment* (WSP PB 2016f).
- the *Hume Coal Project Revised Groundwater Modelling* report (HydroSimulations 2018), which contains:
 - the *Hume Coal Project Groundwater Assessment Volume 1: Data Analysis* (Coffey 2016a); and
 - the *Hume Coal Project Groundwater Assessment Volume 2: Numerical Modelling and Impact Assessment* report (Coffey 2016b).
- the EIS *Hume Coal Project Hydrogeochemical Assessment* report (Geosyntec 2016).
- the *Hume Coal Project Hydrogeochemical Modelling Assessment* report (RGS 2018).

The proposed project life is 23 years, with active mining occurring over 19 years. Hume Coal has adopted a number of leading practices in mine design such that it will minimise impacts to water assets. Extensive technical investigations have taken place over several years to develop and refine the project, and arrive at the proposed design. The key leading practices adopted to minimise impacts to water resources and related assets are:

- innovative and tailored non-caving mine design (resulting in imperceptible levels of subsidence);
- underground emplacement of reject (which removes the need for permanent surface stockpiles); and
- sealing mined panels, and filling with water (which allows groundwater to recover more rapidly).

The project area is proposed in a semi-rural setting, with the wider region characterised by grazing properties, small-scale farm businesses, natural areas, forestry, scattered rural residences, villages and towns, industrial activities such as the Berrima Cement Works and Inghams Berrima Feed Mill, some extractive industry and major transport infrastructure such as the Hume Highway.

There is a long history of mining in the Southern Coalfield, including mining for coal, iron ore, bauxite, gold, diamonds, shale, sand, clay and kerosene shale. There is also a history of hard rock quarrying in the area, including basalt quarries at Exeter and Mount Gingenbullen as well as the heritage-listed dimension stone quarry at Mount Gibraltar. Mining still occurs at various locations within Wingecarribee Shire LGA, including the Dendrobium longwall coal mine in the shire's north-east. Deposits of potentially commercial bauxite are known to occur in the south of the shire.

The project is within the Southern Coalfield of the sedimentary Permo-Triassic Sydney Basin. The Triassic Ashfield Shale outcrops over much of the eastern part of the project area while the Triassic Hawkesbury Sandstone outcrops over much of the western part (Moffit 1999). Mining is proposed in the Wongawilli Coal Seam of the Permian Illawarra Coal Measures which directly and unconformably underlie the Hawkesbury Sandstone in the project area.

5.2 Local water resources

The surface water and groundwater sources near the project area are within water sharing plans and therefore most aspects of project water management come under the *Water Management Act 2000*. However, licensing monitoring bores is regulated under the *Water Act 1912*.

The project area and A349 are mostly within the Wingecarribee River catchment of the Upper Nepean and Upstream Warragamba Water Source, which is managed under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. A small portion of the south-east corner of A349 is within the Bundanoon Creek catchment, a sub-catchment of the Shoalhaven River catchment (WSP PB 2016c), and this is still managed under the same water sharing plan.

The groundwater resources of the project area are within Nepean Management Zone 1 of the Sydney Basin Nepean Groundwater Source, which is managed under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*.

The project area is traversed by several drainage lines all of which ultimately discharge to the Wingecarribee River, at least 5 km downstream of the project area. The Wingecarribee River's catchment forms part of the broader Warragamba Dam and Hawkesbury-Nepean River catchments, which supply water to Sydney. Most local drainage lines are classified as 'confined valley setting with occasional floodplain', under the River Styles Framework.

The groundwater units within the project area are defined as:

- localised low permeability groundwater systems associated with the Robertson Basalt and Wianamatta Group shales;
- regional porous fractured rock groundwater system located in the Hawkesbury Sandstone; and
- localised water bearing zones associated with the Illawarra Coal Measures and the Shoalhaven Group.

The Hawkesbury Sandstone is the main groundwater bearing unit used for water resources in the project area. Groundwater within the Hawkesbury Sandstone is generally fresh with varying bore yields (the median bore yield of registered bores in the area is 2 L/s).

Streams in the area are mostly 'gaining' streams with groundwater providing stream baseflows. Recharge to the groundwater system is via rainfall infiltration. Lateral groundwater flow dominates with regional flow influenced by the regional topography (ie incised streams to the north-west) and the general dip of the strata to the east. Faults and igneous intrusions can operate as both barriers and conduits to flow on a local scale; however, they do not appear to influence groundwater flow on a regional scale.

Water quality is mostly good in both groundwater and surface water systems. Surface water is generally fresh, but has elevated salinity when associated with the shale geology. Elevated nutrients are associated with agricultural practices and town effluent discharges, and elevated metals are associated with the geology, which is naturally high in some metals such as iron and manganese. Medway Dam is prone to algal blooms as a result of the high nutrient loads. Groundwater is relatively fresh in the Hawkesbury Sandstone and Illawarra Coal Measures and mostly comparable to surface water. The shale geology hosts brackish groundwater remnant from the marine depositional setting.

5.3 Mining methods and water management

A non-caving mining layout will be adopted, with mining occurring sequentially in panels that are separated from each other by solid barriers of unmined coal. The proposed method is low impact with negligible surface and subsurface subsidence impacts. Once mined, the open voids will be used for the emplacement of reject materials left over from washing raw coal.

After mining is complete, each panel will be sealed with an impermeable bulkhead and water will be allowed to flow into the sealed panels, resulting in a decreased volume of groundwater inflow to the workings and faster recovery post-mining. Once mining ceases (end of year 19) groundwater inflow to the void is expected to continue for two to five years (ie until all panels are full at the end of year 24) (HydroSimulations 2018). Water in the void will be part of the greater groundwater source and will be available for others to use.

The water management objectives are to minimise disturbance to water resources; runoff will be diverted from undisturbed areas, collected and reused, and releases minimised. This will be achieved via a series of mine water dams and stormwater basins. Water supply for the project will be fully self-contained by using:

- rainfall-runoff stored in the mine water dams;
- groundwater collected in the underground mine sump (where groundwater inflow to underground workings will be captured); and
- when required, groundwater will be extracted from behind the sealed mine void bulkheads.

The volume of water required to be licensed for the project is defined within the Aquifer Interference Policy (NOW 2012) as the groundwater inflow to the sump that is physically extracted, plus the groundwater inflow to the void, even though the majority of the groundwater in the void remains physically within the groundwater source, and the resulting flux of water from adjacent water sources.

5.4 Monitoring network

A water monitoring network has been designed and implemented to establish comprehensive baseline data for the project. The surface water monitoring network measures hydrologic conditions in the project area, providing up to six years of baseline data (2012–2018, inclusive) progressively across 11 streamflow gauging locations and 24 water quality monitoring locations as they were installed.

Up to five years of baseline hydrogeological data have been collected at 54 groundwater monitoring bores at 22 locations, 11 vibrating wire piezometer sensors at three locations, and three landholder bores. The network was developed in consultation with the NSW Department of Primary Industries (DPI) Water (formerly NSW Office of Water) and documented in the Hume Coal Project Groundwater Monitoring and Modelling Plan (EMM 2017f).

A diverse range of hydraulic tests have been made to provide site-specific information on the hydraulic properties of the groundwater systems, including rising and falling head tests (slug tests), packer tests, laboratory core permeability tests and constant rate pumping tests (WSP PB 2016e).

There are no identified high-priority groundwater dependent ecosystems (GDEs) within or proximate to the project area. Stygofauna sampling assessed 19 groundwater monitoring bores (eight within the project area and 11 outside of the project area) in 2013 and 2014 (EMM 2017e), and no rare or significant stygofauna was found. Stygofauna are fauna that live in underground water. They are mainly crustaceans but include worms, snails, insects, other invertebrate groups, and, in Australia, two species of blind fish. Most species spend their entire lives in groundwater.

5.5 Assessment and findings

Numerical modelling and analytical techniques have been used in this assessment to develop the site water balance, investigate potential changes in the extent of flooding, and predict quantity and quality changes in groundwater and surface water resources. As stated in Chapter 4, some revisions to the models used in the assessment have been made following receipt of submissions on the EIS.

Assessment of the project considers the NSW Aquifer Interference Policy, the Commonwealth Department of Environment *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources* (DoE 2013) and the *Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals* (IESC 2015). In addition the principles of Neutral or Beneficial (NorBE) impact on water quality have been adopted.

Although revisions have been made, the overall results of the assessment essentially remain similar to what was presented in the EIS. The possible predicted effects and assessed significance are:

- flow and yield changes for users and the environment – **insignificant** (refer to Section 10.1 and 10.5 of Appendix 2);
- stream bank erosion and geomorphology changes – **insignificant** (refer to Section 10.5.1 of Appendix 2);
- surface water quality changes – **insignificant** (refer to Section 10.2 of Appendix 2);
- flooding – **insignificant** (refer to Section 10.3 of Appendix 2);
- **no impacts** predicted for GDEs (refer to Section 11.4 of Appendix 2);
- effects on ecosystems that potentially use groundwater – **insignificant** (refer to Section 11.4 of Appendix 2);
- reductions to baseflow – **insignificant** (refer to Section 10.1, 10.5 and 11.1.3 of Appendix 2);
- surface water quality changes due to coal dust deposition – **insignificant** (refer to Section 10.2.3 of Appendix 2);

- water quality changes for private landholder bores – **insignificant** (refer to Section 11.2 of Appendix 2); and
- drawdown on private landholder bores – **significant** (refer to Section 11.1.2 and 11.4.3 of Appendix 2).
- All possible predicted impacts that are assessed as insignificant are discussed in further detail in the relevant sections of Appendix 2 as noted above and not discussed in this chapter further. The possible predicted effects assessed as significant (drawdown on private landholder bores) are summarised below.

5.6 Drawdown in landholder bores

Predictive simulations were used to quantify the potential impact for registered landholder bores. Impacts to landholder bores have been assessed against the AIP minimal impact requirements of a maximum 2 m decline cumulatively at any water supply work for 'post-water sharing plan' variations.

The predicted bore water levels at each bore over time are plotted in hydrographs in Appendix M of Appendix 2. Table 5.1 summarises drawdown statistics for the landholder bores predicted to be affected by the project and compared to the results presented in the EIS for reference.

Table 5.1 Landholder bores – summary of drawdown statistics

	Revised assessment	EIS
Number of bores impacted	94 ¹	93 ¹
Maximum drawdown range	2–47 m	2–80 m
Median maximum drawdown	6 m	12 m
Number of landholders (properties) with impacted bores	72	71
Average time for a bore to recover by 75% since impact begins	20 years	23 years
Time until all impacted bores recover, after mining starts	76 years	72 years

Notes: 1. Not including bores located on properties owned by Hume Coal.

The majority of the impacted bores (79%) are predicted to experience a maximum drawdown of less than 15 m. The magnitude and timing of the drawdown at each bore depends on its location and depth with respect to the mine workings. Shallower and/or remote bores are predicted to experience smaller drawdown than deeper and/or closer bores. For example, the maximum project drawdown in a bore is 46.7 m, and this is for a deep bore, very close to the mine workings.

With reference to the AIP assessment criteria, 94 landholder bores (not including bores owned by Hume Coal) on 72 properties are predicted to be subject to a project drawdown of 2 m or more (Figure 5.2), which triggers the Level 2 AIP criteria, of 'greater than minimal impact'. This has triggered additional assessment of the model predictions for each individual bore, as required by Section 3.2 of the AIP. This additional work (as required by the AIP) is presented in Appendix M of Appendix 2.

Nine bores are predicted to be potentially intercepted by mining due to their location being either in the rock within the immediate roof of the mine workings or through the coal seam itself, within the mining footprint. A histogram of the maximum project drawdown for the landholder bores is shown in Figure 5.1. The median project drawdown is predicted to be 6 m and the median duration of drawdown on the 94 affected bores is 46 years, with the maximum duration being 65 years.

The results of the 'make good' assessment are included in Appendix M of Appendix 2. All bores predicted to experience a drawdown of 2 m or greater will be subject to 'make good' measures from Hume Coal to account for the potential impacts on bores. About a third of these bores may incur additional operational costs associated with a lower groundwater level and will not require any further measures (ie will not require bore pump intake deepening or replacement). Another third are assessed as potentially needing submersible pump intake depths repositioned for a certain period of time depending on the duration of drawdown. The final third are assessed as potentially requiring bore replacement or an alternative source of supply.

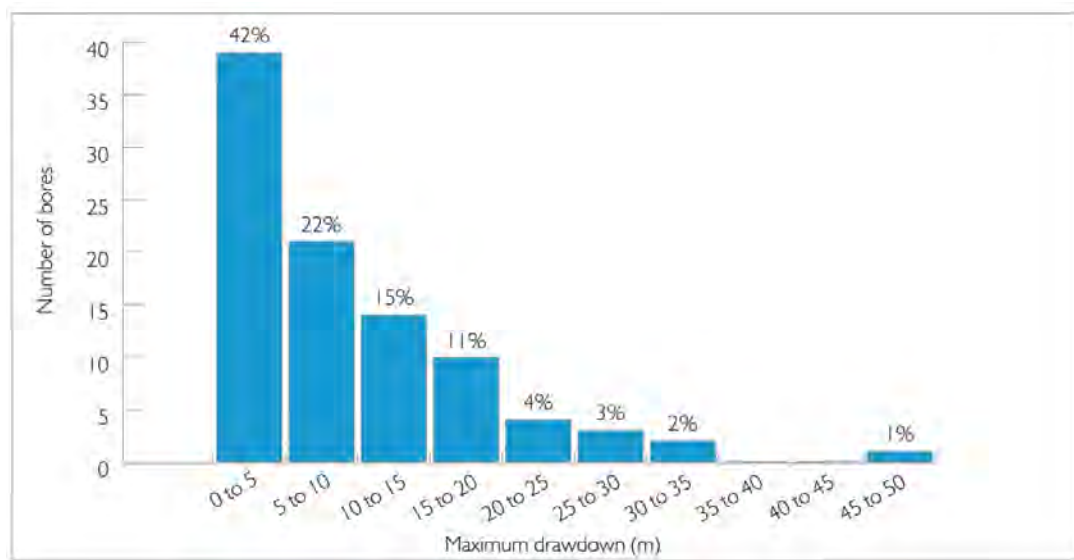


Figure 5.1 Maximum drawdown on landholder bores

With regard to the AIP requirements in relation to groundwater quality, the project activities will not result in a lowering of the beneficial use category of the groundwater source beyond 40 m from the activity, provided the mitigation measures discussed in the Section 13 of Appendix 2 are implemented. Cumulative impacts to groundwater quality are not anticipated as a result of mining activities.

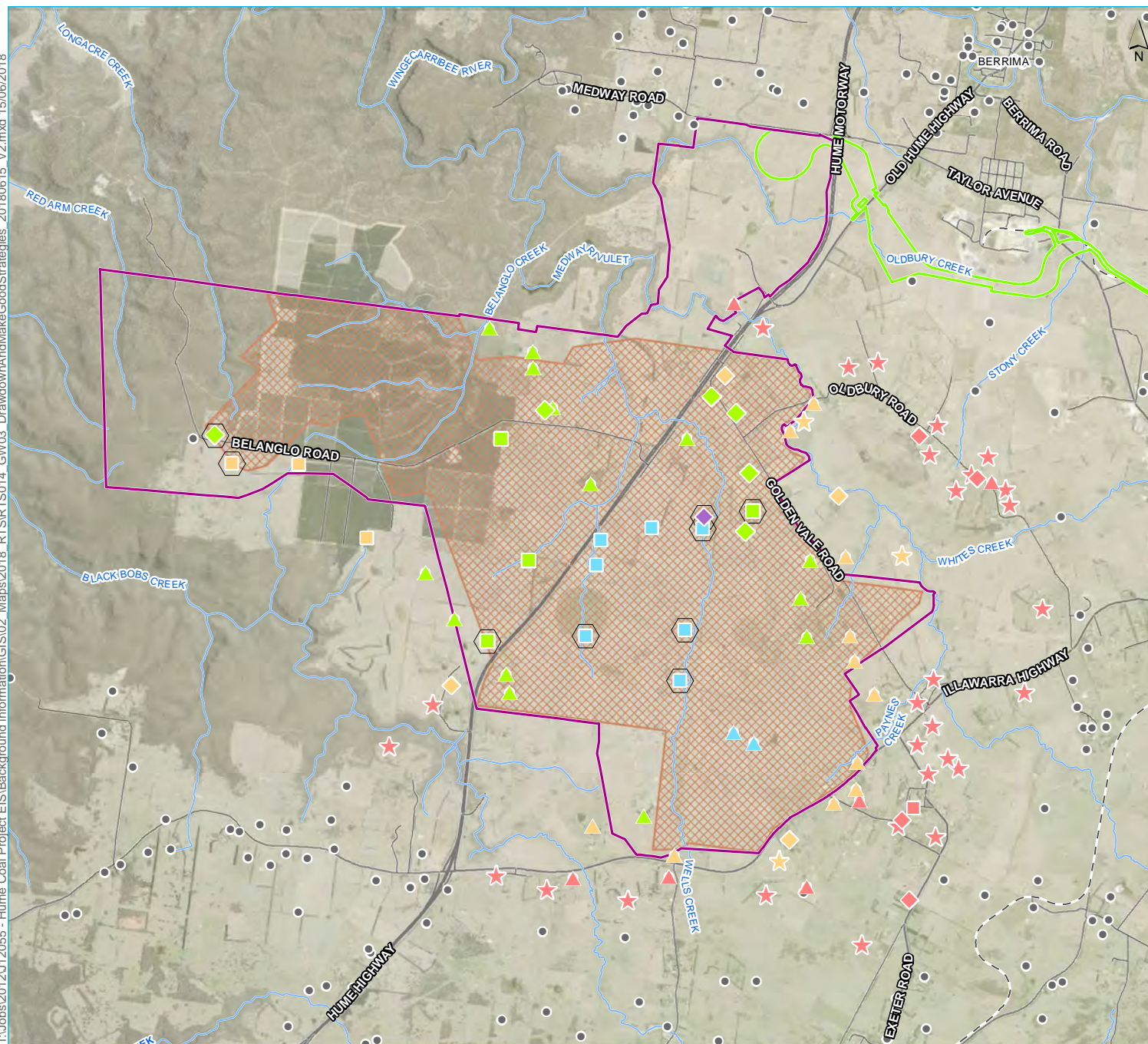
For implementation of make good in landholder bores, a staged approach will be adopted. The timing of when the drawdown exceeds the AIP Level 2 at each of the 94 bores predicted varies depending on the depth of the bore and its proximity to the mine area.

Table 5.2 presents the distribution of bores predicted to be impacted within 5-year stages. Bores identified in Stage 1 are bores predicted to be first affected by 2 m drawdown within the first 5 years of mining; Stage 2 bores are bores predicted to be first affected within 5-10 years of mining, and so on.

The make good process for each subsequent stage will be implemented every subsequent 5-year period in order for each bore to be incorporated into the make good process prior to the Level 2 impacts occurring. The spatial distribution of the make good bores within each stage is summarised in Figure 5.3.

Table 5.2 Make good bores within individual stages

Stage	1	2	3	4	5	6	Total
Time when bore first impacted by 2 drawdown	0-5 yrs	5-10 yrs	10-15 yrs	15-20 yrs	20-25 yrs	+25 years	
Make good provision							
1. increased pumping costs	-	3	7	9	5	7	31
2. deepen pump	6	9	13	3	2	-	33
3a. replace a stock / domestic bore	5	4	2	2	1	1	15
3b. replace an irrigation bore	5	8	1	1	-	-	15
	16	24	23	15	8	8	94



KEY

- Hume Coal Project area
- Berrima Rail Project area
- Underground mining area

Maximum drawdown (m)

- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 40
- 40+

Make good provision

- ★ 1. increased pumping costs only
- ▲ 2. deepen pump
- 3a. replacement bore (stock / domestic)
- ◆ 3b. replacement bore (irrigation)
- Bore to be intersected by mining
- Non-affected bores

Existing features

- Main road
- Local road
- Drainage line
- - Rail line

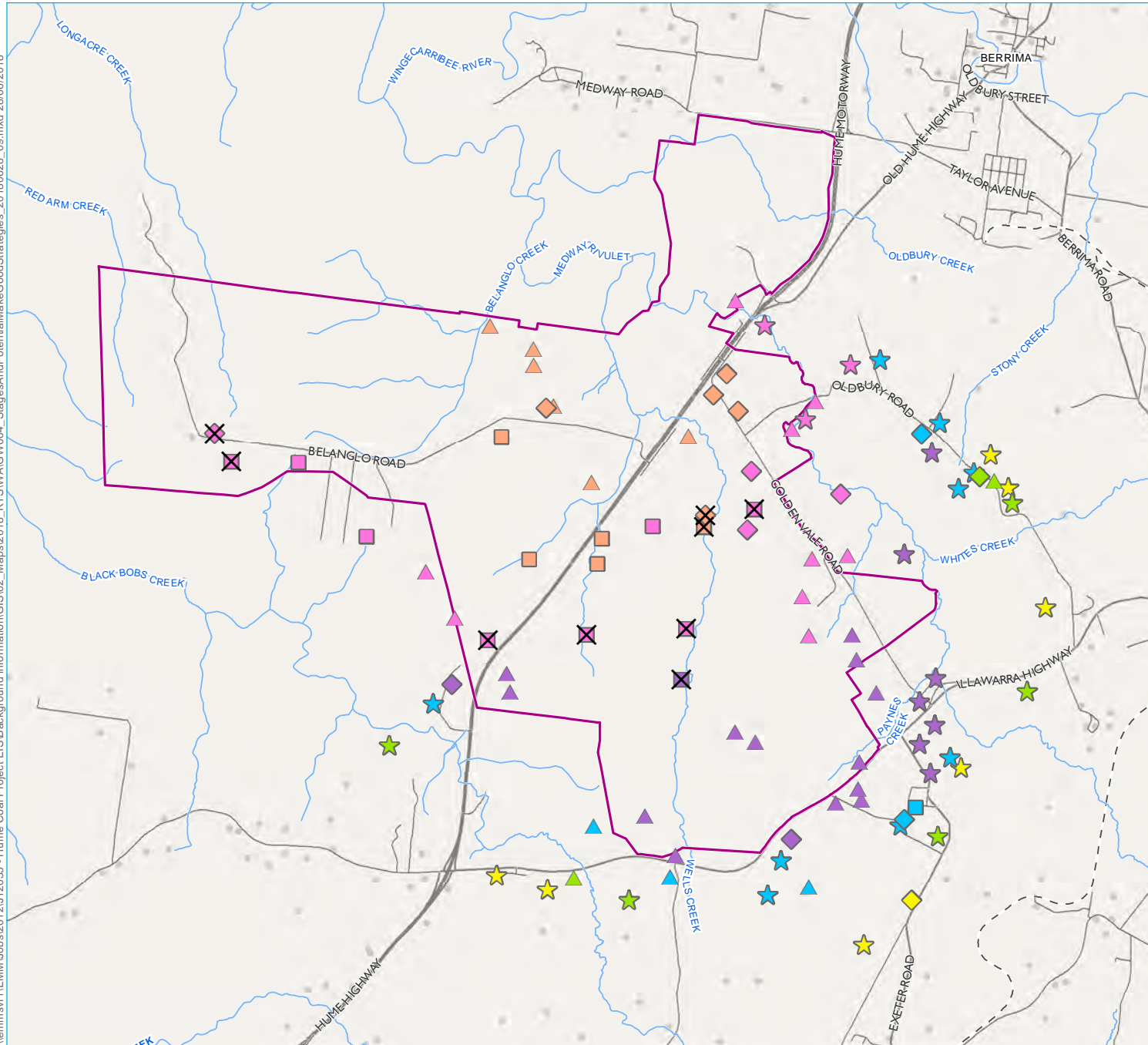
Project drawdown and proposed
make good provisions

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 5.2



\\lemmsvr1\EMM\Jobs\2012\J12055 - Hume Coal Project EIS\Background Information\GIS\02_Maps\2018_RTS\WAGW004_StagesAndPotentialMakeGood\Stages_20180628_09.mxd 28/06/2018



KEY

 Hume Coal Project area

Make Good stage

- Stage 1 impact observed <5 years
- Stage 2 impact observed 5-10 years
- Stage 3 impact observed 10-15 years
- Stage 4 impact observed 15-20 years
- Stage 5 impact observed 20-25 years
- Stage 6 impact observed 25+ years

Make good provision

- ☆ 1. increased pumping costs only
- △ 2. deepen pump
- 3a. replacement bore (stock / domestic)
- ◇ 3b. replacement bore (irrigation)
- ✕ Bore to be intersected by mining
- Non-affected bores

Existing features

- Main road
- Local road
- Drainage line
- - Rail line

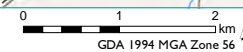
Stages of make good bores

Hume Coal and Berrima Rail Project
Response to submissions

Figure 5.3



Source: EMM (2018); DFSI (2017); Hume Coal (2017)



5.7 Licensing

5.7.1 Modelled water inflows

Modelled groundwater inflow to the sump (active mine area) and the sealed void are illustrated in Figure 5.4. The volume of inflow to the active mining area (ie water that is physically taken) is represented in blue in Figure 5.4. The majority of groundwater that inflows into the sealed void remains within the groundwater source and is not physically taken – this is represented in white on Figure 5.4. A small volume of the inflow to void will be harvested in some years to make-up operational water supply in those years.

The volume of inflow predicted in the revised assessment is very similar to what was presented in the EIS. For example, the average yearly inflow to the mine sump is 463 ML/yr and 798 ML/yr to the sealed underground void in the revised assessment; while the EIS presented the average yearly inflow to the mine sump as 440 ML/yr and 1,157 ML/yr to the sealed underground void.

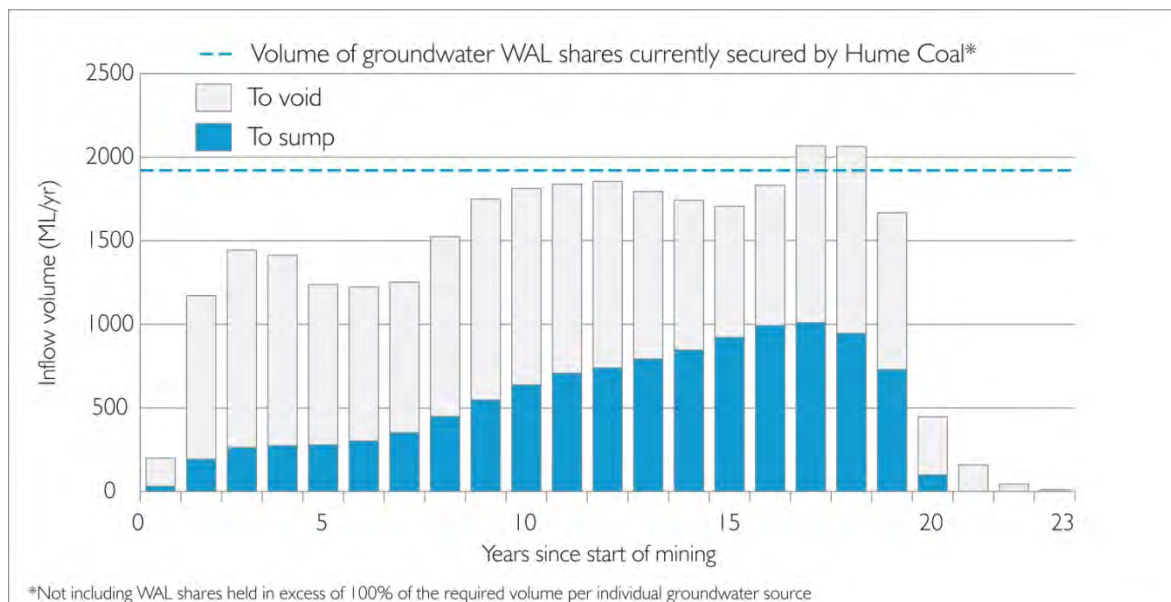


Figure 5.4 Expected inflow volumes over active mining and refilling of voids

i Source of water

Water that inflows to the mine sump and void is mainly sourced from the Nepean Management Zone 1 of the Sydney Basin Nepean Groundwater Source. By the end of year 23 there is no additional groundwater take occurring from within Zone 1. However, there is minor throughflow from Sydney Basin Nepean Management Zone 2, the Sydney Basin South Groundwater Source, and induced leakage from surface water.

ii Intercepted baseflow and induced leakage

Baseflow is the component of streamflow that is groundwater. Baseflow is defined as a withdrawal of groundwater from storage and is part of groundwater recession inflow to the stream (Domenico & Schwartz 1990).

The groundwater table (which in many areas is perched) in the project area is generally higher than the beds of intersected streams for most of the stream length and for most of the time. Hence, the streams in the project area are generally classified as gaining streams and receive baseflow from groundwater. In much of the project area the drainage lines are also considered ephemeral. Ephemeral streams are defined as those streams that do not flow continuously year round, and mainly flow following rain.

Although most streams are classified as gaining, it is important to note that many are gaining from shallow perched or interflow groundwater which is disconnected from the regional groundwater table, while others are gaining from the regional water table.

For the Hume Coal project, most streams are classified as gaining streams which continue to be gaining streams throughout the project (ie even after the regional groundwater table is lowered). This is due to many streams overlying perched shallow groundwater systems that are not affected by the regional water table. The main exception is Medway Dam, which temporarily transitions from a gaining to a losing system during mining (likely due to the artificial elevation of the water surface).

iii Approach to licensing

Aligned with the NSW Government AIP Fact Sheet 3 (NOW 2013a) that describes in detail the licensing of water, the project will licence:

- intercepted groundwater as groundwater;
- intercepted baseflow as groundwater; and
- leakage from surface water sources as surface water.

This is also in accordance with the Water Management Act, which requires water taken by mining to be licenced at its source. This source of baseflow is groundwater.

5.7.2 Required licence volumes

The project's mining method progressively seals off the mine void from the active mine workings with bulkheads, so most groundwater that would have otherwise flowed into the mine is not extracted and pumped to the surface, but physically remains in the groundwater source and is available to other groundwater users.

The volume of water required to be licensed for the project is defined as the groundwater inflow to the sump that is physically handled by the mine's water management system, plus the groundwater inflow to the void, even though the majority of the groundwater in the void remains physically within the groundwater source.

Based on the results of the numerical groundwater model (HydroSimulations 2018), the water balance model (WSP 2018), and the localised model of Medway Dam, the maximum volume required for licensing is 2,093 ML/yr, and for each individual source is:

- Nepean Management Zone 1 Sydney Basin Nepean Groundwater Source 2,059 ML/yr in year 17;
- Nepean Management Zone 2 Sydney Basin Nepean Groundwater Source 7.1 ML/yr in year 25;
- Sydney Basin South Groundwater Source 6.5 ML/yr in year 72; and
- Medway Rivulet Management Zone of the Upper Nepean and Upstream Warragamba Water Source, 19 ML/yr in year 21.

These licence volumes are comparable to what was presented in the EIS, which was:

- A maximum volume required for licensing: 2,290 ML/yr, and for each individual source:
 - Nepean Management Zone 1 Sydney Basin Nepean Groundwater Source 2,235 ML/yr in year 15;
 - Nepean Management Zone 2 Sydney Basin Nepean Groundwater Source 1 ML/yr from years 5 through to 18;

- Sydney Basin South Groundwater Source 18 ML/yr for years 14 through to 16; and
- Medway Rivulet Management Zone of the Upper Nepean and Upstream Warragamba Water Source, 36.5 ML/yr for all years of mining and rehabilitation.

The yearly licence requirements during mining (based on the revised assessment) are shown in Table 5.3.

Table 5.3 Required licence volumes from water sources during mining

Year	Surface water leakage Medway Rivulet Management Zone of the Upper Nepean and Upstream Warragamba Water Source (ML)	Groundwater interception Sydney Basin South Groundwater Source (ML)	Groundwater interception Sydney Basin Nepean Groundwater Source	
			Nepean Management Zone 2 (ML)	Nepean Management Zone 1 (ML)
1	0.0	0.0	0.0	200
2	0.0	0.0	0.0	1171
3	0.0	0.0	0.0	1443
4	0.0	0.0	0.1	1413
5	0.0	0.0	0.2	1238
6	0.0	0.0	0.4	1222
7	0.0	0.0	0.7	1251
8	0.0	0.0	1.1	1523
9	0.0	0.0	1.6	1747
10	0.0	0.0	2.1	1810
11	0.8	0.1	2.7	1835
12	3.4	0.2	3.2	1850
13	5.9	0.3	3.8	1790
14	8.2	0.4	4.3	1736
15	10.4	0.6	4.8	1701
16	12.4	0.7	5.2	1826
17	14.3	0.9	5.5	2059
18	16.1	1.1	5.8	2056
19	17.8	1.2	6.1	1660
20	18.8	1.4	6.2	440
21	18.8	1.5	6.5	151
22	18.4	1.5	6.7	36
23	17.8	1.5	6.9	3
Maximum (during mining and void filling)	18.8	1.5	6.9	2,059
Maximum impact (ML in year from commencement)	18.8 (in year 21)	6.5 (in year 72)	7.1 (in year 25)	2,059 (in year 17)

5.7.3 Licences currently owned by Hume Coal and mechanism to secure more

Hume Coal and its subsidiaries currently hold Water Access Licences shares for several water sources:

- 31 shares of unregulated river surface water in the Medway Rivulet Zone;
- 1,909 ML of groundwater share components for Sydney Basin Nepean Management Zone 1;
- 5 ML of groundwater share components for Sydney Basin Nepean Management Zone 2; and
- 25 ML of groundwater share components for Sydney Basin South.

Hume Coal has already secured 93% of the total licence requirement for the project, with a clear pathway for how the remaining licence volume will be secured to meet extraction requirements.

Hume Coal proposes to trade existing water licences from the Nepean Management Zone 1 on the open market to secure the remaining 150 ML (remaining 7%) of the licence requirement from that zone. For the additional 3ML of share component required from the Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source either an application through the next controlled allocation order, or trading from within that zone is proposed.

Table 5.4 summarises the secured and remaining required licence volumes for respective water sources and zones. The water market depth is sufficient to secure remaining required licence volumes.

Table 5.4 Secured water licences

Water source	Management zone	Total volume required for project (ML/yr)	Volume currently held in licences (ML/yr)	Outstanding volume required to be secured (ML/yr)	Method for acquisition	Total available trading pool in management zone(ML/yr)
Sydney Basin Nepean	Nepean Management Zone 1	2,059	1,909 (93%)	150	Trade	12,553 ^a
	Nepean Management Zone 2	8	5 (63%)	3	Controlled allocation or trade	50,000 ^b
Sydney Basin South		7	25 (>100%)	0	No more required	69,892
Upper Nepean and Upstream Warragamba	Medway Rivulet Management Zone	19	31 (>100%)	0	No more required	
Total		2,093	1,970	153		

Notes: a. From an October 2016 search of the online Water Licence Register (town water supply volumes removed).

b. Approximated for Zone 2 from the 99,658 ML of LTAAEL in the Metro Groundwater WSP and areas of Zones 1 and 2.

5.8 Mitigation, avoidance, management and monitoring

The primary mitigation strategy to protect water resources has been the mine design (non-caving) and operation of the mine (progressively sealing panels and pumping water in following mining). Other mitigation strategies include efficient and optimised water management practices, underground reject emplacement, and use of limestone.

Two overarching and adaptive Water Management Plans (WMPs) will be prepared for the project in consultation with NSW Government agencies: one for the construction phase (CWMP) and one for the operational phase (OWMP). Two overarching WMPs will be developed for the project, one for the construction phase and one for the operational phase. The WMPs will document the proposed mitigation and management measures for the project, and will describe:

- the surface and groundwater monitoring program, including any expansions to the baseline monitoring network;
- reporting requirements;
- spill management and response;
- trigger levels for water quality parameters to assist in early identification of water quality trends;
- corrective actions and contingencies;
- a programme for reviewing and updating the numerical groundwater model as more data and information become available; and
- responsibilities for all management measures.

The WMPs will also identify erosion and sediment control measures to be implemented on site, which will be included as Soil and Water Management sub-plan (which incorporates the sediment and erosion control measures). Management measures will be designed in accordance with the relevant standards and best practice guidelines, including *Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries* (DECCW 2008).

The management and mitigation measures proposed in the revised assessment are very similar to what was presented in the EIS; however some minor changes have been made to address submissions received on the EIS. With regard to the surface water quality assessment of mine access roads, to ensure NorBE criteria are met, the following mitigation measures are included in the revised assessment that were not included in the EIS:

- installation of longer vegetated swales (up to 1,250 m long for the unsealed road catchment);
- installation of constructed wetlands; and
- creation of 45 ha of protection zones where clearing farming and industrial activities/infrastructure will be restricted.

A range of make good provisions for landholder bores that could experience a drawdown of 2 m or more have been proposed (refer to Appendix M of Appendix 2). The actual provisions that will be applied will be identified following case-by-case assessments and will depend on the existing infrastructure, the degree of drawdown at each site and the outcome of consultation with the relevant landholder. Strategies could include compensation for increased pumping costs, repositioning pumps to unaffected strata, or relocating bores. The strategies proposed for make good and the number of bores subject to each individual make good strategy are comparable between the revised assessment and what was presented in the EIS.

5.9 Conclusion

The revised water assessment has been prepared for the project based on the updated groundwater model and other minor revisions and/or additions to the surface water assessment and groundwater quality assessment. The results of the revised assessment are not substantially different to what was presented in the EIS.

Effective and efficient water management is essential to the project's operation. The mine design and associated water management system were developed iteratively, with early results of surface water and groundwater modelling providing input into the mine design. The resulting water management system and mine design (non-caving and progressively sealing panels) minimises physical water extraction and groundwater inflow, conserves and reuses water, minimises evaporation losses, and minimises discharge to surface water systems.

The effects on surface water resources as a result of the project will be minimal. A temporary 0.8% reduction in the catchment area of Medway Rivulet, in which the surface infrastructure area will be located, will occur as a result of constructing and operating the project. The project will not significantly reduce the quantity of water in the catchment area.

Potential TSS and nutrient loads and concentrations in Oldbury Creek show releases from stormwater basins will be in accordance with the neutral or beneficial effect (NorBE) criteria. Swales and constructed wetlands can be used to provide an effective treatment system for runoff from access roads to meet the NorBE criteria for TSS and nutrients. The water balance model demonstrates that the PWD has enough capacity to contain all surplus water and treatment and release of water from the PWD is not required.

Changes in flood levels as a result of the project for land Hume Coal does not own are minor or negligible and considered acceptable with reference to the assessment criteria. Changes to flood peak velocities are considered acceptable with reference to the assessment criteria.

Groundwater inflows to the active mine sump area will occur throughout the operational mine life, and this water will be reused for mining operations with the excess pumped into the sealed void area to enhance the groundwater recovery time. The sealed void remains part of the groundwater source, with water available for other users.

The Aquifer Interference Policy (AIP) requires landholder bores affected by a drawdown of 2 m or more as a result of the project are subject to 'make good' provisions. There are 94 private landholder bores on 72 properties that are predicted to drawdown 2 m or more as a result of the project.

A 'make good' assessment addressed the project's effects on these 94 bores. About a third of the potentially affected bores will incur increased operational costs associated the lower groundwater level, and will not require further measures (such as bore intake deepening or replacement). Another third may need submersible pump intake depths repositioned for certain periods of time, and the final third may require bore replacement or an alternative source of supply.

With regard to the AIP's groundwater quality requirements, the project is not anticipated to result in a lowering of the beneficial use category of the groundwater source beyond 40 m from the activity, provided the mitigation measures discussed in Chapter 13 of Appendix 2 are implemented.

Cumulative impacts to groundwater and surface water quality are not anticipated as a result of the project.

Monitoring the extensive surface water and groundwater network will continue. Monitoring each component of the water management system underpins if, how, and when management responses are required. Triggers and thresholds will be developed to provide context on if, how, and when management measures are required as part of the water management plan for the project.

Hume Coal has already secured 93% of the total water licence requirement for the project. The remaining volume required can be sourced by controlled allocation and via the trading market.



Part C

Response to Submissions

Chapter 6: Legislation, planning instruments and policies
Chapter 7: Stakeholder engagement and community outreach
Chapter 8: Surface water
Chapter 9: Groundwater
Chapter 10: Rejects management
Chapter 11: Water licensing
Chapter 12: Agriculture, land and soil resources
Chapter 13: Biodiversity
Chapter 14: Noise and vibration
Chapter 15: Air quality
Chapter 16: Mine design, geology and subsidence

Chapter 17: Traffic and transport
Chapter 18: Visual amenity
Chapter 19: Closure and rehabilitation
Chapter 20: Economics
Chapter 21: Social impacts
Chapter 22: Health
Chapter 23: Tourism
Chapter 24: Aboriginal heritage
Chapter 25: European heritage
Chapter 26: Greenhouse gas
Chapter 27: Other matters



6 Legislation, planning instruments and policies

A number of submissions raised issues relating to the approval process and matters to be assessed under various statutory instruments. This chapter addresses these issues.

6.1 NSW Protection of the Environment Operations Act 1997

6.1.1 Hume Coal Project

The EPA raised a number of matters relating to the NSW *Protection of the Environment Operations Act 1997* (POEO Act) to be addressed; namely that the EIS does not address the need for an Environment Protection Licence (EPL) for water pollution to surface and groundwater. The EPA also includes a discussion in their submission on coal wash reject licensing, exemptions and levy, which is noted.

Schedule 1 of the POEO Act lists the activities which require an EPL. Section 3.3.3 of the Hume Coal Project EIS acknowledges that the mine will require an EPL on the basis that it meets the definition of a premise-based activity ('mining for coal'- producing more than 500 t of coal per day, and 'coal works'). Pursuant to section 4.42 of the EP&A Act, the EPL cannot be refused if the development consent is granted, because the Hume Coal Project is a State significant development (SSD). The conditions of the EPL will be determined by the EPA which will include relevant conditions relating to discharges to air, water and land.

As explained in Chapter 5, the water balance model demonstrates that the primary water dam (PWD) has enough capacity to contain all surplus water generated by surface and underground activities without the need to release excess water to the local creeks. Therefore, treatment and release of water from the PWD will not be required.

An assessment of potential releases to Oldbury Creek from stormwater basins (SB03 and SB04) has been provided in Chapter 7 (water resources) of the Hume Coal Project EIS, and Chapter 7 of the Revised Water Assessment (refer to Appendix 2 of this report). Chapter 7 states that no releases into Oldbury Creek will occur unless the specified first flush criteria are met. Importantly, the assessment of water quality provided in the Hume Coal Project EIS and in the Revised Water Assessment (Appendix 2) concludes that discharges to Oldbury Creek will be in accordance with the Neutral or Beneficial Effect (NorBE) criteria.

Further, as also explained in Chapter 9, the groundwater quality assessment in both the Hume Coal Project EIS and subsequent rework concluded that there will be negligible impacts to groundwater quality. The risk of any potential impact to groundwater from the quality of collected water (eg in the PWD) or coal reject slurry transferred into underground workings has been assessed as part of the RGS hydrogeochemical modelling program and has been demonstrated to be negligible (RGS 2018).

6.1.2 Berrima Rail Project

The EPA noted that the appropriate regulatory authority for any operational rail issues associated with the 8.2 km of private rail track is the WSC (unless it forms part of the Hume Coal premises licence). It also noted that the Main Southern Railway Line from Berrima to Port Kembla is regulated by the EPA under the ARTC licence (EPL 3142). The EIS states that the Proponent will use the latest generation locomotives and wagons; however no detail has been provided. The ARTC licence includes locomotive noise limits for new locomotives. Whilst Hume Coal is proposing to cover train wagons, this EPL also contains requirements in relation to coal dust management in this rail corridor.

i Requirement for an EPL

The Berrima Rail Project involves the construction and operation of a new private rail spur off an existing private track. As stated in Section 4.3.3 of the Berrima Rail Project EIS, Schedule 1 of the POEO Act includes 'railway systems activities', meaning the installation, on site repair, on site maintenance or on site upgrading of track, including the construction or significant alteration of any ancillary works. However, the definition of 'track' to trigger 'railway systems activities' as a scheduled activity is a network of more than 30 km of track, other than railway track that is used solely by railway vehicles that are themselves used solely for heritage purposes. As less than 30 km of track will be constructed or upgraded as part of the Berrima Rail Project, it will not require an EPL. On this basis, and as per the EPA submission, the regulatory authority for operational issues under the POEO Act will be the local government authority (ie WSC).

ii Management of noise

As committed to in the Berrima Rail Project EIS (EMM 2017b), Hume Coal will use latest generation locomotives and wagons with electronically controlled pneumatic brakes. As explained in Section 14.3 of this RTS report, the bunching of wagons and associated noise as the train decelerates where required along the rail line will be minimised by the electronically controlled pneumatic brakes. This type of braking is designed for this purpose.

The noise limits specified in the EPL 3142 (condition L2.5) held by ARTC for the Main Southern Railway are shown in Table 6.1.

Table 6.1 EPA locomotive noise limits for the the Main Southern Railway (EPL 3142)

Operating condition	Location of measurement	Noise limit – microphone height: 1.5.m above
Low idle with compressor radiator fans and air conditioning operating at maximum load occurring at low idle	Stationary 15 m contour, except end positions (front and rear)	70 dB(A) LAMax, F, 30s
All other throttle settings under self load with compressor radiator fans and air conditioning operating	Stationary 15 m contour, except end positions (front and rear)	87 dB LAMax, F, 30s 95 dB LZMax, F, 30s

Conditions L2.6 and L2.7 also set limits relating to tonality and noise emission test method for locomotives, respectively.

Hume Coal consulted with ARTC throughout the planning and environmental assessment phase of the Berrima Rail Project. It is acknowledged that the Hume Coal locomotives will need to demonstrate compliance with the noise limits specified in the ARTC EPL before commencement of use on the railway.

In addition to the above, clause L2.9 of EPL 3142 states that the EPA can approve locomotives that do not comply with all limits prescribed in Conditions L2.6 and L2.7, if it can be demonstrated that the noise emission performance of locatives is consistent with current best practice, all measures for minimising the extent of non-compliance have been investigated and reasonable and feasible measures implemented, and none of the non-compliances will result in unacceptable environmental impacts.

Further detail on noise measures is provided in Chapters 14.

iii Management of dust

EPL 3142 does not prescribe specific limits for dust emissions. Rather, condition O3.1 states that 'dust generating activities on the premises must be managed to minimise the generation of dust and prevent it going offsite so far as reasonably practicable'. Accordingly, Hume Coal has incorporated significant measures into the project design which go beyond current standard practice; namely covering coal wagons, so that dust emissions from Hume Coal trains will be minimised as much as practical. The air quality impact assessment prepared for the Berrima Rail Project (Ramboll Environ 2017b) found that the dust emissions from Hume Coal trains will not result in an exceedance of any applicable air quality criteria at any receptor location, and when considered with existing users of the Berrima Branch Line, emissions will remain well below applicable air quality criteria at all surrounding receptors.

Further detail on air quality management measures is provided in Chapter 15.

6.2 Wingecarribee LEP and zoning

A number of community submissions submitted that the development contravenes the objectives of the Wingecarribee LEP and in particular the objectives of the E3 Environmental Management zone. Views were put forward that the projects are/should be subject to local planning laws, and are in conflict with the zoning of the area.

One community member also submitted that the rail works are not permitted in the SP2 Infrastructure, E2 Environmental Conservation, and E3 Environmental Management zones.

6.2.1 Hume Coal Project

i Permissibility

The majority of the project area for the Hume Coal Project is on land zoned E3 Environmental Management (70%) under the Wingecarribee LEP, as is much of the surrounding land. 26% of the project area is zoned RU3 Forestry, with the remaining areas on land zoned RU2 Rural Landscape (3%), SP2 Infrastructure (1%) and E2 Environmental Conservation (0.1%).

Permissibility of mining developments is governed by a number of instruments, primarily the relevant LEP and the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP), which prevails over any inconsistencies with a LEP. Clause 5(3) of the Mining SEPP, section 3.28 of the EP&A Act and clause 1.9 of the Wingecarribee LEP provide that the Mining SEPP prevails over other planning instruments, to the extent there is any inconsistency. Therefore, the prohibitions in the LEPs are overridden by clause 7 of the Mining SEPP.

Clause 7 of the Mining SEPP defines mining development that can be undertaken with development consent. Clause 7(1) of the Mining SEPP states the following:

Mining

Development for any of the following purposes may be carried out only with development consent:

- a) underground mining carried out on any land,
- b) mining carried out:
 - i) on land where development for the purposes of agriculture or industry may be carried out (with or without development consent), or

- ii) on land that is, immediately before the commencement of this clause, the subject of a mining lease under the Mining Act 1992 or a mining licence under the Offshore Minerals Act 1999,

...

- d) facilities for the processing or transportation of minerals or mineral bearing ores on land on which mining may be carried out (with or without development consent), but only if they were mined from that land or adjoining land...

Under the Mining SEPP, 'mining' is defined as:

Mining means the winning or removal of materials by methods such as excavating, dredging, or tunnelling for the purpose of obtaining minerals, and includes:

- a) the construction, operation and decommissioning of associated works, and
- b) the stockpiling, processing, treatment and transportation of materials extracted, and
- c) the rehabilitation of land affected by mining.

Additionally, 'underground mining' is defined as:

- a) mining carried out beneath the earth's surface, including bord and pillar mining, longwall mining, top-level caving, sub-level caving and auger mining, and
- b) shafts, drill holes, gas and water drainage works, surface rehabilitation works and access pits associated with that mining (whether carried out on or beneath the earth's surface),

but does not include open cut mining.

Therefore, under clause 7(1)(a) of the Mining SEPP, the proposed underground mining area is permissible with consent in all land use zones, including the E3 Environmental Management zone, as the project falls within the definition of underground mining.

The surface infrastructure area will be on land zoned as E3 Environmental Management and RU2 Rural Landscape pursuant to the Wingecarribee LEP. Under the LEP, whilst the surface infrastructure activity is a prohibited land use in both zones, agriculture is permitted. The surface infrastructure activity falls within the definition of mining under the Mining SEPP and therefore, under clause 7(1)(b)(i) of the SEPP, the surface infrastructure activity is permissible with consent. Further, one of the downcast ventilation shafts will be constructed in the Belanglo State Forest in the RU3 Rural Landscape zone and one on the Carlisle Downs property in the E3 Environmental Management zone. 'Shafts' fall under the definition of underground mining, as noted above, and therefore construction of the shafts within the E3 Environmental Management and RU3 Rural Landscape zones is also permissible with consent.

It is therefore established that the development is permissible with consent in all zones in the project area, including the E3 Environmental Management zone.

Notwithstanding, it is also noted that the existing land uses across the majority of the project area zoned as E3 Environmental Management would continue during construction and operation of the project. Of the 3,524 ha zoned as E3 Environmental Management in the Hume Coal Project area, just 117 ha will comprise the surface infrastructure area of the mine, and a further 22 ha will comprise the footprint of the rail loop. The remaining 3,385 ha will not be disturbed by the project and the agricultural/rural residential land uses will continue unimpeded by the mine.

The project's compatibility with the Wingecarribee LEP is discussed below.

ii Consistency with the relevant land use zone objectives

The objectives of each land use zone within the Hume Coal Project area, and commentary on how the project is compatible with these objectives is provided in Tables 6.2 to 6.5.

Table 6.2 The objectives of the E3 Environmental Management zone and compatibility of the Hume Coal Project

Objectives	Compatibility of the Hume Coal Project
<p>To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values.</p> <p>To provide for a limited range of development that does not have an adverse effect on those values.</p>	<p>Improving Mereworth House and Garden - Hume Coal is committed to maintaining and improving the house and garden at Mereworth while adhering to Sorensen's design. This work will be undertaken by specialists in their field and will be fully funded by Hume Coal. The grounds are maintained as part of the Hume Coal property budget.</p> <p>The non-caving underground mine means surface features will be protected.</p>
<p>To encourage the retention of the remaining evidence of significant historic and social values expressed in existing landscape and land use patterns.</p>	<p>Historic values - the area has a long history of coal mining</p> <p>Existing landscape - no impacts to surface features from underground mining due to the non-caving underground mine design. The surface infrastructure comprises just 2% of the project area.</p> <p>Existing land use patterns – Existing land use patterns will continue across 98% of the project area. The predominant land uses are agricultural across the project area, as well as State Forest in the western portion; both of which will continue unaffected by the project.</p>
<p>To minimise the proliferation of buildings and other structures in these sensitive landscape areas.</p>	<p>Just 2% of the project area will comprise the surface infrastructure area. This infrastructure will be removed at the cessation of mining. A temporary construction accommodation facility will be established for the project, comprising demountable buildings; however these buildings will be removed when no longer needed after the approximate three year construction period.</p>
<p>To provide for a restricted range of development and land use activities that provide for rural settlement, sustainable agriculture, other types of economic and employment development, recreation and community amenity in identified drinking water catchment areas.</p>	<p>The project is 'other types of economic and employment development' that is compatible with the catchment area as it will meet NorBE criteria. It will provide positive economic benefits to the region through the generation of 300 jobs during operations, as well as the flow-on benefits from this employment.</p> <p>The underground, non-caving nature of the mine means that existing land uses including agriculture will continue across the majority (98%) of the project area. Notably, agricultural productivity over the land purchased by Hume Coal in the region has improved since Hume Coal's purchase, as evidenced by the greater gross margins reported in the Agricultural Impact Statement in the EIS (EMM 2017k).</p>
<p>To protect significant agricultural resources (soil, water and vegetation) in recognition of their value to Wingecarribee's longer term economic sustainability.</p>	<p>Agricultural resources such as soil and vegetation will be protected due to the non-caving, underground mine design. Make good measures will be implemented to effectively mitigate impacts to privately owned bores (as described in Chapter 9).</p>

Table 6.3 The objectives of the RU2 Rural Landscape zone and compatibility of the Hume Coal Project

Objectives	Compatibility of the Hume Coal Project
To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.	Existing land uses, which include primary production, will continue across 98% of the project area. No subsidence will occur, and therefore there will be no impacts to land and soil resources across the underground mining area. The project will not affect other agricultural land uses in the region, as explained in detail in Chapter 12. Make good measures will be implemented to effectively mitigate impacts to privately owned bores (as described in Chapter 9).
To maintain the rural landscape character of the land.	The underground nature of the project means that the rural landscape nature will remain across the majority of the project area.
To provide for a range of compatible land uses, including extensive agriculture.	The project has been designed to be compatible with surrounding land uses, and in particular agricultural land, as much as practicable; primarily through the mine design and mining method to be used so as to avoid subsidence impacts, and the emplacement of rejects underground so as to eliminate the need for a permanent surface waste emplacement. Disturbance of agricultural land will be limited to areas required for construction and operation of surface infrastructure. This represents approximately 2% of the total project area. This land will be rehabilitated after the cessation of mining to restore the pre-mining agricultural land-use of grazing on improved pastures.
To provide opportunities for employment-generating development that is compatible with, and adds value to, local agricultural production through food and beverage processing and that integrates with tourism.	The project is an employment generating development that, as explained above, is compatible with surrounding land uses.

Table 6.4 The objectives of the RU3 Forestry zone and compatibility of the Hume Coal Project

Objectives	Compatibility of the Hume Coal Project
To enable development for forestry purposes	The Belanglo State Forest covers the western portion of the project area. The underground, non-caving nature of the mine means that forestry can continue unaffected by the project.
To enable other development that is compatible with forestry land uses.	The project is compatible with forestry land uses as a result of the underground mine design, and nil associated subsidence effects on the surface.

Table 6.5 The objectives of the SP2 Infrastructure zone and compatibility of the Hume Coal Project

Objectives	Compatibility of the Hume Coal Project
To provide for infrastructure and related uses	The location of the project was chosen in part due to the availability of infrastructure such as rail, close by. The project will enable the upgrade of the infrastructure (ie the Berrima Branch Line) resulting in further efficient use of this infrastructure.
To prevent development that is not compatible with or that may detract from the provision of infrastructure.	As above, the location of the project was chosen in part due to the availability of infrastructure such as rail, close by. The project will enable further efficient use of this infrastructure.
To ensure that the scale and character of infrastructure is compatible with the landscape setting and built form of surrounding development.	The underground nature of the project means that the scale of infrastructure on the surface is limited and has been sited to ensure it is compatible with the surrounding environment.

As shown in the tables above, the nature and design of the proposed Hume Coal Project is such that it is compatible with the objectives of the land use zones covered by the project area.

In addition, the project is compatible and suitable with the surrounding locality. The project is in close proximity to the Boral Cement works, which has been operating in the area for over 100 years, as well as the Moss Vale Enterprise Corridor (approximately 1.2 km away from the project area at its closest point) and therefore represents a continuation of the industrial land uses that this zone is encouraging. As discussed further in Section 6.7, the project will efficiently recover an economic coal resource beneath privately owned land. Resources extracted in this way avoid land use conflicts by continuing existing land uses at the surface and minimising impacts to significant environmental, cultural and built features. There are a number of other extractive industries operating or proposed in the area, which continue the long history of mining in the area. Agricultural land use in the area, such as grazing, some cropping and other small scale agricultural businesses, will continue unaffected by the mine due to its underground, non-caving design.

6.2.2 Berrima Rail Project

i Permissibility

The Berrima Rail Project area traverses land zoned IN1 General Industrial, IN3 Heavy Industrial, RU2 Rural Landscape, SP2 Infrastructure, E2 Environmental Conservation and E3 Environmental Management pursuant to the Wingecarribee LEP. The rail works are only permitted with consent in the IN1 General Industrial and IN3 Heavy Industrial zones. However, section 3.28 of the EP&A Act and clause 1.9 of the Wingecarribee LEP provide that the Mining SEPP prevails over any inconsistencies with an LEP.

Pursuant to the Mining SEPP, the rail works fall within the definition of mining. Clause 7(1)(b)(i) of the SEPP allows mining in any zone where agriculture or industries are permitted. Development for the purpose of agriculture is permitted in the RU2 Rural Landscape and E3 Environmental Management zones, and therefore the Mining SEPP overrides the LEP prohibition in these zones.

With respect to the land zoned E2 Environmental Conservation, that land is the subject of a mining lease - Consolidated Coal Lease (CCL) 748 – and has been since 18 December 1990. Therefore, that land was the subject of a mining lease immediately before the commencement of clause 7 of the Mining SEPP, which was on 17 February 2007. Clause 7(1)(b)(ii) of the Mining SEPP therefore overrides the LEP prohibition in the land zoned E2 Environmental Conservation.

The rail works are not permitted under the Mining SEPP in the SP2 Infrastructure zone. That the rail works are prohibited in the SP2 Infrastructure zone is of no material consequence for the consent authority's power to lawfully grant consent for the Berrima Rail Project. It is not necessary that the Berrima Rail Project be wholly permissible under relevant environmental planning instruments in order to be the subject of a lawfully granted development consent. This is because, in relation to SSD, section 4.38(3) of the EP&A Act states:

Development consent may be granted despite the development being partly prohibited by an environmental planning instrument.

Notably, land zoned SP2 Infrastructure only comprises 2.6% of the Berrima Rail Project area.

Nevertheless, how the project is compatible with the LEP is discussed below.

ii Consistency with the Wingecarribee LEP and relevant land use zone objectives

The objectives of each land use zone within the Berrima Rail Project area, and commentary on how the project is compatible with these objectives is provided in Tables 6.6 to 6.11.

Table 6.6 The objectives of the E3 Environmental Management zone and compatibility of the Berrima Rail Project

Objectives	Compatibility of the Berrima Rail Project
To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values. To provide for a limited range of development that does not have an adverse effect on those values.	The project has a limited disturbance footprint, approximately half of which is within an existing rail corridor.
To encourage the retention of the remaining evidence of significant historic and social values expressed in existing landscape and land use patterns.	There is a long history of the use of rail to supply coal in the region (at least since 1881 in a portion of the Berrima Rail Project area). The project utilises this long-standing railway, and will restore a portion of the western section of the railway that has been decommissioned. Therefore, the project retains the remaining evidence of significant historic and social values expressed in existing landscape and land use patterns. Further, the remembrance driveway, commemorating war veterans form area, was dedicated by the former Steel Federation.
To minimise the proliferation of buildings and other structures in these sensitive landscape areas.	The project is a linear infrastructure project, the majority of which is in an industrial setting.
To provide for a restricted range of development and land use activities that provide for rural settlement, sustainable agriculture, other types of economic and employment development, recreation and community amenity in identified drinking water catchment areas	The project has a limited disturbance footprint, approximately half of which is within an existing rail corridor.
To protect significant agricultural resources (soil, water and vegetation) in recognition of their value to Wingecarribee's longer term economic sustainability	Existing land uses, which are predominantly agricultural, will continue across 98% of the project area throughout the operational phase of the project. Upon the cessation of mining, all infrastructure will be removed and the area rehabilitated to a final land use of grazing.

Table 6.7 The objectives of the E2 Environmental Conservation zone and compatibility of the Berrima Rail Project

Objectives	Compatibility of the Berrima Rail Project
To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values	The project will not have significant impacts on biodiversity or heritage, as described in the EIS.
To prevent development that could destroy, damage or otherwise have an adverse effect on those values.	The project will not have significant impacts on biodiversity or heritage, as described in the EIS.

Table 6.8 The objectives of the RU2 Rural Landscape zone and compatibility of the Berrima Rail Project

Objectives	Compatibility of the Berrima Rail Project
To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.	The project will not impact on primary industry in the area. Agricultural land uses will continue un-impacted by the project.
To maintain the rural landscape character of the land.	Agricultural land uses will continue un-impacted by the project.
To provide for a range of compatible land uses, including extensive agriculture.	Agricultural land uses will continue un-impacted by the project
To provide opportunities for employment-generating development that is compatible with, and adds value to, local agricultural production through food and beverage processing and that integrates with tourism.	The project is an employment generating development that is compatible with surrounding land uses.

Table 6.9 The objectives of the SP2 Infrastructure zone and compatibility of the Berrima Rail Project

Objectives	Compatibility of the Berrima Rail Project
To provide for infrastructure and related uses	The project involves the upgrade of an existing rail line, enabling the more efficient use of this infrastructure.
To prevent development that is not compatible with or that may detract from the provision of infrastructure.	The project involves the upgrade of an existing rail line, enabling the more efficient use of this infrastructure. The majority of the project area is within the Moss Vale Enterprise Corridor, and is compatible with this industrial land use.
To ensure that the scale and character of infrastructure is compatible with the landscape setting and built form of surrounding development.	The majority of the project area is within the Moss Vale Enterprise Corridor, and is compatible with this industrial land use.

Table 6.10 The objectives of the IN1 General Industrial zone and compatibility of the Berrima Rail Project

Objectives	Compatibility of the Berrima Rail Project
To provide a wide range of industrial and warehouse land uses.	The project represents an industrial land use.
To encourage employment opportunities.	The project is an employment generating development.
To minimise any adverse effect of industry on other land uses.	The project is compatible with surrounding land uses, with minimal offsite impacts predicted.
To support and protect industrial land for industrial uses.	The project represents an industrial land use.
To allow a range of non-industrial land uses, including selected commercial activities, that provide direct services to the industrial activities and their workforce or that, due to their type, nature or scale, are appropriately located in the zone without impacting on the viability of business and commercial centres in Wingecarribee.	The project represents an industrial land use.
To ensure that new development and land uses incorporate measures that take account of their spatial context and mitigate any potential impacts on neighbourhood amenity and character, or the efficient operation of the local or regional road system.	The project is compatible with surrounding land uses, with minimal offsite impacts predicted.

Table 6.11 The objectives of the IN3 Heavy Industrial zone and compatibility of the Berrima Rail Project

Objectives	Compatibility of the Berrima Rail Project
To provide suitable areas for those industries that need to be separated from other land uses.	N/A
To encourage employment opportunities	The project is an employment generating development.
To minimise any adverse effect of heavy industry on other land uses.	The project involves the upgrade of the Berrima Branch Line which is used by heavy industry in the area.
To support and protect industrial land for industrial uses.	The majority of the project area is within the Moss Vale Enterprise Corridor, and is compatible with this industrial land use.

As shown in the tables above, the nature and design of the proposed Berrima Rail Project is such that it is compatible with the objectives of the land use zones covered by the project area.

A discussion on how both the Hume Coal Project and the Berrima Rail Project are consistent with the aims of the Wingecarribee LEP is provided in Table 6.12.

Table 6.12 **Compatibility of the Hume Coal and Berrima Rail projects the aims of the Wingecarribee LEP**

Aims	Compatibility of the Hume Coal Project
To conserve and enhance, for current and future generations, the ecological integrity, environmental heritage and environmental significance of Wingecarribee,	<p>The underground nature of the project means that the scale of infrastructure on the surface is limited and has been sited to ensure it is compatible with the surrounding environment. The rural landscape nature will remain across the majority of the project area.</p> <p>There will be no impacts to surface features as a result of underground mining due to the negligible subsidence associated with the mine design. The surface infrastructure comprises just 2% of the project area.</p> <p>Agricultural resources such as soil and vegetation will be protected due to the non-caving, underground mine design. Make good measures will be implemented to effectively mitigate impacts to privately owned bores (as described in Chapter 9).</p>
To maintain Wingecarribee's original settlement pattern of towns and villages dispersed throughout a rural and native vegetation landscape,	<p>The project has been designed to be compatible with surrounding land uses, and in particular agricultural land, as much as practicable; primarily through the mine design and mining method to be used so as to avoid subsidence impacts, and the emplacement of rejects underground so as to eliminate the need for a permanent surface waste emplacement. Disturbance of agricultural land will be limited to areas required for construction and operation of surface infrastructure. This represents approximately 2% of the total project area. This land will be rehabilitated after the cessation of mining to restore the pre-mining agricultural land-use of grazing on improved pastures.</p> <p>Existing land uses, which include primary production (agricultural land uses) will continue across 98% of the project area.</p> <p>The underground nature of the project means that the rural landscape nature will remain across the majority of the project area.</p> <p>A temporary construction accommodation facility will be established for the project, comprising demountable buildings; however these buildings will be removed when no longer needed after the approximate three year construction period.</p>
To encourage the efficient use and development of urban land, minimising the spread of urban areas into rural and native vegetation environments, thereby increasing the accessibility of the population to urban facilities and services	<p>A temporary construction accommodation facility will be established for the project, comprising demountable buildings; however these buildings will be removed when no longer needed after the approximate three year construction period.</p> <p>The project does not represent a spread of urban land.</p>
<p>To provide opportunities for development and land use activities that:</p> <p>(i) make an effective contribution towards the economic wellbeing of the community in a socially and environmentally responsible manner, and</p> <p>(ii) do not adversely impact on natural systems and processes and the overall quality of Wingecarribee's natural environment, and</p> <p>(iii) retain the critical natural, rural and built environmental landscape elements that make up the scenic and cultural heritage value of Wingecarribee,</p>	<p>The project will provide positive economic benefits to the region through the generation of around 300 jobs during operations, as well as the flow-on benefits from this employment. It will result in a total benefit (net of economic costs) to NSW of \$368 million, which includes a total net benefit to the local area of \$128 million (including both direct and indirect benefits).</p> <p>The underground, non-caving nature of the mine means that existing land uses, which include agriculture, will continue across the majority (98%) of the project area and surface features will not be affected.</p> <p>The underground nature of the project means that the rural landscape nature will remain across the majority of the project area.</p>
To provide opportunities for a range of new housing and housing choice in locations that have good access to public transport, community facilities and services, retail and commercial services and employment opportunities, including opportunities for the provision of adaptable and affordable housing	Not applicable to this project

Table 6.12 **Compatibility of the Hume Coal and Berrima Rail projects the aims of the Wingecarribee LEP**

Aims	Compatibility of the Hume Coal Project
To provide for a range of living opportunities that address differing lifestyle needs without compromising the environmental quality of Wingecarribee, and the value of its natural resources such as water, biodiversity and agricultural land.	Not applicable to this project.
To strengthen the viability of Wingecarribee's business centres as central places for investment, employment and cultural activity, and encourage a majority of future housing opportunities to be located in relatively close proximity to those centres.	The project will provide positive economic benefits to the region through the generation of around 300 jobs during operations, as well as the flow benefits from this employment. It will result in a total benefit (net of economic costs) to NSW of \$368 million, which includes a total net benefit to the local area of \$128 million (including both direct and indirect benefits).
To promote the economic wellbeing of the community in a socially and environmentally responsible way, focusing new employment growth at identified employment hubs like business centres and enterprise zones that can be better accessed by public and private transport.	The project will provide around 300 jobs during the 19 year operational phase, 1.2 km from the Moss Vale Enterprise Corridor.
To protect the primary production potential of suitable rural land, and prevent the fragmentation of agricultural holdings.	The underground, non-caving nature of the mine means that existing land uses, including agriculture, will continue across the majority (98%) of the project area. Hume Coal has purchased approximately 1,306 ha of agricultural land, which is leased to a pastoral company that is now running a productive, consolidated agricultural business on these properties.
To conserve the Aboriginal and European cultural and environmental heritage of Wingecarribee.	<p>The underground, non-caving nature of the mine means that the potential for project-related impacts to built and cultural heritage has been primarily avoided, or minimised, as much as possible.</p> <p>With regards to built heritage, the mine plan was specifically designed to avoid undermining state heritage listed items, which was a conservative approach due to the non-caving mine method adopted. As described in Chapter 24, the project design also avoids impacts to Aboriginal sites where possible. This involved desktop constraints analyses and staged archaeological surveys to identify the most archaeologically sensitive areas so that the project could be designed to avoid or minimise impacts to these areas.</p> <p>Hume Coal is also committed to maintaining and improving the house and garden at Mereworth while adhering to Sorensen's design.</p> <p>The project is also consistent with the region's long coal mining and steel making history.</p>
To protect areas of high scenic landscape value.	<p>The underground nature of the project means that the rural landscape nature will remain across the majority of the project area.</p> <p>The surface infrastructure has been situated so as to minimise the views available of the infrastructure. Tree screens have already been planted so as to provide effective screening of the surface infrastructure area when constructed.</p>
To develop an ecologically sustainable future for Wingecarribee through the conservation, rehabilitation and regeneration of native vegetation (particularly threatened species populations and ecological communities), soil, waterways, riparian land and water quality (surface and groundwater).	<p>The project has been designed, primarily through the mining method to be used so as to avoid subsidence impacts, and the emplacement of rejects underground so as to eliminate the need for a permanent surface waste emplacement. This land will be rehabilitated after the cessation of mining to restore the pre-mining agricultural land-use of grazing on improved pastures.</p> <p>A discussion on the how the project meets the principles of ESD is provided in Section 24.6 in the Hume Coal Project EIS (EMM 2017a).</p> <p>The conservation of native vegetation and threatened species (EIS Chapter 10), soil (Chapter 9), waterways, riparian land and water quality (Chapter 7) are discussed in the EIS and this RTS.</p>

Table 6.12 **Compatibility of the Hume Coal and Berrima Rail projects the aims of the Wingecarribee LEP**

Aims	Compatibility of the Hume Coal Project
To prevent loss of life and property by bush fires, by discouraging the establishment of incompatible uses in bush fire prone areas and incorporating as part of compatible developments protective measures that minimise bush fire risk without unacceptable environmental degradation.	The surface infrastructure area is not located on bushfire prone land. Bushfire protection measures are discussed in chapter 18.6 of the Hume Coal Project EIS.
To provide for a range of sustainable development opportunities in harmony with recreation and lifestyle choices, emerging markets and changes in technology, and capitalise on Wingecarribee's regional distinctiveness and existing tourism asset base.	The underground nature of the project means that the rural landscape nature will remain across the majority of the project area. The project will not affect the tourism industry of the region (refer to Chapter 23). Leading practice design elements have been incorporated into the proposal to either avoid or minimise impacts, including non-caving coal extraction, placing rejects underground and covering coal wagons to minimise dust generation.
To ensure that extractive resources and mineral deposits are not rendered sterile by future development, but at the same time ensuring that subsequent extraction, open cut mining and transportation activities are undertaken in a way that maintains residential amenity.	The project will ensure that the coal resource is not rendered sterile. This project is not open cut mining. Coal from the Hume Coal Project will be transported by rail, predominately through the use of an existing rail line (the Main Southern Rail Line, the Unanderra Line and the Illawarra Line, to Port Kembla), minimising impacts to residential amenity.
To protect and enhance waterways, riparian land and water quality in the drinking water catchments of Wingecarribee.	The impact on waterways, riparian land and water quality in the drinking water catchments of Wingecarribee will be protected because the project will have neutral or beneficial effect on water quality. In addition, protection zones are proposed on the Evandale and Mereworth properties, which is within the Medway Rivulet Management Zone. The total protection area is 42.5 ha, comprising 19.6 ha on the Evandale property and 22.9 ha on the Mereworth property. Clearing, farming and industrial activities (including roads, infrastructure etc) will be restricted within these zones to reduce pollutant loads and to have a positive impact on water quality.

6.3 Wingecarribee Strategic Plan 2031

A number of community and special interest group submissions raised the Wingecarribee Shire Council's Strategic Plan 2031, submitting that the Hume Coal and Berrima Rail Projects are not consistent with the long term strategy for the Shire presented in this plan. The submissions also noted the 'Coal Free Shire' stance of the council, which is displayed on signs along roads entering the LGA.

6.3.1 Coal mining in the Wingecarribee LGA

The above views are noted. However, it is also noted that coal mining developments are currently permissible developments in two zones in the Wingecarribee Shire LGA¹. Coal mines that are State significant development are permitted in many more zones pursuant to the Mining SEPP. Permissibility is discussed above in Section 6.2.1. Further, a number of coal mines continue to operate in the broader Wingecarribee LGA today. The CCL 747 of Tahmoor Colliery, which is an underground longwall mine operating in the Bulli Seam, extends into the northern end of the LGA. The mining leases associated with Dendrobium and Wongawilli Collieries also extend into the north-east of the LGA, with Dendrobium extracting longwall panels within the shire.

Notwithstanding the above, the project has been carefully designed in consideration of the site and context of the area and broader LGA, with some specific project design elements adopted as a result and setting a new benchmark for underground coal mining in NSW. These include the following:

1. the rail wagons that will transport product coal will be covered, both when full of coal and on the return route when empty. The mine will be the first to do so in NSW;
2. all coal reject material will be returned underground to partially backfill the mined-out void, reducing potential visual and other environmental impacts that could be associated with a permanent surface emplacement area; and
3. a mining system will be used that specifically avoids subsidence impacts across the project area. The first workings mining method leaves pillars of coal in place so that the overlying strata is supported, rather than collapsing into the mined-out void, and therefore surface subsidence impacts will be negligible.

Finally, as presented in Chapters 1 and 5 of the Hume Coal Project EIS, it is also noted that the Southern Highlands has a long history of coal mining, with coal exploration and mining occurring since the 19th century. There are two short adits in the north western part of A349, in the valley of Longacre Creek, indicating historical mining activity there. Murrimba Colliery and Belanglo Extended Colliery operated from adits near Black Bobs Creek just to the west of A349, with Murrimba Colliery closing in the 1970s. The Southern Colliery also operated in the 1950s and 1960s near Canyonleigh, south-west of A349. To the north, the Wongawilli Seam was mined at Loch Catherine from 1923 until the 1950s, and the Wongawilli Seam was mined at Berrima Colliery until 2013. The Berrima Colliery mining lease (CCL748) lies immediately north of A349, and the colliery was in operation for over 90 years, providing around 220,000 tonnes of coal per annum to the Berrima Cement Works prior to being placed in care and maintenance in 2013.

It is also noted that the project area for the Hume Coal Project has been subject to an exploration licence since 1985. The exploration licence (A349) was issued on 23 September 1985. Hume coal acquired the lease in December 2010 and commenced exploration drilling in May 2011.

Coal mining is not a new land use to be introduced to the Wingecarribee LGA, but is consistent with past and current land use within the LGA. The 'Coal Free Shire' signage is therefore inconsistent with the zoning provided by the Wingecarribee LEP.

¹ RU1 - open cut mining permitted with consent; IN3 - underground mining permitted with consent.

6.3.2 Wingecarribee Strategic Plan 2031

In 2009, the NSW *Local Government Act 1993* (LG Act) was amended to require every council in NSW to develop and endorse a community strategic plan. Section 402 of the LG Act states that the purpose of the plan is to identify the main priorities and aspirations for the LGA for a period of at least ten years. Accordingly, the Wingecarribee Shire Council initiated development of the Wingecarribee Community Strategic Plan 2031+ (the Plan) in 2009 and adopted the Plan in 2010 following a process of community involvement, exhibition and review.

The Plan sets the goals and strategies for the LGA under five key themes of leadership, people, places, environment and economy. Of particular relevance to the Hume Coal and Berrima Rail projects are the themes of the environment, economy and places. The Hume Coal and Berrima Rail projects advance the objectives of the Plan, as discussed below.

Economy

One of the goals of the plan in relation to the economy is that “Wingecarribee’s diverse economy drives a wide range of job and career opportunities”, and to retain people to live and work in the area. As reported in the Social Impact Assessment for the Hume Coal Project (EMM 2017h), the unemployment rate in the Wingecarribee LGA in December 2015 was 3.3%, or about 760 people compared with 5.8% for NSW (Department of Employment 2016). Notably, the unemployment rate in the Wingecarribee LGA has been increasing while the NSW unemployment rate has remained relatively stable (Department of Employment 2016). The ABS 2016 census notes that 4,731 or 23% of Wingecarribee LGA’s resident workers travel outside of the area to work. Further, a recent report by the Brotherhood of St Laurence titled *An unfair Australia? Mapping youth unemployment hotspots* (March 2018) found that the Southern Highlands and Shoalhaven have the highest youth unemployment rate in all of NSW.

The main industries of employment in the Wingecarribee LGA are health care and social assistance (11.9%), retail trade (11.7%) and manufacturing (10.1%). There was also significant growth in employment in public administration and safety (34.0%), administrative and support services (33.1%) and health care and social assistance (33.0%). Employment declined in information media and telecommunications (-31.2%) and agriculture, forestry and fishing (-21.5%) over the same period (ABS 2011a). The most common occupations in the Wingecarribee LGA are professionals (20.1%), technicians and trade workers (15.7%) and managers (14.7%). There was a large increase in community and personal service workers (37.3%), professionals (23.1%) and sales workers (13.5%) between 2001 and 2011 (ABS 2011a).

The Hume Coal Project and Berrima Rail Project will provide significant and diverse employment over the life of the two projects, providing approximately 454 direct jobs during the construction phase and 316 direct jobs during operations (over a 19 year period). The projects will therefore provide a significant contribution to the further diversification of the economy and job opportunities, which is important in a region with increasing unemployment. The project will also mean that more people can live and work in the local area without being forced to travel to find work (due to the commitment for all employees to live within a 45 minute travel time). During the public exhibition period, Hume Coal fielded enquiries from locals who have to travel to Mudgee, the Hunter Valley, Tasmania and Western Australia for work in the mining industry.

Environment

The Plan also sets a number of goals in relation to the environment, which include:

1. Wingecarribee’s distinct and diverse natural environment is protected and enhanced.
2. Wingecarribee communities live sustainably by choice.
3. Wingecarribee achieves continuous reduction in waste generation and disposal to landfill.
4. Wingecarribee community has a carbon neutral economy.

Of relevance to the Hume Coal Project and the Berrima Rail Project is the first goal of protecting and enhancing the natural environment. The projects were specifically designed to avoid environmental impacts as much as possible, namely avoiding subsidence through the mining method chosen, eliminating the need for a permanent surface waste emplacement, and covering coal rail wagons to minimise the dust emissions from coal transport. The underground nature of the mine means that limited land will be cleared for the project, with the surface infrastructure area specifically situated on land previously cleared for agricultural activities. 64 paddock trees will be removed by the Hume Coal Project, and this removal will be offset. A potential offset site was identified as part of the preparation of the biodiversity assessment, which identified an area of 32 ha which would meet the offset requirement of the project. The overall outcome of the offsetting arrangement will be an increase in the area and quality of land conserved for biodiversity protection, meaning the ecological integrity of the area will be strengthened. In addition, tree corridors have already been planted around the project area which will perform a dual purpose of providing visual screening as well as positive biodiversity outcomes.

Places

The Plan also sets a number of goals and strategies in relation to 'places'. Specifically, it states that Wingecarribee is a place of significant heritage conservation, with the goal of ensuring the unique heritage qualities of towns, villages and special areas are protected. In this regard, the mine plan was developed so that mining under State heritage listed properties is avoided. Further, given the distance of the proposed surface infrastructure area to nearby towns, the closest of which is Berrima, there will be no amenity related impacts on towns and villages, with noise and dust levels predicted to be within relevant criteria. The mine will also not be seen from Berrima. In addition, the Remembrance Driveway, which was dedicated by the former steel federation, will not be impacted by the projects.

The locally listed Mereworth house and garden is within the project area. Hume Coal has invested considerably in repairing and restoring the property. A conservation management plan will be developed for the property in consultation with relevant stakeholders, and the company has allocated an annual budget for maintenance, repairs and upgrades.

The region has a long industrial heritage. The prominent Berrima Cement Works have been operating since around 1929, along with numerous coal mines, as discussed above in Section 6.3.1. Australia's first ironworks also operated in Mittagong from 1848². The project is consistent with this long and important heritage.

6.4 Potential for modification and expansion

Numerous community members and specialist interest groups raised concerns relating to the potential for expansion or significant changes to the project once approved. A number submitted that there is a risk that if the mine is approved, Hume Coal would seek to modify the development consent to allow for a longwall mine or an open cut, extend the life of the project or footprint of the mine, and that once approved, modifications to expand will be easier to obtain. One special interest group noted that A349 extends much further than the project area, and that this implies an extension to the mining area could be sought in the future.

As described in Chapter 1 of the EIS for the Hume Coal Project, the project design for which approval is sought has been developed over many years; evolving progressively on the basis of detailed geological, engineering, environmental, financial and other technical investigations to define the mineable resource that can be extracted efficiently and to address identified environmental and technical constraints. This process began with exploration drilling in May 2011, culminating in the final project design presented in the EIS that was submitted to the DPE in March 2017, some six years since investigations began. The project for which Hume Coal is seeking approval for is therefore a carefully considered development.

² Southern Highland News, <https://www.southernhighlandnews.com.au/story/2429124/highlands-history-australias-first-ironworks-operated-at-mittagong-from-1848/> accessed 14 June 2018

Notwithstanding, section 4.55 of the EP&A Act provides a number of pathways for development consents for State significant development to be modified in circumstances where this is required. There are three types of modifications under section 4.55:

- section 4.55(1) modifications involving minor error, misdescription or miscalculation;
- section 4.55(1A) modifications involving minimal environmental impact; and
- section 4.55(2) 'substantially the same development' modifications.

Modification under sections 4.55(1) and (1A) are applicable to minor modifications that involve a minor error, misdescription of miscalculation, or involving minimal environmental impact.

Modifications involving greater changes would be subject to approval under section 4.55(2) of the Act. Pursuant to section 4.55(2)(a), a consent authority can only modify the consent if it is satisfied that the development to which the consent as modified relates is substantially the same development for which consent was originally granted. Thus any application to modify the Hume Coal Project or Berrima Rail Project development consents, if granted, to enable for example an expansion of the footprint, would therefore have to satisfy the 'substantially the same' test. Importantly, this test is applied to the consent as originally approved. Significant changes to the project would not meet this test, and would require new development applications under the EP&A Act.

Notwithstanding the above, any application to modify a development consent, or any new development application, would be required to be assessed under the relevant provisions of the EP&A Act, including the heads of consideration under section 4.15, which are required to be taken into consideration by a consent authority when assessing an application. Approval of an application to modify a development consent, or a new development application, would only be granted if the proposal met the relevant provisions of the EP&A Act, including the heads of consideration under section 4.15.

A number of submissions specifically expressed concerns about the risk of Hume Coal seeking to change the project to a longwall mine or an open cut mining operation once approval is granted. Such a change in mining method from the non-caving method for which approval is now being sought is unlikely to meet the 'substantially the same' test in accordance with the requirements of section 4.55(2).

As explained in the Hume Coal Project EIS (EMM 2017a), open cut mining methods were never considered to be an appropriate method for extracting the coal resource in the project area due to the nature and location of the deposit. Aside from the increased surface disturbance related environmental impacts associated with an open cut mine when compared to an underground mine, the stripping ratio would exceed 20 bcm/tonne even in areas of the deposit with a relatively shallow depth of cover, meaning that this option is not economically viable.

A submission claimed that the fact A349 extends beyond the project area implies an extension to the mining area could be sought in the future. The activity for which approval is being sought from the NSW and Commonwealth Governments only relates to the extraction of coal within the defined project area. The project area is consistent with the mining lease application boundaries, in the areas where underground mining is proposed.

6.5 Objects of the EP&A Act

It was submitted that the development is not rational and orderly development nor sustainable development, both of which are key objects of the EP&A Act. Further, it was contended that instead, the proposal represents unsustainable development, having adverse social, environmental and economic impacts, which are neither mitigated or outweighed by any benefits.

The objects of the EP&A Act changed with effect from 1 March 2018. This section discusses the submission with reference to the objects before and after the amendment.

6.5.1 Objects at the time of submission and prior to the 2018 amendment

As described in Section 3.2.4 of the Hume Coal Project EIS, the orderly and economic use of land is best served by development which is permissible under the relevant planning regime, is in accordance with the prevailing planning controls and which does not unduly restrict other beneficial uses around a project site. The project is a permissible development which is consistent with the relevant planning controls, as documented in the EIS. The project will recover a valuable coal resource without significant residual impacts and will bring significant social and economic benefits to the region. The current land use of the surface infrastructure area is an agricultural use and, as described in the economic assessment prepared for the project (BAEconomics 2017), the estimated foregone value added of agriculture production (ie the land removed from production due to the project multiplied by the corresponding gross margins) is \$1.72 million. With a net benefit of \$295 million, the project therefore represents the highest value land use. Wages for labour will contribute to the regional economy, as well as regional spending for production related inputs.

The project is responsive to its surroundings and will limit all external impacts to acceptable levels. Where unmitigated impacts are predicted to exceed regulatory criteria, ie for noise and groundwater, mitigation measures have been proposed and committed to, to reduce these residual impacts to an acceptable level. Accordingly, the project will not displace other beneficial land uses in the locality.

As such, the project is consistent with the objects of the EP&A Act.

A revised project evaluation in consideration of the social, environmental and economic impacts is provided in Chapter 28 of this report. A more detailed discussion on the consistency of the project with the objects of the Act is provided in Section 3.2.4 of the Hume Coal Project EIS.

6.5.2 Objects since 1 March 2018

The objects of the EP&A Act were amended from 1 March 2018. Sections 5(1)(iii)-(v) were removed, and sections 1.3(f)-(h) were inserted. The new objects are discussed below.

(f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage)

The nature of the mine means that the potential for project-related impacts to built and cultural heritage has been primarily avoided, or minimised, as much as possible. With regards to built heritage, the mine plan was specifically designed to avoid undermining state heritage listed items, which was a conservative approach due to the non-caving mine method adopted. As described in Chapter 24, Hume Coal consulted with EMM archaeologists and Registered Aboriginal Parties, to avoid impacts to Aboriginal sites where possible. This involved desktop constraints analyses and staged archaeological surveys to identify the most archaeologically sensitive areas so that the project could be designed to avoid or minimise impacts to these areas.

A major design modification of the initial surface infrastructure layout involved setting back most of the surface infrastructure area beyond 200 m from the banks of the main drainage lines in the project area (Oldbury Creek and Medway Rivulet). Consequently, the surface infrastructure area will avoid most of the nearby Aboriginal sites and areas of moderate archaeological sensitivity. Overall, a substantial archaeological resource will remain in the project area, considering that 191 of the 219 Aboriginal sites assessed in the Aboriginal Cultural Heritage Assessment (91%) will not be impacted by the Hume Coal Project or Berrima Rail Project.

(g) to promote good design and amenity of the built environment,

The siting and design of the surface infrastructure area involved an extensive process, comprising the consideration of numerous locations and layout options. A suitably sized area, relatively free from environmental, urban and other constraints was sought, specifically to enable:

- avoidance of more densely populated areas and areas with fragmented land ownership;
- avoidance of flood-prone land;
- avoidance of large tracts of native vegetation;
- integration with the existing topography and landform by selecting a relatively flat site where the need for cut and fill is minimised, and with the site surrounded by landforms and/or vegetation that would minimise exposure from the Hume Highway and other sensitive viewing points;
- minimisation of the number of watercourse and road crossings by new infrastructure; and
- concealing surface infrastructure from sensitive receptors as much as possible, to minimise the potential for visual, noise, dust and amenity impacts.

(h) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants,

The project involves the construction of a temporary construction accommodation facility. This facility will provide safe and appropriate accommodation for the construction workers, whilst also ensuring that undue pressure is not placed on local rental and housing stock during the construction period. The village will include a dining hall, gym, and recreation room. The buildings required during the operational phase of the project will be constructed and maintained in accordance with the relevant building codes.

6.6 Precautionary principle

Submissions claimed that the Hume Coal Project does not accord with the precautionary principle. Reasons for this included claims that the 'science is imprecise' and that there are a number of uncertainties, especially in relation to impacts on groundwater. In particular, a submission on behalf of the Coal Free Southern Highlands group contends that the precautionary principle is triggered because Hume Coal has failed to demonstrate in its EIS that the threat of serious environmental damage does not exist or is negligible.

The precautionary principle holds that where there are threats of serious or irreversible environmental damage, a lack of full scientific certainty should not be used as a reason for postponing measures to prevent such damage.

As noted in the Coal Free Southern Highlands submission, the precautionary principle was defined by CJ Preston in the Telstra case at [128]³.

“The application of the precautionary principle and the concomitant need to take precautionary measures is triggered by the satisfaction of two conditions precedent or thresholds: a threat of serious or irreversible environmental damage and scientific uncertainty as to the environmental damage. These conditions or thresholds are cumulative. Once both these conditions are satisfied, a precautionary measure may be taken to avert the anticipated threat of environmental damage, but it must be proportionate.”

Therefore, there are two condition precedents that must be proved before the precautionary principle is triggered. These are:

1. a “threat of serious or irreversible environmental damage”⁴, which is “based on scientifically plausible reasoning, ... scenarios or models”⁵, and “adequately sustained by scientific evidence”⁶; and
2. a “highly uncertain of threat”⁷, or “considerable level of scientific uncertainty”⁸ as to the “nature and scope of the environmental damage”⁹. This is demonstrated by showing that:
 - a. there is a “reasonable scientific plausibility” that there is a “cause-and-effect relationship” between the project and the threatened environmental damage, or
 - b. “a threat or risk of environmental damage is considered scientifically likely”, which is “when empirical scientific data” or “hypothesis formulated with methodological rigour that wins support of minor part of the scientific community” “make it reasonable to envisage” the environmental damage, “even if it does not enjoy unanimous scientific support.”¹⁰

Notably, the precautionary principle does not apply if the first condition precedent is satisfied but the second is not.

Measures will still need to be taken but these will be preventative measures to control or regulate the relatively certain threat of serious or irreversible environmental damage, rather than precautionary measures which are appropriate in relation to uncertain threats.¹¹

The Hume Coal Project does not meet either condition. Further discussion on the two condition precedents is provided below in section 6.6.1 and 6.6.2.

The consequence of the principle applying

If the principle applies, the decision-maker is “to assume that there is, or will be, a serious or irreversible threat of environmental damage and to take this into account notwithstanding that there is a degree of scientific uncertainty about whether the threat really exists”.¹²

³ Telstra Corporation Ltd v Hornsby Shire Council [2006] NSWLEC 133 (Telstra case)

⁴ Telstra case paragraphs 129,132

⁵ Telstra case paragraph 133

⁶ Telstra case paragraph 134

⁷ Telstra case paragraph 146

⁸ Telstra case paragraph 147

⁹ Telstra case paragraph 140

¹⁰ Telstra case paragraph 148

¹¹ Telstra case paragraph 149

The application of the principle does not “necessarily prohibit the carrying out of a development” because that will “result in a paralysing bias in favour of the status quo and against taking precautions against risk. The precautionary principle so construed would ban “the very steps that it requires”¹³.

As such, the consequence of triggering the principle is that the decision maker must “assess the risk-weighted consequences of various options and select the option that affords the appropriate degree of precaution for the set of risks associated with the option.”¹⁴

This may require “taking of proportionate precautionary measure ... to avert the anticipated threat of environmental damage.”¹⁵

It must be borne in mind the Courts repeat warnings against baseless, unscientific claims from triggering the principle. These warnings were summarised in the Telstra case:

- “Not every claim or scientifically unfounded presumption of potential risk to human health or the environment can justify the adoption of national protective measures.” (Telstra case paragraph 134)
- “...The mere apprehension of a possible ‘peril’ could not suffice...” (Telstra case paragraph 136)
- “The precautionary principle does not apply, and precautionary measures cannot be taken, to regulate a threat of negligible environmental damage.” (Telstra case paragraph 138)
- “...simple hypothesis, speculation, or intuition” is insufficient to establish the second condition precedent. (Telstra case paragraph 148)
- “Rationality dictates that the precautionary principle and any preventative measure cannot be based on a purely hypothetical approach to the risk, founded on mere conjecture which has not been scientifically verified.” (Telstra case paragraph 159)

Regarding the second condition precedent, “On a literal reading, the threshold is crossed whenever there is a lack of “full” scientific certainty. Yet, such a literal interpretation of the principle would render this condition meaningless.” (Telstra case paragraph 142)

- “the [precautionary] principle’s field of application must exclude those risks characterised as residual, that is, hypothetical risks resting on purely speculative considerations without any scientific foundation. Speculation, conjecture, intuition, warnings, denunciations, or implications should not suffice in and of themselves to justify an attitude of precaution”. (Telstra case paragraph 160)

¹² Telstra case paragraph 152

¹³ Telstra case paragraph 154

¹⁴ Telstra case paragraphs 179-181

¹⁵ Telstra case paragraphs 128, 156

6.6.1 First condition precedent

In relation to the first condition, consideration of seriousness or irreversibility of the environmental damage depends on various factors such as the spatial scale of the threat, the temporal scale of possible impacts, the reversibility of the possible impacts and, if reversible, the timeframe for reversing the impacts, and the difficulty and expense of reversing the impacts¹⁶.

As described in the Hume Coal Project EIS, the proposed mine plan and overall project design were progressively devised over several years and based on detailed investigations of geological, environmental, engineering and financial considerations. The baseline environmental investigations began in 2011 and included monitoring of groundwater, surface water, ecology, air quality, noise, soils, heritage, visual, social and economic conditions, and geologic factors relating to potential subsidence. Potential risks were identified and taken into account in the project design. Hume Coal has therefore developed a comprehensive understanding of the project area and environment over the last seven years.

As explained in Chapter 6 of the Hume Coal Project EIS, project planning included multiple rounds of design, assessment and refinement to avoid impacts or, if unavoidable, minimise or offset them. A number of leading practice design elements have been incorporated into the proposal to either avoid or minimise impacts, including non-caving coal extraction, placing rejects underground and covering coal wagons to minimise dust generation. That is, lack of full scientific certainty has not been used as a reason to postpone the mitigation measures (which is what the precautionary principle seeks to avoid).

The result is that for all potential impacts no serious or irreversible harm will occur. Unavoidable impacts will meet applicable regulatory criteria, such as for noise, air quality and water quality. The groundwater model predicts there will be up to 94 bores affected by drawdown of 2 m or more as result of the project; however it has also been demonstrated that make good measures can and will be implemented to mitigate these impacts (refer to the Make Good Strategy in Appendix 2 (EMM 2018a)). Further, the numerical groundwater model demonstrates that the water levels in all bores will fully recover approximately 76 years after the start of mining, with 75% of the recovery occurring on average across all bores within 20 years. Therefore, there will be no serious or irreversible harm to the groundwater source.

In instances where no regulatory criteria exist, such as for social or land subsidence impacts, the project has been designed to avoid adverse impacts and in many instances will have a positive outcome. Therefore, the project does not trigger the first condition precedent of the precautionary principle because there will be no serious or irreversible environmental damage.

6.6.2 Second condition precedent

In relation to the second condition precedent, following is an analysis of the statements contained in the Coal Free Southern Highlands submission that the first and second condition precedent is satisfied. The following analysis is provided of the Independent Expert Scientific Committee (IESC) advice in order to respond to the submission only, without making a statement on the correctness of the IESC advice. Contrary to what the submission alleges, the first two condition precedents are not satisfied.

The original IESC advice is also now out of date since the original groundwater model has been upgraded and additional analyses have been run, and concerns raised in the advice have now been addressed.

¹⁶ Telstra case paragraph 131

Key potential lists

The IESC Advice lists a number of issues as “key potential impacts”.

The lists are silent on whether the issues are serious or irreversible, or whether there is scientific evidence establishing a reasonable scientific plausibility that there is a cause-and-effect relationship. As such, those lists are insufficient to trigger the principle.¹⁷

Inability to verify key conclusions

The IESC Advice states its inability to “verify” “key conclusions”.

Not being able to verify key conclusions (a lack of a conclusion) does not demonstrate scientifically that there is going to be environmental damage, or that the environmental damage is going to be serious or irreversible (a positive conclusion, which is required to satisfy the first condition precedent).

Similarly, not being able to verify “key conclusions” (a lack of a conclusion) does not establish a reasonable scientific plausibility that there is a cause-and-effect relationship between the project and the threat of damage (a positive conclusion, required to satisfy the second precedent).

Relying on the IESC’s alleged inability to verify key conclusions as a basis for satisfying either or both of the two condition precedents misconstrues the principle.

Claiming that the proponent has failed to provide sufficient certainty illegally reverses the burden of proof by getting the proponent to prove the negative, which is impossible to do. Paragraph 144 of the Telstra case states:

“It cannot be unequivocally stated that a particular phenomenon will never cause adverse effects. This is because a null hypothesis can never be proven through processes of inductive logic.”

Even if the two condition precedents were satisfied by the IESC advice, the appropriate consequence is to provide the information that the IESC requested, rather than refusing the project.¹⁸

Ways to improve limitations or inconsistencies in Hume Coal’s environmental assessment

The IESC advice points to limitations or inconsistencies in Hume Coal’s environmental assessment and suggests ways to improve it¹⁹.

Even if Hume Coal’s environmental assessment “could be improved”, or contains “limited” assessments, “contains gaps” or is “unclear”, is “uncertain”, such simple assertions are not scientific reasoning, scenario or evidence of the threat of serious or irreversible environmental damage; something that must be proved before the first condition is satisfied.

Put another way, not being able to verify something is not the same as saying the thing will cause environmental damage, or that the damage will be serious or irreversible. The IESC was not asked if the threats of environmental damage were serious or irreversible.

¹⁷ Telstra case paragraph 134

¹⁸ Telstra case paragraphs 179-181

¹⁹ Under the heading “Application of appropriate methods and interpretation of model outputs:”, and numbered paragraphs 1, 2.a., 2.c-d, 3-10, and 28.

Pointing at alleged deficiencies in Hume coal's environmental assessment does not amount to providing scientific evidence that the threat of environmental damage is considered scientifically likely, something that must be proved positively before the second condition is satisfied. Lack of full assessment does not equate to scientific reasoning that there is a threat of serious or irreversible environmental damage.

Even if the principle applied, the appropriate response is to provide further information around the mitigation measure as the IESC requested, rather than refusing the project.

Notwithstanding, a response regarding the adequacy of the EIS is provided in Section 27.1 of this RTS report. As stated, a robust EIS was prepared over a number of years in accordance with the requirements of the DPE, DoEE and other government agencies, as set out in the SEARs. The complex areas of groundwater, economics, noise and the mine design have been peer reviewed by experts on behalf of DPE. The overall outcome of all of the expert reviews and the additional work undertaken on groundwater and the mine design is that none resulted in the requirement to make any changes to the project. The project description as described in Chapter 2 of the Hume Coal Project EIS remains an accurate description of the project, as does the project evaluation and justification.

Potential underestimation of environmental impacts

The IESC advice raises concern at paragraph 2b that the groundwater model's environmental impacts may be underestimated or in some cases, overestimated.

However, even if true, this paragraph contains no analysis of whether the potential impacts amount to "serious or irreversible environmental damage"; an assessment which must be based on scientific evidence.

Consideration of seriousness or irreversibility of the environmental damage depends on various factors such as the spatial scale of the threat, the temporal scale of possible impacts, the reversibility of the possible impacts and, if reversible, the time frame for reversing the impacts and the difficulty and expense of reversing the impacts²⁰. The IESC advice does not consider any of these factors, or even make a claim that the underestimated impacts are serious or irreversible.

As such paragraph 2b does not satisfy the first condition precedent.

Even if paragraph 2b was sufficient to trigger the precautionary principle, the appropriate response is not to refuse the project, but to commission a sensitivity analysis of the groundwater model, just as requested by the IESC in paragraph 2.b. Case law makes it clear that the effect of triggering the principle is to enable the taking of measures to mitigate the threat of environmental harm, where such measures are practicable. As such, the appropriate response is to recalibrate the groundwater model (as requested by the IESC), rather than refusing the project.

Notwithstanding, and as discussed in the Revised Water Assessment report (Appendix 2) and Chapter 9, a detailed uncertainty and sensitivity analysis has been undertaken for the numerical groundwater modelling by Hydrosimulations. The revised model has also been peer reviewed and accepted by the NSW Government independent peer reviewer.

²⁰ Telstra case paragraph 131

Proposed mitigation measures need more proof or consideration

The second and third questions put to the IESC concerns the mitigation measures to be taken.²¹

The IESC raises concerns that some of the measures “still needs to be proven” or “need further consideration”. For others, the IESC recommends additional data, such as additional monitoring locations or updating the model with newer data.

The IESC advice does not contain any discussion that the alleged unproven measures will cause serious or irreversible harm, or that the failure of the alleged unproven measures will lead to serious or irreversible environmental harm. As such, the first condition precedent is not satisfied.

An assertion that the mining method “still needs to be proven” or that a proposed measure need to be given “further consideration”, even if true, is merely an assertion of a lack of certainty (a negative statement), rather than a positive conclusion based on scientific reasoning that there is a likelihood of the environmental damage (required to satisfy the second condition precedent).

The IESC advice lacks the requisite “empirical scientific data” that shows it is “reasonable to envisage a scenario” “where a threat or risk of environmental damage is considered scientifically likely”. Neither has the IESC presented a “hypothesis formulated with methodological rigour and wins the support of part of the scientific community” that “threat or risk of environmental damage is considered scientifically likely.”

At best, the IESC statement is a “claim or scientifically unfounded presumption of potential risk to human health or the environment” which cannot “justify the adoption of national protective measures.”²²

Nevertheless, as described in Chapter 16, the mining method and mine design is robust, and this has been re-affirmed by the additional numerical modelling undertaken by Dr Keith Heasley (refer to Section 4.2 and Chapter 16).

ii Claim that other experts highlight lack of data and use of inappropriate parameters

The submission states that “other experts highlight lack of geological data, the use of parameters which are not applicable to the site for hydraulic conductivity”, and this means that the principle is triggered. Because the submission does not provide any more information on these ‘experts’, this response assumes that the claim is true for the sake of providing a complete response.

Even if the claim is true, as discussed above, criticism of lack of data (a negative claim) cannot amount to the requisite scientific evidence of threat of serious or irreversible damage, or scientific hypothesis that the threat is likely (a positive claim).

Even if Hume Coal used inappropriate data, it not mean the objector has scientifically proven that there is a threat of environmental damage, that damage may be serious or irreversible, and that scientific evidence show that the damage is likely.

Nevertheless, again as stated above, a robust EIS was prepared over a number of years using extensive baseline data. Further, the complex areas of groundwater, economics, noise and the mine design have been peer reviewed by experts on behalf of DPE.

²¹ Numbered paragraph 11, 12 and 17

²² Telstra case paragraph 134

Even if the principle did apply on the basis of the claims, the appropriate consequence is to provide the geological data and to use the appropriate parameters. It is incorrect to justify refusal of a project on basis of the principle alone.²³ Further, the submission contends that because Hume Coal has admitted the harm, the precautionary principle is applied. Because in their view the precautionary principle is triggered, the burden of proof has shifted to Hume Coal to prove that the threatened harm does not exist, and as a consequence of the principle applying, the project should be refused.

- (iv) **the Precautionary Principle is triggered** requiring Hume to prove that the threat does not exist or is negligible. Hume's admission of harm set out above means the precautionary principle has not been satisfied. Development consent should be refused on this basis.

The abovementioned claim is incorrect because, as discussed above, there is no threat of serious or irreversible environmental damage, and therefore the first condition precedent of the principle has not been triggered.

Further, it is incorrect to claim that Hume's admission of harm results in application of the principle. The principle applies to uncertain threats only²⁴. This is because, if the threat is relatively certain (because Hume Coal has allegedly admitted it), there is no reason for the principle to apply.

Even if the principle did apply, it is incorrect to require the refusal of the project on the basis of the principle alone.

Conclusion

The application of the principle does not "necessarily prohibit the carrying out of a development" because that will "result in a paralysing bias in favour of the status quo and against taking precautions against risk. The precautionary principle so construed would ban "the very steps that it requires"²⁵.

The application of the principle requires the decision maker to assume the threat as real, then "assess the risk-weighted consequences of various options and select the option that affords the appropriate degree of precaution for the set of risks associated with the option."²⁶ The decision maker is not to give more weight to the assumed threat over other factors that are relevant to the decision.²⁷

6.7 Site suitability

A few submissions from the community and special interest groups stated that the area is not suitable for the development. One community submission claims that mining should only be permitted on unused land and subsequent settlement by people willing to live in an industrial environment. One special interest group also submits that the prohibition of mining in some of the land use zones within the project area is evidence the site is not suitable for the coal and rail projects.

As stated above, section 4.15 of the EP&A Act describes the matters the consent authority is to consider when assessing a development application, one of which is the suitability of a site for the development. The suitability of the project area for both the Hume Coal Project and the Berrima Rail Project was discussed in each EIS.

²³ Telstra case paragraphs 154, 179-181

²⁴ Telstra case paragraph 149

²⁵ Telstra case paragraph 154

²⁶ Telstra case paragraphs 179-181

²⁷ Telstra case paragraphs 154 and 177

As noted in Section 6.2, the fact that the NSW zoning rules (when considering the order of precedent between SEPP and LEP) permit underground mining in the project area shows that the mine may be suitable in the area. Approval by the NSW Government has been granted in this area for exploration activities since the mid 1950's. The fact there have been a granting of the right to explore with the intent to develop a coal mine in the area over a long period of time indicates the area is deemed suitable for coal mining activities, provided environmental impacts can be managed and mitigated. Principally, the Hume Coal Project will efficiently recover an economic coal resource beneath privately owned land. Resources extracted in this way avoid land use conflicts by continuing existing land uses at the surface and minimising impacts to significant environmental, cultural and built features. The site is well served by necessary services and infrastructure, particularly nearby rail infrastructure and Port Kembla. A range of commitments have been made by Hume Coal to mitigate potential impacts on surrounding land uses. When these commitments are applied, the project is unlikely to have a significant land use impacts.

Is it also notable that the Southern Coalfield is the only significant source of quality hard metallurgical coal in NSW. Proposed mining developments need to balance the impacts of a development in a particular area, with the location of the resource. Within the project area, coal deposits have been extensively explored and analysed for well over 60 years and particularly since 2011 by Hume Coal. The results show the coking coal product has the necessary characteristics to meet export coking coal specifications. The remaining unallocated prime coking coal resources in the Southern Coalfield are in the Bulli and Balgownie seams underlying the Campbelltown-Camden-Picton region, and in the Wongawilli Seam in the southern part of the coalfield. Further mine development in much of the Campbelltown-Camden-Picton area is constrained by its closeness to existing and planned urban areas. Conversely, the project area is in a rural area and has the substantial advantage of closeness to rail infrastructure that links directly to the Port Kembla coal terminal. The coal project seeks to draw on these positive features.

In relation to the Berrima Rail Project, the project will facilitate the efficient transport of coal produced by the Hume Coal Project to market while also maintaining current rail usage by other users, currently Boral, Inghams and Omya. The fact that much of the project area is on or adjacent to an existing railway evidences the fact that the site is suitable for railways. The project will avoid land use conflicts by using existing rail infrastructure where possible and by locating new rail works in areas which avoid impacts to significant environmental, cultural and built features. A range of commitments have been made by Hume Coal to mitigate potential impacts of the project on surrounding land uses, and with the implementation of these commitments, the project is unlikely to have a significant impact on these land uses.

6.8 The public interest

A number of community members, one business submission and a specialist interest group submitted that approval of the Hume Coal and Berrima Rail Projects would not be in the public interest.

The Hume Coal Project and Berrima Rail Project will enable the development of a valuable, publically owned natural resource (Wongawilli Seam coal). At the same time valuable environmental and cultural resources will be managed effectively and will be protected, as described in detail in the EIS and further in this RTS report. When the economic and social benefits of the project are also taken into account, it is evident that community welfare will increase. The project's design and proposed management procedures are based on a comprehensive understanding of environmental conditions in and around the project area. The design avoids threats of serious or irreversible environmental damage.

As noted above in Section 6.7, the Southern Coalfield is the only significant source of quality hard metallurgical coal in NSW. Within the project area, coal deposits have been extensively explored and analysed for well over 60 years and particularly since 2011 by Hume Coal. The results show the majority of the coal has all the necessary characteristics to meet export coking coal specifications. The project will transform this natural capital (coal), into economic and social capital in the form of greater income and employment, and material capital in the form of steel and other products that are essential for everyday life.

In addition to the above, and relevant to the public interest, is the significance of the resource. Matters that can be used to determine the resource's importance for NSW are: employment generation, expenditure, including capital investment, and royalty payments to the state government. The resource's importance in light of these factors can be summarised as follows:

1. Employment generation: at its operational peak the mine will employ approximately 300 full time jobs.
2. Expenditure: capital expenditure will be around \$860 million and operating expenditure will be around \$1.4 billion over the life of the mine.
3. Royalties: payments to the NSW government will total around \$266 million over the life of the project in 2016 dollars.

It is evident the project, which will develop the dormant publically owned resource of Wongawilli Seam coal, will be of significant benefit to the local and broader NSW communities, and for the reasons given above, will serve the public interest.

A discussion on the public interest is also provided in Section 3.2.5 and Chapter 24 of the Hume Coal Project EIS (EMM 2017a).

6.9 Voluntary Planning Agreement (or similar mechanism)

A few submissions from the community and special interest groups raised the issue of a Voluntary Planning Agreement (VPA), claiming a lack of detail in the EIS relating to a VPA. A submission on behalf of Battle for Berrima raised a concern that no VPA was provided with the development application, nor a legally binding offer, which they claim would ordinarily be part of an exhibited development application package.

As stated in the Hume Coal Project EIS, it is expected that the requirement to enter into a VPA or similar mechanism will be a condition of development consent, if the project is approved. Hume Coal is committed to entering into a VPA, or similar mechanism, as per the conditions of project approval, if granted. The process for negotiating a VPA occurs throughout and beyond the assessment period for a project. Contrary to what is stated in the Battle for Berrima submission, the details of a VPA are not ordinarily part of an 'exhibited development application package'.

The Battle for Berrima's criticism that no legally binding offer was provided is contrary to the law, since section 7.7(1) of the EP&A Act provides that requiring a planning agreement to be entered into before a development consent can be considered or determined has no effect, and section 7.7(2) provides that a consent authority cannot refuse development consent on the ground that a planning agreement has not been entered into.

Hume Coal has approached WSC on a number of occasions to commence discussions on a suitable VPA or similar mechanism. The WSC passed a motion (as detailed in the WSC document: *Agenda for the Ordinary Meeting of Council Wednesday 14 June 2017*) that Council wait until such time as the Planning Assessment Commission (PAC, now the Independent Planning Commission (IPC)) make a final decision on Hume Coal's proposal before Council consider entering into a draft VPA.

In the absence of any reasonable expectation of dialogue with the WSC, Hume Coal made a formal VPA offer to the Minister for Planning on 6 September 2017 as a relevant planning authority. This meets the requirements of making a formal offer and to allow the IPC to consider that offer as part of its project determination.

6.10 State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

Compliance of the Hume Coal Project with Clauses 12, 12AB and 14 of the Mining SEPP were questioned by special interest groups.

Clause 12

Clause 12 of the Mining SEPP requires a consent authority to consider the compatibility of the development with other land uses. It states:

Before determining an application for consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must:

(a) consider:

(i) the existing uses and approved uses of land in the vicinity of the development, and

(ii) whether or not the development is likely to have a significant impact on the uses that, in the opinion of the consent authority having regard to land use trends, are likely to be the preferred uses of land in the vicinity of the development, and

(iii) any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses, and

(b) evaluate and compare the respective public benefits of the development and the land uses referred to in paragraph (a) (i) and (ii), and

(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a) (iii).

Paragraph 12(a) – evaluation of impacts on existing uses

Land uses near the mine include forestry, industrial, environmental management, agricultural, rural residential and residential developments. Potential impacts on these land uses have been assessed in the EIS, demonstrating that the project will not have a significant impact on existing and approved land uses around the project. Importantly, due to the underground nature of the project, existing land uses across the majority of the project area will be able to continue during the construction and operation of the project. Just 2% of the project area for the Hume Coal Project will experience a change in land use to accommodate the mine surface infrastructure area.

Paragraph 12(b) – evaluate and compare public benefits of existing land uses and the project

A cost benefit analysis was undertaken as part of the economic impact assessment of the project (BAEconomics 2017).

The existing land uses in the local area include:

- Industrial;
- Agriculture;
- Tourism;

- public infrastructure and utilities;
- forestry;
- environmental management;
- rural residential; and
- residential developments.

The project will have no material impact on any of these land uses other than those explicitly specified in the Economic Impact Assessment.

In comparison to the existing land uses, the project will result in the following increases in public benefits:

- royalties;
- increases in income taxes resulting from the comparatively higher levels of income associated with mining salaries, as well as company income tax;
- increases in payroll tax resulting from the comparatively higher levels of income associated with mining salaries; and
- increases in utilisation of underutilised public assets such as the ARTC-owned and controlled public railways.

The economic assessment (BAEconomics 2017) determined the net benefit of the project to NSW, as well as to the local community, taking into account existing land uses. The current land use of the surface infrastructure area is predominantly an agricultural use and, as described in the economic assessment, the estimated foregone value added of agriculture production (ie the land removed from production due to the project multiplied by the corresponding gross margins) is \$1.72 million. With a net direct benefit to NSW of \$295 million, the project therefore represents the highest value land use.

Paragraph 12(c) – evaluation of mitigation measures to address any incompatibility

The project evaluation provided in the Hume Coal EIS (refer to Chapter 24) demonstrates that due to the carefully considered mine design and other avoidance and mitigation measures committed to, such as the covering of coal wagons, the emplacement of rejects underground, and the make good measures identified for privately owned bores, the project is compatible with existing land uses.

Clause 12AB

Clause 12 AB of the Mining SEPP provides nondiscretionary development standards for mining. Paragraph (1) states that (emphasis added):

“The object of this clause is to identify development standards on particular matters relating to mining that, if complied with, prevents the consent authority from requiring more onerous standards for those matters (but that does not prevent the consent authority granting consent even though any such standard is not complied with).”

In relation to the non-discretionary standards relating to aquifer interference, DI Water state in their submission they consider that the project, in accordance with the AIP minimal impact criteria, triggers a ‘Level 2 impact’ for drawdown in landholder bores and a ‘Level 1’ impact in groundwater quality. If predicted impacts are less than or equal to the Level 1 minimal impact considerations, then these impacts will be considered acceptable.

The words in parenthesis of cl 12AB(1) make it clear that non-compliance with clause 12AB(7) does not prevent approval of a project. However, it does mean that additional studies, conditions and mitigation measures may be required for the project before it is approved. AIP sections 3.2 and 3.2.1 discuss the need for further studies if level 1 not met:

“under the Level 2 minimal impact considerations, what further studies are necessary to assess whether the project will not prevent the long-term viability of a relevant dependent ecosystem or significant site”

“Where the predicted impacts are greater than the Level 1 minimal impact considerations by more than the accuracy of an otherwise robust model, then the assessment will involve additional studies to fully assess these predicted impacts. If this assessment shows that the predicted impacts do not prevent the long-term viability of the relevant water-dependent asset, as defined in Table 1, then the impacts will be considered to be acceptable.”

These additional studies and identification of mitigation measures required by the AIP have been undertaken and are presented with this RTS report (refer to Appendix 2). The assessments demonstrate certainty in the predicted impacts and licensing requirements of the project, and that the required mitigation measures (ie make good measures) have been identified and can be achieved, respectively. The assessment demonstrates that the long term viability of the water dependent asset (ie the groundwater source) will not be compromised.

Therefore, pursuant to the AIP, since the further studies demonstrate the long-term viability of the water asset, the impacts from the project are acceptable for the purposes of clause 12AB.

6.11 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The Nature Conservation Council stated they do not support mining within the Sydney drinking water catchment. Their submission claimed that the EIS fails to satisfactorily explain how the project will meet the requirements of the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (Drinking Water SEPP), noting that a project cannot be approved on land in the Sydney drinking water catchment unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect (NorBE) on water quality. Coal-Free Southern Highlands also claimed that the project will not achieve NorBE.

The Nature Council submitted that the “Coal EIS devotes very little attention to the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 and fails to satisfactorily explain how the project will meet the requirements of the SEPP”.

The surface water assessment conducted for the Hume Coal Project confirmed that the project will meet the relevant NorBE criteria. A detailed discussion on the ability of the project to meet NorBE and other requirements of the Drinking Water SEPP was provided in the Hume Coal Project Water Assessment (EMM 2017c) and is updated in Section 10.2 of the Revised Water Assessment (attached in Appendix 2).

6.12 Water licensing requirements under the NSW Water Management Act 2000

The Southern Highlands Greens submit that the EIS ‘assumes away’ issues that need to be addressed before proceeding, such as the extent of water licences needed for the project. A special interest group submission raised the issue of water licensing, submitting that development consent should not be granted on the basis that it is ‘probable’ the necessary water access licence and aquifer interference approval will not be granted as the project does not meet the ‘no more than minimal harm’ criteria.

6.12.1 Water licensing

A detailed discussion on the water licensing requirements of the project, and how they will be met, was provided in Section 7.6 of the Hume Coal Project EIS. Further discussion on water licences is provided in Chapter 11 of this report. Below is a summary to respond to the submissions summarised above.

At the time of submission of the EIS, Hume Coal had secured in excess of 60% of the total groundwater licences required for the project on the open market, with a clear pathway for how the remaining volume is to be secured to meet extraction requirements.

DPI Water acknowledged in their submission on the Hume Coal Project that the volume of water licence is sufficient for project needs and capture of incidental water, and therefore, licensing of water does not represent a risk for the project. Further, they agreed that based on the volume required (as per the EIS modelling), the strategy for ensuring licences are in place is satisfactory and can be managed.

Water licences will be required from the following water sources:

- Groundwater:
 - Sydney Basin Nepean Groundwater Source - Nepean Management Zone 1;
 - Sydney Basin Nepean Groundwater Source - Nepean Management Zone 2; and
 - Sydney Basin South Groundwater Source.
- Surface water:
 - Medway Rivulet Management Zone of the Upper Nepean and Upstream Warragamba Unregulated River Water Source.

Since the submission of the EIS, Hume Coal has acquired a further 548 ML of groundwater licences, securing the majority of their groundwater licence requirements on the transfer market. Hume Coal has 93% of the licence requirements for the Sydney Basin Nepean Groundwater Source – Management Zone 1 (the outstanding 7% volume equates to approximately 150 ML). Hume Coal also holds the necessary licences for the other groundwater sources (Nepean Management Zone 2 and Sydney Basin South), with the exception of 3 ML from the Sydney Basin Nepean Groundwater Source – Management Zone 2. Notably however, this groundwater source has unassigned water that is available to be purchased via the next NSW Government controlled allocation release, or is available via permanent or temporary transfers from existing users. The ability to readily purchase water licences on the market has been sufficiently demonstrated.

In relation to surface water, Hume Coal owns 31 ML of surface water licence. No additional surface water licence volume will be required over the life of the mine.

It is therefore irrelevant to suggest that development consent should not be granted on the basis that it is 'probable' the necessary water access licence will not be granted as the project does not meet the 'no more than minimal harm' criteria, with 93% of the required licence volume already secured. Notwithstanding, the issue of minimal harm is addressed below.

6.12.2 'Minimal harm' and aquifer interference approval

The term 'minimal impact' for purposes of the implementation of the Aquifer Interference Policy is a localised consideration that applies to measurable impacts at a local scale. Projects are assessed against minimal impact criteria, which in turn inform potential additional mitigation and management measures that need to be adopted if the impacts are assessed as greater than minimal impact. The project can still be approved (and are routinely approved) if impacts that are greater than minimal are predicted.

Therefore the terms 'minimal harm' as used in the *Water Management Act 2000* (WMA 2000) at the water source scale is very different to the term 'minimal impact' as used in the Aquifer Interference Policy at a local scale. They are different terms, under different Acts, used for different purposes.

Further, in relation to the claim that the project should not be approved on the basis it is probable an aquifer interference approval will not be granted, it is noted that the relevant provisions of the WMA 2000 relating to such an approval (Section 91) are not currently active. They will come into force when the Aquifer Interference Regulation is made under the WMA 2000. In the meantime the Aquifer Interference Policy sets out the policy with respect to interference to water levels, water pressures and water quality in the course of carrying out mining. Although an aquifer interference approval is not required, the volumetric take of water does require licensing, as discussed above in Section 6.12.1.

6.13 Mineral ownership

A submission from Fenugreek investments claimed that the mineral rights associated with their property (Cherry Tree Hill) were compulsorily acquired by the NSW government, possibly for no value (because the NSW Government provided a valuation report saying that the land will not be mined for at least 200 years), and questioned whether landholders would be re-compensated if mining is allowed in a shorter space of time.

The submission also questions the legality or morality of issuing an exploration licence and possibly allowing mining when 200 years from 1980 has not yet passed.

Hume Coal does not have a copy of the valuation report by the NSW Government and therefore does not have the facts relating to the compensation payment to Fenugreek. Notwithstanding, the issue of what the NSW Government does regarding compulsory acquisition of coal is up to the democratically elected parliament, rather than the proponent.

It is noted that section 6 of the NSW *Coal Acquisition Act 1981* provides for compensation to be paid for the compulsory acquisition of coal. If the compensation provided under section 6 of the NSW *Coal Acquisition Act 1981* was inadequate as claimed by Fenugreek, Fenugreek had an opportunity to appeal the decision of the Compensation Board to the Compensation Review Tribunal under section 27 of the NSW *Coal Acquisition (Compensation) Arrangements 1985*.

If Fenugreek opposed the compulsory nature of the acquisition, Fenugreek had an opportunity to purchase the coal rights back from the NSW Government by repaying the compensation received, pursuant to section 5 of the NSW *Coal Ownership (Restitution) Act 1990*, for 17 years between 1990 and 2007.

As such, it appears that the NSW government provided processes to remedy any wrong suffered by the landholders who had to compulsorily sell the coal rights by either the quantum of the compensation or by offering to sell the coal rights back. Therefore it is submitted that the appropriate recourse for Fenugreek was to seek redress through those processes provided by the legislature, rather than as a submission to Hume Coal.

The question raised in the submission that "how is it possible for the NSW government to grant coal exploration licences over the same lands and possibly allow mining over the same lands within a much shorter space of time [than 200 years]" cannot reasonably be sustained, since various coal mines were in existence before and during 1980, and coal exploration licence (EL0181) over the Fenugreek lands in 1970.

Further, it is advised that the following lands are not within the project area as claimed by Fenugreek in its submission:

- Lots 36, 109, 119, 122, 174 in Deposited Plan (DP) 751251; and
- Lot 1 in DP 213223

6.14 Reliance of the Hume Coal Project and Berrima Rail Project

A number of community submissions and a special interest group submission stated that there is uncertainty surrounding the Hume Coal Project due to the reliance on another development consent (ie the Berrima Rail Project).

Section 1.5 of the Hume Coal Project EIS notes that several approvals will be required under the EP&A Act for the Hume Coal mine to operate. These are:

- development consent for the mine and associated facilities under Part 4, Division 4.1 of the EP&A Act;
- development consent for the construction and use of a new rail spur and loop (the Berrima Rail Project) under Part 4, Division 4.1 of the EP&A Act; and
- an activity approval for proposed electricity supply works under Part 5 of the EP&A Act.

Section 1.5 of the Hume Coal Project EIS acknowledges that “all three projects are inextricably linked, in that one will not be developed without the other two. Approval for each project is being sought separately and will be constructed concurrently”.

Further the reliance on a privately-owned railway does not pose undue uncertainties that cause the project to become dubious. This is on the basis that:

1. Hume Coal have a commercial agreement with Boral that covers the situation where ownership changes; and
2. it is common industry practice for mines to utilise railway owned by private entities in order to avoid building unnecessary, duplicate railways. Currently Ingham and Omya currently use the section of railway owned by Boral. Other coal mine examples in NSW include:
 - i. BHP's Mt Arthur Coal and Malabar's Drayton coal mine in the Hunter Valley - Mt Arthur's railway (located part on land it owns and part on land Malabar owns) joins and uses Drayton coal mine's rail spur, which in turn runs over land owned by AGL Macquarie before it joins the main railway. Therefore BHP is reliant on two private entities to operate its railway and Malabar is reliant on one private entity to operate its railway.
 - ii. Glencore's Integra coal mine uses Bloomfield's Rix's Creek balloon loop and rail spur, which is on Bloomfield land. Therefore Glencore is reliant on Bloomfield to operate its trains.

7 Stakeholder engagement and community outreach

This chapter responds to submissions relating to the consultation conducted by Hume Coal throughout the project planning phase and preparation of the Hume Coal Project EIS and Berrima Rail Project EIS. A description of the continued engagement with relevant stakeholders by Hume Coal during and after the exhibition period is provided in Chapter 4.

Submissions received in support of the two projects referenced the active role Hume Coal has played in the community, such as sponsoring a number of junior and senior sporting teams. Responses to submissions querying/and or criticising the consultation undertaken is provided in the sub-sections below.

7.1 Scope and approach to community engagement

7.1.1 Stakeholders not included in consultation

Extent of consultation: Some community, business and special interest group respondents submitted they were not specifically consulted by Hume Coal about the Hume Coal Project, such as residents along Medway Road, the restaurant Zen Oasis (also located on Medway Road, north of the proposed location of the surface infrastructure area), Fenugreek Investments (Cherry Tree Hill Wines) and the Berrima Residents Association. However, Fenugreek Investments noted that Hume Coal recently sent them a letter regarding their bores. Some bore owners also submitted that whilst Hume Coal sent letters regarding their bore, Hume Coal did not discuss the potential impacts of the project in person, despite promises in the letters to do so.

Berrima: The Berrima Residents Association submitted that Hume Coal refused an offer for a public meeting in Berrima, denying the town an open public debate, and noted that whilst a community information session was held in New Berrima, one was not held in Berrima.

i Extent of consultation

Hume Coal has been actively engaging with stakeholders since 2011 when its exploration program began. The primary goals of this engagement were to identify and inform relevant stakeholders about the project, and to obtain feedback on the project design. Accordingly, Hume Coal developed a Stakeholder Engagement and Consultation Plan (the plan) for the project, which is still ongoing and updated regularly. The initial step in developing this plan was to identify relevant stakeholders so that clear and timely information about the project and its potential impacts could be made available to them. The community stakeholders identified included:

- landholders within Exploration Lease Area A349;
- other nearby residents that may be indirectly impacted; and
- community groups such as: local businesses and industry groups, special interest groups, cultural heritage groups, service providers, non-government and not-for-profit organisations.

The aim of the plan was to provide sufficient means by which these identified stakeholders could obtain information about the project and to provide feedback and raise concerns. The methods of engagement identified in the stakeholder engagement plan for these community groups were:

- the Hume Coal community office;
- Hume Coal website, which is continually updated with new information;

- published fact sheets;
- community bulletins and newsletters;
- monthly publications in the local newspaper;
- neighbour notification letters;
- community updates via letters and other mail outs;
- social media platforms;
- Hume Coal community advisory groups (social reference group and water advisory group);
- community perception surveys; and
- community open days/information sessions.

In July 2015, Hume distributed 145 letters to those landholders located within and adjacent to the project area. These letters were personally addressed to each landholder and included information on project plans, approvals timeline and an offer to meet with the Hume Coal team to discuss the project in detail.

The Berrima community project office was opened in May 2016 and is staffed with community and technical team members, providing opportunities to discuss the project face-to-face, collect fact sheets and information about the project, and view 3D models of the surface infrastructure and underground mining system. It is located in the centre of town, right next to the local post office, and was open up to five days per week and on Saturdays during the EIS exhibition period. After the exhibition period closed, due to a lack of people attending the community office the facility was opened only by appointment when required. It re-opened five days per week in mid-May 2018 ahead of the lodgement of this Response to Submissions Report. The community office therefore provides an all year round opportunity for residents and members of the local community to learn more about the project.

Further, research was undertaken by an independent research consultant on behalf of Hume Coal, to understand community perceptions using quantitative surveys and qualitative focus groups in November and December 2013, October and November 2014, and June and September 2015. The quantitative surveys each had a sample size of at least 400 people drawn from across the Wingecarribee LGA. In each case a random stratified sample was used to obtain representative samples of the population. Interviews were structured and all stakeholders were asked pre-determined questions so that consistent data were collected. This information was used to inform the project design, focus future community information sessions on matters of interest to the community, and to ensure the EIS addressed areas of concern. Further information on the outcomes of the community perceptions survey, and consultation undertaken more broadly, is contained in Section 7.1.2, as well as Chapter 4 of the Hume Coal Project EIS and Chapter 5 of the Berrima Rail Project EIS.

ii Community open days and Berrima

A number of community information sessions and open days were also held throughout 2014, 2015 and 2016. These open days were attended by Hume Coal staff, as well as some of the technical specialists who prepared various technical studies for the EIS. These open days therefore provided an opportunity for community members to obtain detailed information about the project. Information sessions were held across the region, and whilst not held in every township (given the large number of towns throughout the Southern Highlands), they were held in major centres throughout the area, providing ample opportunity for residents to attend. Information sessions were held in East Bowral (5 March 2014 and 12 August 2015), New Berrima (14 May 2014 and 6 August 2015); Moss Vale (11 August 2015 and 25 August 2015); Robertson (19 August 2015); and Exeter (20 August 2015). Hume Coal also held community information sessions during the exhibition period at both the Mittagong RSL Club and at the Mereworth property. Eight information sessions were held across weekends and week days (two at Mittagong RSL and the remainder at Mereworth), with a total of approximately 200 community members attending these sessions.

Hume Coal has a responsibility to ensure a safe venue is provided for each community information session. This means ensuring the venue can cater for the number of people expected to attend (seating and amenities), and that plenty of off-road parking is available to ensure the safety of all visitors and team members. Each venue was carefully chosen based on accessibility, capacity, parking, amenities and availability. For example, Medway does not have a suitable venue. However, it is just over a 3 km drive from Medway, to the New Berrima Hall. It is also a 3 km drive from Berrima to the New Berrima Hall, and therefore it was decided that New Berrima Hall was a suitable, centrally located option for Medway, Berrima and New Berrima residents and other nearby community to attend an information session.

iii Consultation with specific stakeholders raised in the submissions

In relation to residents along Medway Road, Hume Coal have met with several Medway road residents over the past few years to discuss the project and specific aspects that might relate to their properties, such as exploration, environmental studies, visual amenity and noise. Details of some consultation activities with landowners are described below:

1. Consultation commenced with a Medway resident commenced in 2013, regarding land access related to the exploration and drilling programs, and to provide project updates. Phone calls, face-to-face meetings and emails were the main forms of communication during this time and continue now in 2018.
2. One of the neighbouring Medway residents began discussions with Hume Coal in 2015 to enquire about future employment opportunities and to get an update on the project. A phone call took place in February 2016 to discuss the project and land access. In March 2016, a meeting took place at the Hume Coal main office with the landholder to discuss the project again and future business opportunities.
3. In 2016, discussions commenced with another Medway Resident to discuss the project and arrange land access to assess potential impacts the proposal may have on the property in the future. Permission to access the property was granted and a meeting took place in late 2016 at the property on Medway Road. In early 2017, a letter was sent to the property owner regarding potential noise impacts and offering another time to meet to discuss before the EIS was released to the general public. A meeting took place in April with two representatives from Hume Coal and the owner. Discussions are continuing.

Hume Coal has attempted to consult with Fenugreek Investments, owners of Cherry Tree Hill Wines, since 2011. Cherry Tree Hill Wines was invited to join the Water Advisory Group (WAG) in 2011, but declined. A letter and three emails were sent from Hume Coal in regards to this invitation. Hume Coal left the invitation open to Fenugreek Investments if they were to re-consider and decide to join the WAG at a later date. This was never accepted.

In October 2011, a neighbour notification letter was sent to Fenugreek Investments regarding their property, Cherry Tree Hill, in relation to upcoming drilling and exploration planned at Wongonbra, a nearby property owned by Hume Coal at the time. On 23 March 2012, a letter addressed to the Directors of Fenugreek Investments P/L was sent regarding Hume Coal's proposed exploration program and land access program. An offer to discuss the letter was offered and the community liaison team contact details were provided. On 10 April 2012, a Hume Coal representative spoke with the Property Manager seeking permission to inspect the historic boreholes located on the property. A day was proposed to meet later that week. However, no permission was granted by Fenugreek Investments to inspect the property.

More recently in early 2017, as noted by Fenugreek Investments, a personally addressed letter was sent regarding the Hume Coal Project and make good requirements. Then on 21 February 2017, there was email correspondence between a Hume Coal representative and a Fenugreek Investments representative regarding information about bore consultation.

On 28 July 2017, a Hume Coal representative emailed the same Fenugreek Investments representative. The email offered to discuss the possibility of undertaking baseline bore assessments on the groundwater bores located on the Cherry Tree Hill property. No correspondence has been received by Hume Coal in response to these attempts to contact Fenugreek Investments.

Several attempts were made to consult with the owners of Zen Oasis, including letters, a visit to Zen Oasis to hand deliver a letter, and phone calls. Representatives of Hume Coal also met with representatives of Zen Oasis to discuss the project at the Mittagong RSL during a community info session in 2017. Hume Coal representatives have tried to facilitate further meetings via a local community group, but this has not been successful.

It is considered therefore, that contrary to some of the views put forward regarding the absence of consultation with various stakeholders, extensive opportunities were made available to the local community to obtain information about the project, to provide feedback on the project design, and to ask for further information.

iv Consultation with potentially affected bore owners

Once the potential impacts of the project on neighbouring registered bores were understood upon completion of the groundwater impact assessment in early 2017, letters were provided to potentially affected bore owners advising of these impacts. As noted in the submissions, these letters advised Hume Coal would be in touch to discuss individual bores. This commitment remains the case. The intention of the next round of consultation referred to in the letters to land owners is to discuss the predicted impacts to individual bores and the appropriate make good measures required. Since the completion and submission of the EIS, further work has been undertaken by Hume Coal and the groundwater specialists who prepared the groundwater impact assessment to determine what these required make good measures are for each potentially affected bore (ie a project related drawdown of 2 m or more). This work needed to be completed before effective, individual consultation could take place.

A broad make good strategy was included in the EIS (as Appendix 4B of the Water Impact Assessment). This make good strategy noted that consultation with potentially affected landholders commenced in January 2017 via individual letters, and that landholders would be contacted again during the bore verification process, which is the next step in determining the required make good measure at individual bores. This verification process involves inspections of each bore to obtain information on groundwater levels and quality, as well as bore construction and pump details. This information is required to determine the pre-project conditions at individual bores, providing a reference point for comparison with subsequent bore assessments.

The letters sent in January 2017 informed each potentially affected bore owner that make good provisions would apply to their bore, and requested access to undertake a baseline bore assessment. In May 2017 Hume Coal sent personalised information packages via registered post to all potentially affected landowners. Included in this package were the modelled impacts to the landowner's groundwater bore, a copy of the groundwater baseline assessment form, the NSW aquifer interference policy, a plan detailing the company's understanding of the bores location and schematics of the proposed mitigation measure specific to the landowner's bore.

Face-to-face meetings have been held with several landowners throughout the consultation process. Many landowners refused to discuss the matter, citing advice not to engage with the company by a local community group.

Hume Coal will continue engaging with identified bore owners as the verification process is undertaken and, where access is granted, continue to undertake baseline monitoring of the current bore condition. Once the verification process is complete, legally binding make good agreements will be negotiated with each affected landholder where possible, on a case-by-case basis. The development of the make good provisions for individual bores is a complex process that requires sufficient time to firstly understand the potential impacts (as was done in the EIS), undertake the next step of bore verification, and negotiate make good agreements. Extensive, individual engagement will be undertaken as individual make good agreements are negotiated and finalised.

7.1.2 Inadequate consultation with nominated stakeholders

It was contended in some community and special interest group submissions that insufficient and/or inadequate consultation has been undertaken by Hume Coal. Specific claims made are listed below.

- i. Insufficient community involvement - there has been little genuine effort to minimise any potential impact and harm to the local community and region above the bare minimum required.
- ii. The community information sessions held were criticised; some claiming that the sessions were intimidating, and about informing people, not answering questions. Another noted the information sessions increased since the EIS was submitted, wondering why this was not the case before the EIS was submitted to allow changes based on feedback.
- iii. Hume Coal should deal with water affected landholders as a group, not as individuals.
- iv. One submission questioned why no doorknocking was undertaken.
- v. The Berrima Residents Association claimed that whilst Hume Coal opened an office in Berrima in May 2016, this did not lead to consultations with the community. They claim the office was 'an empty gesture designed to present the appearance of consultation while actually avoiding dialogue'.

i Insufficient community involvement

As described in the response in 7.1.1, extensive efforts were made to involve the community prior to and throughout the preparation of the EIS, and to obtain feedback on the project and potential impacts so that changes to the project design could be made before the EIS was submitted. The Water Advisory Group (WAG) was voluntarily established by Hume Coal in 2011, which consisted of local residents, community members, and individuals with technical knowledge and experience in surface and groundwater. In 2014 the Social Reference Group (SRG) was formed, made up of local residents from Berrima, Robertson, Sutton Forest, Bowral and Moss Vale. This group discussed topics and issues that informed the social impact assessment and aspects of the mine design.

Focus groups were facilitated by an independent research consultant in 2013, 2014 and 2015 to understand the issues of most concern to the local community. Figure 7.1 below is a re-production of Figure 4.2 from the Hume Coal Project EIS, and illustrates the concerns raised by the community during these focus groups. As shown, a range of issues were raised. The top three issues raised, accounting for 67%, are discussed below, including aspects of the project design adopted to alleviate these concerns:

- a. *Affecting local aquifers and water supplies:* a number of pre-eminent hydrogeologists and groundwater modellers were engaged to assess the potential impact of the project to ensure a high confidence in the predicted impacts. Alternative mining methods that were originally considered, such as longwall mining and the Wongawilli method, that would likely result in heightened fracturing of the Hawkesbury Sandstone and therefore increased flow or permeability of water through the aquifer, were rejected. A mining method was instead adopted that will protect the Hawkesbury Sandstone and groundwater sources from material levels of surface and subsurface deformation. Whilst drawdown in excess of 2 m in privately owned bores is predicted to occur, Hume Coal is committed to implementing the appropriate make good measures at each bore to completely mitigate this impact upon affected landholders.
- b. *Leaving the local area damaged or destroyed, including farmland:* an underground, low impact, non-caving mining method was adopted so that the local area is not impacted by subsidence. Surface subsidence impacts will be negligible. Further, rejects will be emplaced underground so that there is no permanent reject emplacement on the surface, significantly reducing the surface disturbance footprint of the mine. In addition, areas of archaeological and biodiversity significance have been avoided by the surface infrastructure location and layout.
- c. *Not benefiting local people:* Hume Coal is committed to supporting the local community in which it will operate. This is evident in the ongoing commitment to the Hume Coal Charitable Foundation and support of local sporting teams and community groups, as well as the requirement during operations for employees to live within a 45 minute commute of the mine site. This will eliminate the risk of a 'drive-in drive-out' or 'fly-in fly-out' workforce. Further, the economic impact assessment confirmed there will be a net positive economic benefit to the local community of \$84M in net present value terms.

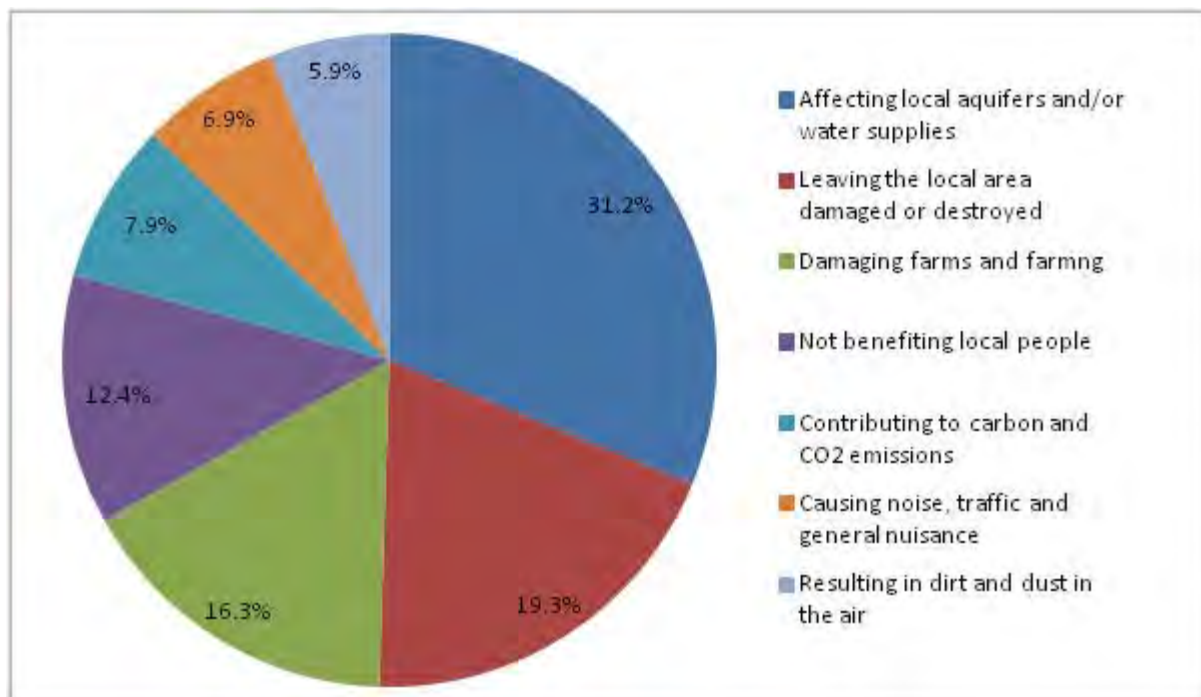


Figure 7.1 Issues of concern raised during stakeholder surveys, by focus area

During the public exhibition period Hume Coal continued to engage with the community, holding open days on the following days:

- Friday 21 April 2017
- Saturday 22 April 2017
- Saturday 27 May 2017
- Sunday 28 May 2017
- Wednesday 7 June 2017
- Thursday 8 June 2017
- Thursday 15 June 2017
- Sunday 25 June 2017

Additional sessions were also held on Saturday 3 June 2017 (a BBQ for people interested in potential employment opportunities), and on Sunday 18 June 2017, which was an information session for the Southern Highlands Nationals Branch Info Session).

ii Community information sessions

Hume Coal has held information sessions in a variety of formats, both formal and informal, since the project commenced in 2011. This has included site visits to drill rigs, presentations and updates on the project's progress and public "town hall" style meetings subsequent to the lodgement of the preliminary environmental assessment in mid-2015. These meetings were followed by formal and informal question and answer sessions where community members could speak directly to the project team on an individual level.

During the EIS exhibition period, Hume Coal utilised a number of different formats for the community information sessions in an effort to find the most suitable form for facilitating positive engagement with the local community. This included adopting a different, less formal approach, with information stands set up around the room to enable community members to look at the information they were most interested in, and in their own time. At each of these sessions Hume Coal staff were available to answer questions. Claims that this was not the case, or that the forums were intimidating are rejected. Further, whilst the EIS was on exhibition, Hume Coal considered it appropriate to hold additional information sessions so that the opportunity was provided to the local community to ask questions about the project that may have arisen upon reading the EIS. These sessions were in addition to the ones held prior to the EIS being finalised where feedback was obtained and incorporated where appropriate and where practicable into the project design, as outlined above. Importantly, the community information sessions are just one of many methods of consultation used by the Hume Coal project team. Other options, such as visiting the main office in Moss Vale and Berrima Community shop to talk to members of the project team was, and remains, an option five days per week and by appointment out of business hours (ie after 5 pm weekdays and on weekends).

iii Bore owners

Consultation with affected bore owners needs to be undertaken on an individual basis because the bore condition and potential impact is specific to each bore. As such, make good agreements will need to be negotiated on an individual basis. In addition, bores will be impacted at different times, and therefore consultation will need to be undertaken at varying stages throughout the project life.

iv Door knocking

Hume Coal views doorknocking as a potentially counterproductive engagement 'tool'. Many properties in the project area are rural in nature and require entry onto land in order to door knock. It was therefore not identified as an appropriate engagement tool for the project.

v Berrima community office

Hume Coal opened the Berrima community office as a genuine means of providing the opportunity for community members to ask questions and obtain information about the project. The community office was, and continues to be, operated by Hume Coal staff, providing plenty of opportunities for community members to visit and discuss any queries or concerns about the project. Over the years there has been a large number of people visit the office, including WSC Councillors, the head of SHCAG (CFSH), Aboriginal group representatives and local residents. On average the office receives about 1-3 visits per week from people seeking information about the project when it is open.

Leading up to, and during the EIS exhibition period, the office was open up to five days per week, on selected Saturdays and by appointment. Encouraging feedback has been received about the shop, including this quote taken directly from an email from a Berrima resident.

Before our meeting, we had wondered whether the Berrima office of Hume Coal was just window-dressing, to provide the appearance of public consultation, but you have dispelled that notion. We want to compliment you on, and thank you for, the time you allowed us and the information you were able to give us. You were courteous, patient, knowledgeable about the project, and willing to follow up the questions you weren't able to answer yourselves. You were also friendly, which cannot be easy given prevailing community attitudes to the mine (May 2016).

The Moss Vale Hume Coal Project Office is also open five days per week, and is generally staffed from 8 am to 4 pm.

7.2 Media and communications

1. Coal Free Southern Highlands contend that Hume Coal has run a 'campaign to divide the community', labelling opponents of the project as anti-coal activists or other 'denigrating' terms. They also claim that Hume Coal has issued misleading and deceptive statements and advertisements. The claim of denigrating or intimidating community members who oppose the mine was also raised in some submissions from the local community, including claims of a disregard of the views of anyone that opposes Hume Coal. Claims of 'propaganda' being distributed by Hume Coal in contradiction to the facts outlined in the EIS were also made.
2. The Southern Highlands Greens claim that the Southern Highlands News provided limited coverage of views opposing the project, linking this perceived lack of coverage to the expenditure by Hume Coal on advertisements in the paper.
3. The use of the Hume Coal website, yoursayhumecoal.com.au, was acknowledged, although the ability to comment on only one topic at a time was criticised. It was also claimed that individual comments were deleted if not considered to be 'on topic' by Hume Coal.
4. It was also claimed that the Hume Coal Facebook page divided the community, with negative comments in opposition to the mine met with moderation; however those in favour of the project were not subject to the same treatment.

1. Hume Coal has a dedicated community engagement team, which includes a full time external relations coordinator and a media coordinator. Throughout the preparation of the EIS, Hume Coal undertook an extensive community engagement program which included providing information on the Hume Coal website (which was modernised and relaunched in early 2016 for better accessibility on smart phones and tablets), social media integration, publications in the Southern Highlands News, weekly interviews on local radio (2ST), publication of fact sheets, an active presence on social media, community surveys, numerous community information sessions, and the use of an online engagement tool, Engagement HQ, which facilitated online discussion forums on various topics.

Hume Coal rejects claims that its community engagement program is a divisive or intimidating campaign. The focus of all engagement activities undertaken by Hume Coal is to provide factual information about the project to, and receive feedback from, the community. Hume Coal acknowledges that there are differing views about the project within the community. The aim of the community engagement program is, as it has been from its inception, to ensure all community members both in support and opposition, are able to obtain the facts of the project and to provide input, enabling informed views about the project to be made.

Community concerns regarding the project, including the views of community members who oppose the project, were actively sought so that these views could be taken into consideration in the project design. A number of examples of how these concerns were addressed are discussed above in the response in Section 7.1.2, and presented in Chapter 6 of the EIS, which explains the alternative project designs considered and how aspects of the project evolved in response to community concerns. Examples include the use of a non-caving mine plan to address concerns regarding subsidence, covering coal wagons for the first time in NSW in response to concerns about dust, and the emplacement of rejects underground to eliminate the need for a large, permanent reject emplacement and the subsequent permanent changes to the landform.

2. Hume Coal utilised the local print media as an effective tool for distributing factual information about the project through monthly updates during the preparation of the EIS, and fortnightly quarter page adverts during the EIS exhibition period encouraging the community to come and talk to Hume Coal to discuss the EIS and answer queries regarding the operation and to make submissions. Periodic advertisements were also used, ranging from full page adverts to strip adverts, to announce project milestones, call for applications to the community investment program, and to inform the community about upcoming events. This use of local media advertising is available to anyone, and was used by Hume Coal so that information about the project was distributed as widely as possible within the local community, especially since print media is particularly suited to the demographic of the Southern Highlands.
3. The online engagement tool, (Engagement HQ, Your Say) used on the Hume Coal website was designed to enable discussion on one topic at a time during the 90 day EIS exhibition period. This was to facilitate a comprehensive and efficient discussion on the most prominent issues relating to the proposed mine, including groundwater, visual impact, noise and air quality. Discussion topics were opened sequentially to also avoid confusion amongst the online discussion tools. The way in which the engagement tool operated was clearly explained on the website, and accordingly, if comments were posted 'off-topic' or were offensive they were moderated. The online engagement platform was independently moderated by the service provider.

Engagement HQ was implemented by Hume Coal as it is recognised as leading practice for facilitated online engagement. Numerous local, state and federal government departments utilise this online platform for consultation activities.

4. Hume Coal applies strict standards to their Facebook page. Accordingly, and as stated on the page, the following is not tolerated; "abusive, offensive or harmful contents, directed at Hume Coal, POSCO or any person; content which advocates intimidation, bullying or violence; and content which is blatantly misleading or untrue". Hume Coal holds that this policy has been applied consistently across all posts on the page, both in opposition or support of the project.

7.3 Community outreach

Community respondents and the Coal Free Southern Highlands group contended that Hume has attempted to 'win over' the community through donations such as to sporting and community groups, and that the donation program has divided the community.

Hume Coal has developed and implemented a number of initiatives to make its presence in the local community a positive experience for the local families, businesses and organisations of the Southern Highlands. Since the commencement of the project the company has supported many organisations and individuals, including sporting, academic and community initiative programs.

The Hume Coal Charitable Foundation was established in 2015, with the aim of making a positive contribution to the community of the Wingecarribee LGA. The foundation has four directors, three of whom represent the local community and are not otherwise associated with the company. This ensures decisions made by the Foundation are objective and in the best interests of the community.

Each year the Foundation provides around \$400,000 in funding in two rounds, closing in July and November. The funding focus is on apprenticeships, traineeships, tertiary education and not-for-profit pre-school child care. The Foundation is advertised all year round, both in print and online, providing information about the program, the application process, what information needs to be provided in the application, the eligibility criteria and the closing dates for each round. All eligible applications are fairly assessed by the Directors of the Foundation, three of whom are independent of the Hume Coal Project and respected members of the local community. To ensure the money is invested in the local community, only residents of the Wingecarribee Shire LGA are eligible to apply.

Of the available funds per annum, \$250,000 is allocated to support the placement of apprentices and trainees in local businesses through the Australian Apprenticeships program, in which apprenticeships are available to anyone of working age and regardless of the level of education or gender. Hume Coal works closely with the local apprenticeship network provider, 1300apprentice.

Hume Coal has contributed over a million dollars to the community, including through sponsorship of local sporting teams and sportspersons, and through donations to disability services, addiction rehabilitation centres and local youth programs. Three tertiary scholarships have been awarded to students at the University of Wollongong and thirteen individuals have completed their upskilling journey through Hume Coal supported apprenticeships and traineeships, with another six individuals still progressing.

Hume Coal is committed to making a significant and lasting contribution to the region in which it operates.

8 Surface water

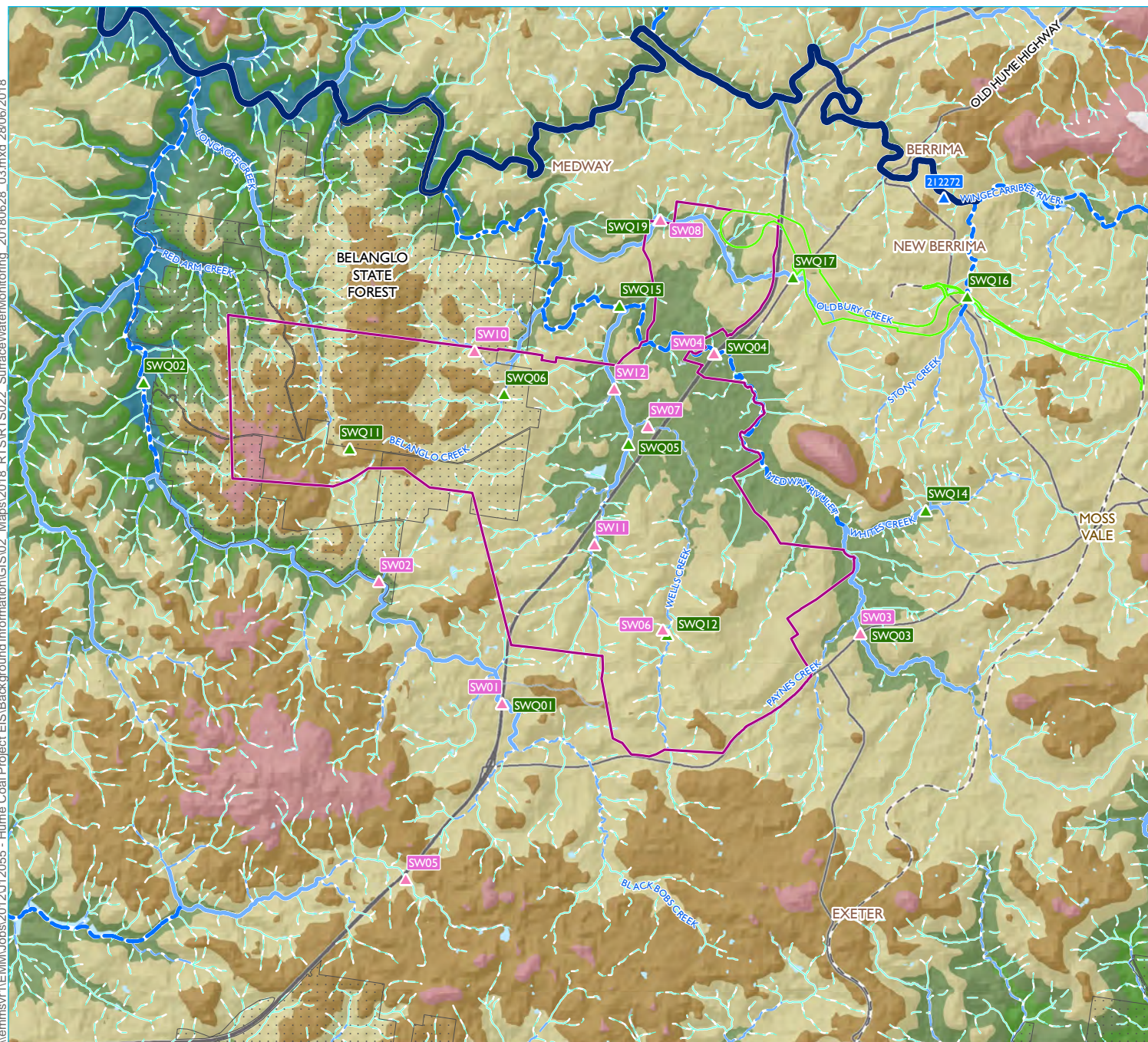
8.1 Existing environment

WaterNSW report that the EIS lacks a single detailed surface water map setting out the position and elevations of relevant waterways, water storages and surface water monitoring locations around the project area. Such a figure would be valuable in interpreting surface water monitoring locations, flow pathways and potentially impacted streams. model results and baseline data.

Numerous detailed maps were provided across the EIS and accompanying reports to provide sufficient information on the surface water resources. Refer to *Hume Coal Project Water Assessment* (EMM 2017c) and appendices, and the *Hume Coal Project Revised Water Assessment* (EMM 2018a) (Appendix 2).

An additional map that contains topographic elevations, surface water monitoring sites, Strahler stream order, and water bodies within and around the project area is included in Figure 8.1.

\\lemmsvr1\EMM\Jobs\2012\J12055 - Hume Coal Project EIS\Background information\GIS\02 Maps\2018 RT\RTS022 SurfaceWaterMonitoring_20180628_03.mxd 28/06/2018



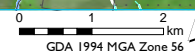
- KEY**
- Berrima Rail Project area
 - Hume Coal Project area
 - Surface water monitoring locations
 - ▲ Surface water flow gauge
 - ▲ Surface water quality
 - ▲ Water NSW surface water gauge
 - Strahler stream order class
 - 1 ---
 - 2 ---
 - 3 ---
 - 4 ---
 - 5 ---
 - 6 ---
 - Existing features
 - Main road
 - Rail line
 - Drainage line
 - State forest
 - Waterbody
 - Elevation (m AHD)
 - 500-550
 - 550-600
 - 600-650
 - 650-700
 - 700-750
 - 750-800
 - 800-850

Surface water features

Hume Coal and Berrima Rail Project
Response to submissions
Figure 8.1



Source: EMM (2018); DFSI (2017); Hume Coal (2017)



8.1.1 Baseline data

NSW DPI and WaterNSW raised concerns in regard to the design of the monitoring program, its adequacy and gaps in the period of record for water quality data at some sites during some time periods. The submissions suggested that this needed to be explained in greater detail and needed comments around the adequacy of the data to inform the assessment.

Community concerns with baseline data focused on surface water quality, with concerns related to strict adoption of the ANZECC guidelines and comparison between model results and baseline data.

Two of the community submissions praised the extensive monitoring network.

The surface water baseline dataset is extensive for the project. The monitoring network design was undertaken in consultation with the then NSW Office of Water (now WaterNSW / DI Water). It was designed specifically to provide data to inform a robust assessment of the baseline conditions and to allow the impacts of the project to be calculated. The design of any monitoring network needs to consider the practical aspects such as site accessibility for installing gauges and loggers, and access for ongoing sampling programs. As with any monitoring network in a rural environment, site access was a factor that contributed to the final monitoring network design.

It is acknowledged that the surface water quality data collected for the project has gaps in the period of record. The reasons for this are mainly due to access restrictions and the ephemeral nature of the streams in the area and site details summarised below:

- SWQ02 – Very difficult access. Only sampled when installing the stream gauge and taking manual flow readings. Not a key monitoring site within the network as there is an upstream location (SWQ01) and a downstream location (SWQ02) on Black Bob's Creek.
- SWQ09 – Physical access was restricted, no samples collected.
- SWQ08 – Regularly dry, samples were able to be collected in 12 out of 24 site visits. This location is considered unlikely to be impacted by mining.
- SWQ13 – Predominantly dry, samples were able to be collected in 2 out of 25 site visits. This location is considered unlikely to be impacted by mining.
- SWQ07 – Predominantly dry, samples were able to be collected in 5 out of 26 site visits. This location is considered unlikely to be impacted by mining.

The surface water quality monitoring program aligns with the recommendations in the ANZECC (ANZECC and ARMCANZ 2000) Guidelines. The NSW Government, as the ultimate regulator, will determine final requirements.

Raw data for all monitoring programs is available in a detailed field report for the project, including original copies of the laboratory analysis sheets. This field report did not form part of the EIS, mainly due to its very large size, but can be made available to the NSW Government if requested.

As for a comparison between model results and baseline data, the water quality impacts of the project were modelled using the MUSIC program, which calculates concentrations of pollutants in the runoff from the catchments within the project area under existing and future conditions – ie Hume Coal considers the water quality entering the stream from the project area specifically. Therefore the project assessed its individual contribution to the overall water quality of the greater catchment. The model does not consider the upstream stream flow or existing concentrations of pollutants in the streams as these are a function of the runoff from the catchments upstream of the project where the project has no influence. The purpose of the MUSIC model is to simulate the existing and future runoff characteristics within the project area catchments before this runoff enters the receiving streams. The results of the MUSIC model are therefore not directly comparable to observed baseline water quality data measured in the streams.

The surface water baseline data for the project is considered adequate to inform the assessment of the project.

The NSW OEH comments that the characterisation of Black Bobs Creek as an ephemeral stream is not supported by adequate flow data and is likely to be incorrect. According to early explorers in the area, Medway Rivulet was originally a chain of ponds system. Much of the vegetation has subsequently been cleared and Medway Rivulet now receives a continuous sewage treatment plant (STP) discharge. The NSW OEH recommends that Medway Rivulet be recategorised recognising that there is now a permanent flow.

The NSW DPI comments that the NSW DPI Water 2012 River Styles® mapping identified “highly fragile river reaches” within the project area which were not identified in the EIS. Ensuring an adequate understanding of impacts to these reaches and developing adequate monitoring and management options is recommended.

The NSW DPI recommends that further surveys be undertaken of unconfined River Styles® identified in the EIS and consistent with the NSW DPI Water 2012 River Styles® mapping. Surveys should include identifying remnant ponds features, extent and standing pond level and depth.

Hume Coal agrees that Black Bobs Creek is unlikely to be ephemeral, and this assessment is consistent with the EIS.

With respect to the NSW DPI comments on the NSW DPI Water 2012 River Styles® mapping, it is noted that this dataset was developed by consultants using remote GIS techniques with no field verification. The geomorphic assessment undertaken for the EIS was developed using the River Styles Framework (Brierly and Fryirs 2005) and were verified by a geomorphological field survey. Although the terminology of “highly fragile river reaches” was not used, the reaches of Medway Rivulet, Wells Creek and Oldbury Creek identified as “high fragility” in the NSW DPI 2012 River Styles® spatial data have generally been identified in the EIS assessment as “stream reaches at risk of erosion due to changes in flow regime”, which is comparable. In terms of geomorphological impacts, the main potential impact to the “high fragility” reaches is erosion associated with increased flows. However, the potential for erosion is low considering the minimal change in flow predicted.

Further geomorphic field surveys will be undertaken for unconfined River Styles® identified in the EIS and consistent with the NSW DPI Water 2012 River Styles® assessment during the detailed design phase of the project. Surveys will focus on reaches identified as possessing high fragility in the NSW DPI Water 2012 River Styles® assessment, subject to land access. Surveys will include identifying remnant pond features, extent and standing pond level and depth. The characterisation of streams in the project area will be confirmed at the detailed design phase using additional stream gauging data collected as part of the ongoing baseline monitoring program. A detailed geomorphic assessment report will be prepared at the detailed design phase to outline the current geomorphic condition and projected recovery trajectories under current management regimes, potential subsidence conditions and with rehabilitation actions in place. The additional geomorphic assessment will include review of the categories assigned to Black Bobs Creek and Medway Rivulet as raised in the above submissions.

Post-mining geomorphic field surveys will be undertaken for areas likely to have differential settlement, subject to land access. There are no areas predicted to have material levels of differential settlement, with vertical subsidence movements predicted to be less than 20 mm. As stated above, no mining is proposed to be undertaken directly beneath Medway Rivulet. Post-mining surveys will focus on identifying likely or potential disturbance and channelisation within, or downstream of, remnant ponds and valley fills. Where areas are classed as swampy meadows, the surveys will incorporate catenary survey lines to detect drawdown within the fill sediments, subject to land access.

Where channelisation impacts resulting from mining are identified, specific remediation programs will be developed to identify controls to prevent further channelisation within and between chain of ponds. Remediation programs will be developed in accordance with existing rehabilitation standards (eg Rutherford et al 2000) and recent research on processes related to geomorphic recovery in high fragility river channels (eg MacTaggart et al. 2006, Mould and Fryirs 2017).

WaterNSW comments that an alleged paucity of high quality flow monitoring data makes it difficult to:

- set meaningful performance measures for baseflow reductions (particularly in low flow situations);
- monitor and verify predicted streamflow and catchment yield impacts for the Medway Rivulet and the Lower Wingecarribee management zones; and
- assess cumulative impacts associated with other licensed river extractions and STP discharges.

Hume Coal has been undertaking baseline stream gauging in the project area since 2012. The baseline stream gauging program is ongoing to establish baseline flow conditions prior to. Appropriate trigger levels and response actions to address measured flow impacts will be developed using the additional stream gauging data prior to construction of the project. Trigger levels and response actions will be developed in consultation with the relevant regulatory agencies.

A surface water flow monitoring program will be implemented in local catchments during construction, operation and rehabilitation of the Hume Coal Project. The surface water flow monitoring program will involve monitoring of the volume of water released from stormwater basins SB03 and SB04 to Oldbury Creek.

8.2 Surface water modelling

8.2.1 Accuracy of input data

WaterNSW comments that high quality flow gauging in the catchments of the project area is limited, particularly downstream on Oldbury and Wells Creek, Medway Rivulet and Wingecarribee River.

They also comment that the quality and distribution of the existing streamflow monitoring network presents significant limitations for calibrating the model, as does the limited availability of gauged data for catchments which will be potentially influenced by the project activities. The limitations in networks and data also make identification of suitable reference catchments for comparison with mining impacts very difficult.

Hume Coal has been undertaking baseline stream gauging in the project area since 2012. The baseline stream gauging program is ongoing to establish baseline flow conditions prior to mining and additional data will be available in the future. Baseline monitoring has been undertaken by Hume Coal at the locations shown on Figure 4.1, at frequencies shown in Figure 4.2 and Figure 4.3, of the Revised Water Assessment (Appendix 2).

Flow monitoring on the Wingecarribee River is undertaken by WaterNSW. Gauging data for the Wingecarribee River at Greenstead (No. 212009) and Wingecarribee River at Bong Bong (No. 212031) gauging stations has been undertaken since 1989. Gauging data for the Wingecarribee River at Berrima (No. 212272) gauging stations has been undertaken since 1975.

The AWBM rainfall-runoff model was calibrated to stream flow records for the Wingecarribee River at Greenstead (No. 212009) gauging station and the nearest Hume Coal gauging stations (SW04 and SW08). The Wingecarribee River at Greenstead (No. 212009) calibration was for the 25 year period from 1989 to 2015 which included wet and dry periods. This record length was considered reasonable for calibration purposes. A reasonable calibration to the available stream flow data was achieved, particularly to high flows. The AWBM model calibration will continue to be refined as more baseline stream gauging data becomes available.

A surface water flow monitoring program will be implemented in local catchments during construction, operation and rehabilitation of the Hume Coal Project. The surface water flow monitoring program will involve monitoring of stream gauges in locations upstream and downstream from the project surface water infrastructure area in locations with appropriate access and where siting for gauges can be undertaken. It is noted that some reaches are not practical for monitoring locations given the highly incised nature of streams in some areas.

WaterNSW comments that almost all catchments within, upstream and downstream of the proposed project area are disturbed / regulated with a number of storages and/or diversion works (pumps) extracting water for various purposes. Surface water flow may be more heavily impacted than is predicted by the models. The lumped rainfall-runoff model does not account for stream flow regulation (storages) or surface water abstraction by other users, greatly reducing its accuracy and reliability for making streamflow impact predictions

The AWBM rainfall-runoff model was calibrated to stream flow records for the Wingecarribee River at Greenstead (No. 212009) gauging station and the nearest Hume Coal gauging stations (SW04 and SW08), therefore taking into account streamflow regulation and abstractions. A reasonable calibration was achieved in the model, regardless of the streamflow regulation and abstraction complications (WSP PB 2016a). The AWBM model calibration will continue to be refined as more baseline stream gauging data becomes available.

WaterNSW notes errors in Table 5.13 of the EIS Surface Water Quality Assessment exist in the nitrogen and phosphorus levels reported for Medway Rivulet.

The typographical errors in nitrogen and phosphorus concentrations for Medway Rivulet in Table 5.13 of the EIS Surface Water Quality Assessment (WSP PB 2016b) are corrected in Table 8.1 below. The errors were only made in Table 5.13 and the incorrect values were not used as inputs to the EIS surface water quality modelling or elsewhere in the EIS Surface Water Quality Assessment.

Table 8.1 Baseline surface water concentrations for Medway Rivulet Management Zone – Medway Rivulet

Nutrients	Unit	80 th percentile result
Ammonia as N	mg/L	0.04
Nitrate (as N)	mg/L	0.11
Nitrite (as N)	mg/L	0.01
Total nitrogen as N	mg/L	1.1
Phosphorus	mg/L	0.08

8.2.2 AWBM input data

WaterNSW notes that descriptions of the assessment methodology vary in the level of details provided for simulations of surface runoff at mine site to those for downstream catchments. Stream flow data used for calibration of the AWBM models developed for each catchment/management zones and calibrated parameters are not presented, and should be included in the report as a daily hydrograph and provided as analysable datasets.

They also comment that predictions of potential stream flow impacts for the Lower Wollondilly Management Zone were approximated using model parameters calibrated to Medway Rivulet. They state that it is not explained why the available and potentially more applicable long-term gauged flows at Station No. 212270 (Wollondilly River at Jooriland) were not used for quantification of yield reduction for this management zone.

Existing flows for Medway Rivulet and Oldbury Creek catchments were estimated using the AWBM rainfall-runoff model for the Medway Rivulet management zone (WSP PB 2016a). This model was calibrated to stream flow records for the Wingecarribee River at Greenstead (No. 212009) gauging station and the nearest Hume Coal gauging stations (SW04 and SW08).

Existing flows for the Lower Wingecarribee River, Upper Wingecarribee River, Lower Wollondilly River, Bundanoon Creek and Nattai River management zones were approximated using the AWBM runoff for the Medway Rivulet management zone scaled to the subject catchment area. This was considered a reasonable approach given that the AWBM model was calibrated to observed flows at the Wingecarribee River at Greenstead (No. 212009) gauging station, which receives runoff from a total catchment area of 58,700 ha and is therefore considered representative of regional scale flows. Stream gauging data is available at gauging station No. 212009 for the period October 1989 to December 2015. A comparison of the gauged flows to the AWBM scaled flows for gauging station No. 212009 (catchment area 587 km²) indicates that the predicted total flow over the period of record is 16.6% higher than the observed flow, which is considered a reasonable calibration.

Calibration of a separate AWBM model for the Lower Wollondilly River management zone was not considered necessary for the assessment of yield impacts given the low predicted baseflow reduction for this management zone. The maximum baseflow reduction for the Lower Wollondilly River management zone was predicted to be 0.006 ML/day from the revised numerical groundwater model (with average climate scenario) (refer to Section 2.2 Figure 2.1 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018)). The yield reduction for the Lower Wollondilly River management zone was predicted to be 0.00004% for the representative wet climate sequence and 0.0001% for the representative dry climate sequence (refer to Section 4.2.2.2 Table 4.3 of the *Hume Coal Project Submissions Revised Surface Water Assessment* (WSP 2018)).

WaterNSW comments that the report should clarify the differences in baseflow results obtained from hydrograph separation (presented in the groundwater data analysis report) to the baseflow index parameter incorporated in the AWBM model.

The baseflow analysis undertaken for the EIS referenced in Coffey (2016a) has been undertaken using the local minimum method. The local minimum method baseflow analysis has made corrections for river regulation (years with releases from the Wingecarribee Reservoir were removed from the analysis), river flow through licensed river extraction, evaporation from major dams, and changes in dam storage. For the Wingecarribee River at Greenstead (No. 212009) gauging station, the local minimum method baseflow analysis estimated an average baseflow of 2.1% of annual rainfall over the period 1 January 1990 to 31 December 2002.

The AWBM rainfall-runoff model developed for the EIS surface water assessment was calibrated to stream flow records for the Wingecarribee River at Greenstead (No. 212009) gauging station and the nearest Hume Coal gauging stations (SW04 and SW08). The Wingecarribee River at Greenstead (No. 212009) calibration was for the 25-year period from 1989 to 2015. The AWBM model, including the baseflow Index (BFI) parameter, was calibrated to the observed total stream flow and no corrections were made for river regulation or abstractions. The AWBM rainfall-runoff predicted baseflow would therefore include surface water low flows in the observed streamflow record that mimic baseflow, including reservoir releases and sewage treatment plant releases. A value of 0.5 has been adopted for the AWBM rainfall-runoff model BFI parameter. For the Wingecarribee River at Greenstead (No. 212009) gauging station, the AWBM rainfall-runoff model predicted an average baseflow of 6.9% of annual rainfall over the period 1 January 1990 to 31 December 2002.

The baseflow predicted by the two methods are considered to compare reasonably well. The higher baseflow predicted by the AWBM rainfall-runoff model compared to the local minimum method is expected as no corrections were made for river regulation or abstractions in the AWBM rainfall-runoff model calibration.

8.2.3 Surface water quality assessment

i Input data

WaterNSW commented that the surface water quality monitoring of sites to create baseline concentrations of existing creeks and baseline for operational monitoring locations has some data issues. The issues identified include:

- Medway Rivulet has 40 months of upstream data readings and only 15 months of downstream data. Oldbury Creek has 17 months of upstream readings and only 5 months of downstream readings.
- Wells Creek (near the proposed ventilation shaft) has only 3 months of data in a very short section of the creek.
- In 2015, 3 sites (with 5 readings each) of supplementary data in connected farm dams were added in Oldbury Creek. Issues exist with both the amalgamation of water samples from farm dams with flowing creeks, and potential pseudo replication of the dam sites.
- Raw data for individual monitoring sites is not presented, nor could the existing variability be assessed.
- The rationale for the treatment of baseline water quality data is not always clearly shown. Issues exist with the treatment of less than detection limit measurements and also outliers. One outlier (ten times the mean) was removed for phosphorus in the Stoney Creek catchment, but for many other sites, single outliers for a site, that are at least 2 standard deviations above the mean have been retained.
- The EIS states that 'ideally site specific Water Quality Objectives (WQO)'s' should be based on 24 months baseline or reference data. Related issues include: the datasets at many of the sampling sites have less than one year of readings. With the last reported measurements being in September 2015, 12 months before the draft Water Quality report was produced and 18 months old when the EIS was released; monthly data has continued to be collected, but not reported (nor able to be assessed); the number of samples downstream the project area significantly less than upstream; and the three supplementary sample sites added in close proximity on Oldbury Creek use farm dams.
- The sample data is only reported as summary statistics by creek system. Detailed water quality data for individual locations was not included in the EIS and only supplied to Water NSW on 15 June 2017.

Hume Coal has been undertaking surface water quality monitoring in the project area since April 2012. The baseline surface water quality monitoring program is outlined in Chapter 4 of the EIS Water Assessment and the Revised Water Assessment (EMM 2017c; EMM 2018a (Appendix 2)). The baseline monitoring program is ongoing to establish baseline surface water quality conditions prior to mining. Monitoring is undertaken monthly and additional baseline monitoring data will be available in the future. Baseline water quality data has been collected from April 2012 through until April 2018 and continues to be collected. Data collected between April 2012 and September 2015 from the Hume Coal surface water monitoring program are included and comprehensively analysed in the EIS (WSP PB 2016b) (this was the period of data used for the EIS assessment). The results from baseline monitoring will continue to be collected up to the start of project construction for future analysis. Data collection will continue during the project's construction and operation. There will be more than 24 months of baseline data available for all Hume Coal monitoring locations prior to the commencement of construction of the project.

Post-approval, the monitoring network will be reviewed and, if deemed warranted, additional monitoring sites will be included. Changes to the monitoring network will be made in consultation with the relevant government agencies.

The WQOs presented in the EIS are preliminary only. Final WQOs will be developed using the additional baseline surface water quality data collected prior to commencement of construction. Final WQOs will be developed in accordance with the National Water Quality Management Strategy and in consultation with the relevant regulatory agencies. Prior to development of WQOs, the baseline water quality dataset will be reviewed, taking into account the submissions' concerns regarding inclusion of potentially inappropriate data points (eg farm dam data).

ii Roads

WaterNSW makes the following comments regarding the water quality modelling relating to roadways:

- Issues with roads modelling include quantification of the infrastructure disturbance, soil parameters used, soil parameters post development after topsoil stripping, size and type of stormwater quality improvement devices (SQIDs) proposed, how the SQIDs fit into the landscape, post development land use categories etc. When the assessment was replicated, WaterNSW could not obtain the same result.
- WaterNSW considers that it is likely that NorBE can be met for the infrastructure and roads but further analysis and different management practices are required which should be addressed in the response to submissions report.
- MUSIC modelling issues exist with the quantification of the infrastructure disturbance, soil parameters used, soil parameters post development after topsoil stripping, size and type of SQIDs proposed, how the SQIDs fit into the landscape, post development land use categories etc. The rerunning of individual MUSIC models with standard parameters that WaterNSW use, show that NorBE was not met.
- These developments should be able to meet NorBE with appropriate SQIDs. However, the methods chosen by the consultant to meet NorBE in models does not always appear appropriate.

The MUSIC water quality modelling undertaken for mine access roads for the Hume Coal Project EIS has been revised to address matters raised in the WaterNSW submission following consultation with WaterNSW. The revised water quality modelling methodology (where the methodology differs from the EIS) and results for mine access roads are outlined in Section 5.3 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018).

The following changes have been made to the MUSIC parameters for the revised water quality modelling compared to the EIS:

- swale exfiltration rate set to 0 mm/hr;
- swale vegetation height set to 0.25 m; and
- industrial land use type adopted for road cut/fill embankments.

It is understood that the WaterNSW submission relating to quantification of the infrastructure disturbance area was based on an older set of engineering drawings for mine access roads. The infrastructure disturbance areas for the EIS were calculated using the latest engineering design drawings for mine access roads and have therefore not been changed from the EIS.

The following changes have been made to the proposed water quality treatment measures for mine access roads in order to achieve NorBE following the changes to the MUSIC parameters:

- proposed swale lengths increased; and
- constructed wetlands proposed downstream of swales as an additional management measure.

The revised water quality treatment measures for mine access roads are outlined in Section 5.3.2.1, Table 5.7 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018).

The revised water quality modelling demonstrates that the revised treatment measures for mine access roads achieve NorBE. Mean annual pollutant loads for total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) are reduced by more than 10% for the operational scenario compared to the existing scenario. Pollutant concentrations for TP and TN for the operational scenario are equal to or better than the existing scenario between the 50th and 98th percentiles.

iii Model method

WaterNSW comments that the methods for quantifying water quality impacts of the surface infrastructure in the EIS have some technical issues. Infrastructure water quality impacts were modelled in MUSIC using GoldSIM output as daily inputs. The use of daily values has much lower repeatability for stochastic load modelling, than 6 minute impacts as required in WaterNSW's standard for the "Use of MUSIC in Sydney's drinking water catchments" (Sydney Catchment Authority 2012).

They also question the method and MUSIC stormwater quality modelling assumptions used in this analysis, citing that issues with the infrastructure modelling include daily stochastic modelling and treating all pre-development flow as stormflow.

The MUSIC water quality modelling undertaken for releases from stormwater basins SB03 and SB04 to Oldbury Creek for the Hume Coal Project EIS has been revised to address matters raised in the WaterNSW submission. The revised water quality modelling methodology (where the methodology differs from the EIS) and results for releases from stormwater basins SB03 and SB04 are outlined in Section 5.2 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018).

The following changes have been made for the revised MUSIC modelling compared to the EIS:

- The predicted time series for releases from SB03 and SB04 to Oldbury Creek has been revised to reflect the results of the revised water balance modelling. Revised water balance modelling was undertaken to reflect the post-EIS numerical groundwater modelling undertaken by HydroSimulations (2018).
- Existing flows have been modelled as a mix of base flow and storm flow.
- The MUSIC model timestep has been changed from daily to 6-minute.

The revised water quality modelling demonstrates that the releases from stormwater basins SB03 and SB04 to Oldbury Creek achieve NorBE due to the significant reduction in agricultural catchment draining to Oldbury Creek during operation of the mine. Mean annual pollutant loads for total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) are reduced by more than 10% for the operational scenario compared to the existing scenario. Pollutant concentrations for TP and TN for the operational scenario are equal to or better than the existing scenario between the 50th and 98th percentiles.

8.3 Site water management

NSW DPI request confirmation that there is a buffer distance between the proposed works and the high banks of the watercourses. They cite that DI Water recommend that the buffers be consistent with the "Guidelines for Controlled Activities on Waterfront Land (NOW 2012b)". NSW DPI request that works within waterfront land must be consistent with the DPI Water "Guidelines for Controlled Activities on Waterfront Land (2012)".

Where relevant, Hume Coal commit to complying with buffers consistent with the "Guidelines for Controlled Activities on Waterfront Land (NOW 2012b)".

The project proposes to construct a conveyor, power line and widen an existing roadway over Oldbury Creek, and construct a conveyor and upgrade an existing farm road over Medway Rivulet. These activities are proposed on waterfront land and meet the criteria for requiring a controlled activity approval. However, as the project is a State Significant Development under section 89J (1) (g) of the EP&A Act 1979, (once development consent is granted) it will be exempt from requiring an approval to undertake work on waterfront land. Despite that, the assessment of these activities has been considered in accordance with the policies and guidelines in respect of waterfront land and riparian corridors.

One special interest groups raised a concern regarding the capacity of the stockpile dust suppression watering systems to cope with extreme weather conditions.

As the EIS states (EMM 2017a, p338) "water sprays, for the purpose of dust suppression, fitted to the ROM and product stockpiles, will be adjusted in real-time based on wind speed and temperature". Similar systems are used elsewhere and are regarded as industry best practice. Ongoing monitoring will occur to confirm dust suppression management is undertaken to maintain impacts within the relevant guideline requirements as is standard industry practice.

8.3.1 Water balance model accuracy

The NSW EPA comments environmental risk may increase if discharge from the primary water dam (PWD) cannot be returned underground. The EPA comments that for successful management of water, the project relies heavily on groundwater and surface water modelling. Although the EPA notes the modelling has been performed conservatively, they state that it contains “inherent risk from assumptions and projections of experience from existing mine operations that may be dissimilar, which may result in uncertainty in defining potential impacts to groundwater and surface water”.

One special interest group also questioned the accuracy of the surface water release predictions, given the water balance model was based on historical climate data, and the potential impacts of the inaccuracy of the predictions on groundwater and surface water. Other community members were concerned that with potential increase in rainfall as a result of climate change has not been properly accounted for, and the dams could overflow and contaminate watercourses.

One community member was also concerned whether the capacity of the PWD would be sufficient if the groundwater inflow to the mine is greater than predicted. Another community member claimed that the estimation of water supply demands for the project are incorrect and should be 7 to 10 times larger. One community member questioned the accuracy of the water balance model regarding the volume predicted to be released into Oldbury Creek, claiming that the predictions are likely to be much smaller and much less frequent than the reality.

Groundwater and surface water modelling have been undertaken as a requirement of the approvals process and in accordance with regulatory guidelines to assist in impact predictions. Numerical models, by definition, are mathematical simulations that attempt to replicate the complex real world situation using appropriate assumptions and field data. Sensitivity and uncertainty analysis are performed to reduce the uncertainty in the assumptions and increase the accuracy and precision of the models' predictions. The numerical modelling that has been undertaken for the Hume Coal Project as presented in the EIS and the revised numerical modelling and detailed uncertainty analysis as provided in Appendix 2 is above industry standards for consideration of uncertainty with model results.

Details regarding the robust uncertainty and sensitivity analysis undertaken for the numerical groundwater modelling are included in Appendix 2 (Section 8.6). Matters concerning groundwater modelling accuracy and uncertainty are addressed in Chapter 9.

The water balance model developed for the Hume Coal Project EIS (WSP PB 2016a) has been revised to include the revised groundwater inflow estimates from post-EIS numerical groundwater modelling, including robust uncertainty analysis and climate sensitivity analysis, undertaken by HydroSimulations (2018). Responses addressing concerns relating to uncertainty in the numerical groundwater modelling are included in Chapter 9.

Water balance modelling for the Hume Coal Project has been based on historical daily rainfall and evaporation data for the site for the period 1889 to 2015 (sourced from Data Drill), which includes prolonged wet and prolonged dry periods. The revised water balance modelling methodology (where the methodology differs from the EIS) and results are outlined in Section 3 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) and Section 8.2 of the Revised Water Assessment (Appendix 2).

The revised water balance model base case adopts groundwater inflow estimates from the groundwater model uncertainty analysis. The uncertainty and sensitivity analysis undertaken in the revised groundwater model demonstrated that the mine inflow is not very sensitive to changes in climate. The results of the water balance base case modelling are provided in Section 3.2 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). A water balance model climate sensitivity analysis has been undertaken adopting groundwater inflow estimates with comparisons between average, wet and dry climate scenarios. The results of the water balance model climate sensitivity analysis are provided in Section 3.3 of the *Hume Coal Revised Surface Water Assessment* (WSP 2018).

The revised water balance base case modelling predicts a peak simulated stored volume of 625 ML in the PWD over the 19-year mining period based on the 107 water balance realisations modelled, with varied climate scenarios. The peak simulated volume in the PWD of 625 ML is significantly lower than the modelled storage capacity of 730 ML, indicating a low risk of overflow from the PWD based on the 107 water balance realisations modelled. The results of the water balance model climate sensitivity analysis demonstrate that the Modified EIS groundwater model wet and dry climate scenario groundwater inflows are not sufficiently different to make any significant change to the predicted peak stored volumes in stormwater basins (SBs) and mine water dams (MWDs) compared to the Modified EIS groundwater model static average climate groundwater inflows.

All SBs, MWDs and the PWD will have the capacity to accommodate at least the 200 year Annual Recurrence Interval (ARI) 72 hour storm runoff volume, with the exception of MWD07 which will have the capacity to store between the 100 and 200 year ARI 72-hour storm runoff volumes. The capacity of the PWD has been sized to hold all water on site without the need to dispose of excess water in local waterways. The capacities of these dams were based on physical constraints and the requirement that no dam overflows would occur when the dams are operated as part of the overall site water management system under historical climate conditions, including wet and dry sequences. The water balance modelling confirmed that the basins or dams will not spill with the adopted capacities for any of the wettest periods in the climate sequences (WSP 2018).

In the highly unlikely and extreme event that neither the PWD nor the void spaces behind the bulkheads are able to contain water, excess water will be transferred to MWD08 (water treatment dam) for treatment and subsequent release to Oldbury Creek, although water balance modelling indicates that this management measure will not be required (WSP 2018).

Releases from SB03 and SB04 following capture of first flush have been predicted across 107 different climate scenarios in the revised water balance model based on historical data (including extreme wet and dry periods) (Table 3.10 of WSP (2018)). Under all climate scenarios, the PWD has the capacity to store all runoff from SB03 and SB04 catchments, if required.

The water balance modelling undertaken for the EIS and RTS assesses the performance of the water management system under historical extremes. Further water balance modelling will be undertaken during the detailed design phase of the project, including sensitivity analyses for potential impact of future climate change on the site water balance.

Water supply demands for the project are considered appropriate for the scale, design and schedule for the mine proposed.

8.3.2 Site water storages

Several special interest groups submitted concerns regarding the integrity of surface water storages (ie mine water dams) and the potential for surface water quality impacts if the storages were compromised.

Where appropriate, Hume Coal Project dams will be designed, constructed, operated and maintained to meet the requirements of the NSW Dams Safety Committee (DSC) under the Dams Safety Act 1978.

The NSW DSC is the State's regulator for dam safety and is responsible for ensuring the safety of dams whose failure would cause serious community consequence, including environmental effects. The NSW DSC prescribes these dams under the provisions of the Dams Safety Act 1978 and uses a consequence category system to determine the need to prescribe a dam. All 'Extreme', 'High' and 'Significant' consequence category dams, along with 'Low' consequence category dams over 15 m high, are prescribed under the Dams Safety Act 1978 on the recommendation of the NSW DSC. However, all dams over 15 m high, or with populations downstream, or containing toxic materials should be referred for DSC consideration regardless of potential failure consequences.

The NSW DSC requires that new dams are designed and constructed according to appropriate engineering standards and safety criteria. After construction, dam safety is monitored by requiring prescribed dam owners to arrange for:

- proper operation and maintenance using trained personnel;
- regular surveillance using trained personnel;
- appropriate dam safety emergency plans to be in place for dams whose failure could cause loss of non-itinerant life;
- ongoing assessment of dam behaviour on the basis of surveillance information;
- periodic review of compliance with current DSC requirements;
- review of all dam information and assessments by experienced personnel; and
- actions, in response to dam assessments, to ensure that dams are maintained in a safe condition.

The EPA suggests that the EIS does not provide details of liner systems for the mine water storages. Liner systems must be designed, constructed and operated to prevent pollution of surface water and groundwater from seepage of contaminants through the base and side walls. The EPA require that for contaminated water storages and tailing storage facilities, a clay liner of a hydraulic conductivity of 1×10^{-9} m/s must be constructed and be at least 1,000 mm in thickness, alternatively, a geosynthetic liner could be placed to provide equivalent or better protection.

The EPA recommends the design details of liner systems for the mine water storage be provided. If the liner permeability proposed is higher or the thickness less than the benchmark requirements, a risk assessment should be provided to demonstrate it will protect potential receiving waters.

WaterNSW comments that due to the scale of the dams, and their depth (PWD is 16 m deep at maximum), the management of the site needs to ensure that the clay liner has sufficiently low permeability to prevent the contamination of groundwater. The stored water in the dam will be a mixture of mine groundwater, rainwater and process water, with potentially elevated levels of metals and other pollutants.

Water NSW also note that there should also be a requirement that the other basins/dams coming into contact with the sediments from coal washings also be lined.

The PWD will be lined up to the normal water storage level to prevent seepage.. Other mine water dams that will contain water in contact with coal will be lined up to the normal storage levels to prevent seepage.

NSW DPI comments that an assessment should be undertaken of impacts on downstream users and the environment due to the proposed raising of the dam wall on an existing dam on Oldbury Creek. NSW DPI comment that consideration of dam safety matters in accordance with the Dams Safety Act is required. Consideration is also recommended of the ability to install culverts to maintain the current flow regime from the dam.

Hume Coal does not intend to raise the wall on the existing dam on Oldbury Creek, but may consider upgrading the existing access track by widening the embankment, if necessary. Widening of the embankment will be designed so to not affect how the dam spills during normal rainfall events or downstream users and the environment. The existing spillway through the embankment will be maintained at the current level so that the water stored within the storage will not increase in volume.

It is noted that Section 6.1.3 of the *Hume Coal Project Flooding Assessment* (WSP PB 2016d) references that the embankment across Oldbury Creek will be raised and that it will also have poles for electricity lines installed. This statement is incorrect. As mentioned above, the embankment will not be raised but may be widened; this work will not affect the storage capacity of the existing dam. The electricity lines will be constructed at the other, upstream crossing of this dam.

As stated above, all Hume Coal Project dams will be designed, constructed, operated and maintained to meet the requirements of the *NSW Dams Safety Committee* (DSC) under the *Dams Safety Act 1978*.

8.3.3 First flush water management

The NSW EPA accepts the use of first flush systems in areas that do not drain continuous sources of pollution. These include roadways, paved areas, buildings and some grassed areas. The NSW EPA states that Hume Coal must ensure that “no unsealed areas” drain to the first flush system that is proposed for the SB03 and SB04 catchments. This must include workshops and equipment storage areas where wheel movements of heavy vehicles tend to break hardstand. The first flush system must not be used for capture in lieu of bunding for chemical storages which should be designed in accordance with appropriate standards.

The NSW EPA requires clarification on how the first flush from the SB03 and SB04 catchments will be managed to minimise the risk of contaminants being deposited in the stormwater basins and later released.

One community member raised a concern with the logistics of determining whether first flush water meets criteria during the rainfall event and impacts of releases if poor water quality is not detected by the proposed monitoring program. Another community member questioned who will monitor the released water.

SB03 and SB04 drain relatively clean (ie non-coal contact) catchments. None of the proposed coal stockpiling areas or direct contact between runoff and coal will occur within these catchments. Bunding for chemical storages within the SB03 and SB04 catchments will be designed in accordance with appropriate standards, and the first flush system will not be used for capture in lieu of bunding for chemical storages.

The first flush system will be designed so that the first flush runoff flows to SB03 and SB04 and the subsequent clean runoff will bypass SB03 and SB04 and be diverted to Oldbury Creek. This will minimise the risk of contaminants being deposited in SB03 and SB04 and later released to Oldbury Creek. The configuration of the first flush system will be determined at the detailed design phase of the project. Under all climate scenarios, the PWD has the capacity to store all runoff from SB03 and SB04 catchments, if required.

- Proposed monitoring relating to SB03 and SB04 will be conducted by Hume Coal and will include:
- real-time water testing for total dissolved solids (TDS) and pH to determine whether water quality is acceptable to be released, with results will be compared to trigger thresholds developed from baseline monitoring data in consultation with the relevant agencies;
- monitoring quality and metering the volume of water releases to Oldbury Creek from SB03 and SB04; and
- additional surface water monitoring sites on Oldbury Creek (downstream of where releases from SB03 and SB04 will occur), and on Medway Rivulet downstream of the junctions with Wells Creek and Oldbury Creek, pending site access.

8.3.4 Excess water management

The NSW EPA raised a concern regarding the potential management measure mentioned in the EIS for dealing with excess water on site being injection into the Hawkesbury Sandstone. They were concerned about the potential water quality impacts that this activity might have and lack of assessment.

Chapter 13 of the EIS Water Impact Assessment (EMM 2017c) notes that “An additional mitigation measure ... that was considered in detail is to pump surplus water back into the Hawkesbury Sandstone. Injection of surplus water into the Hawkesbury Sandstone provides an excellent mitigation measure to minimise groundwater drawdown in landholder bores, and enhance recovery times following mining. However, a trial of this activity (ie injection into a water source) was unable to be licensed by DPI Water, and as such, this mitigation measure will not be included in the proposed project.” As this measure is not included in the proposed project, potential impacts associated with this activity are irrelevant to the water impact assessment.

8.3.5 Water treatment

WaterNSW, one special interest group and community members consider the design criteria of a Water Treatment Plant (WTP) and dam MW08 should be further investigated. WaterNSW suggests that these facilities should be installed during the construction stage as an additional safety factor for the project.

Design criteria are not included in the EIS as both the WTP and MWD08 are considered provisional infrastructure. They may be utilised as control measures in the unlikely event that excess water stored in the PWD may need to be treated and released to Oldbury Creek. The water balance modelling indicates that this is not required for all climate sequences tested. As part of the Water Management Plan, the water balance model will be reconsidered and optimised for water efficiency throughout all years of mining. The optimising of the water balance model will focus on more efficient operation and the water level in the PWD as well as confirm predictions. Consideration for installation of the WTP and MWD08 provisional infrastructure would be revisited following review of water balance model revisions if predictions indicate the PWD will not have sufficient storage.

The NSW EPA comment that the EIS does not appear to propose pre-treatment of coal contaminated water in SB01 and SB02. The EIS also does not appear to propose treatment of water from the PWD for use in the coal processing plant (CPP), for vehicle wash-down, or for use in other mine infrastructure areas, as occurs in many mines. The water treatment processes should be described for water used in surface processes.

SB01 and SB02 will receive water in contact with stockpiles, however, the majority of water collected within these basins will be direct rainfall-runoff. Water from SB01 and SB02 will be transferred to the PWD, and will mix with the other water components (the high majority is groundwater) contained in the PWD (RGS 2018).

Water from the PWD used for vehicle wash-downs, coal processing, or other mine infrastructure areas will be used in areas contained within the mine water management system – ie no surface runoff outside of the water management system will occur.

RGS (2018) undertook geochemical modelling of the range of water qualities predicted to be contained within PWD over the life of the mine considering the various contributing sources. Further details of the monitoring methods and results are described in Chapter 10 and also Appendix 2 (Section 8.7 and Section 11.2.3 of Appendix 2). The modelling indicates that the PWD is likely to maintain a near-neutral pH for the life of the mine, maintain metal(loid) concentrations within ANZECC criteria for livestock (ANZECC and ARMCANZ 2000), and be comparable to baseline groundwater conditions for the Wongawilli Coal seam. Given these results, water treatment prior to use in surface processes is not considered warranted.

8.3.6 Grey and blackwater management

WaterNSW does not consider the assessment or the proposed management of onsite wastewater (grey and blackwater) to be satisfactory, citing that no details regarding the allocation of treatment methodology or the effluent disposal areas (with suitable buffer areas) are provided. The NSW EPA also raised concerns about the lack of information, and therefore associated risks, regarding the onsite sewage management system during construction and operation and its ability to meet required environmental and human health performance outcomes.

WaterNSW also does not consider that the impacts of the construction accommodation village (CAV) on water quality are adequately addressed in the Hume Coal Project EIS.

The Hume Coal Project EIS proposes the construction of the CAV will house 400 people during the construction phases. During some stages, the EIS suggests that sewage will be tanked offsite to a local sewerage treatment plant (STP). Wingecarribee Shire Council (WSC) warns that it is not easy to find disposal of an extra 400 people at its STP's, as some facilities are already close to capacity and that this process would have to be carefully modelled and negotiated.

The NSW EPA comments that a consistent overview of the intended treatment, disposal and/or reuse of wastewater for the Berrima Rail Project is needed for clarity. The NSW EPA recommends that if treated sewage is reused for irrigation or dust suppression onsite, an effluent reuse plan must be developed before irrigation begins.

One community member was concerned of possible parasite contamination of drinking water supplies as a result of raw sewage entering the drinking water catchment.

In response to the above submissions, Hume Coal has undertaken additional work regarding on-site wastewater management for the Hume Coal Project and the Berrima Rail Project. A concept effluent reuse plan for the Hume Coal Project and the Berrima Rail Project has been prepared (Harris Environmental 2018). This will form part of the Water Management Plan for the Hume Coal Project. Details of this additional work are included in Section 2.3.3 of the Revised Water Assessment (Appendix 2).

The assessment included an estimate of the potential volume of wastewater that could be generated from the proposed development and sized the required area for wastewater disposal at a suitable location compliant with the relevant assessment criteria.

In summary, the following features will be included as part of the wastewater management for the two projects:

- Hume Coal Project:
 - early in the construction phase of the CAV, installation of a commercial sewage management facility with capacity to treat up to 33,470 L per day to a secondary standard to accommodate up to 395 workers, depending on the eventual number of non-local workers;
 - installation of up to 200,000 L (equivalent to seven days) of wet weather storage tanks, or potentially use a modified existing farm dam (modified to a lined, turkey's nest dam), for wet weather storage;
 - commercial spray irrigation system, for treated wastewater application, to cover up to 17,470 m², fenced and restricted from public access;
 - stormwater diversion measures to divert clean water away from the proposed irrigation area;
 - cropping of fescue pasture for hay production; and

- monitoring of wastewater quality, soils and groundwater within the vicinity of the wastewater management infrastructure.
- Berrima Coal Project, rail loop and maintenance facility:
 - installation of a domestic aerated wastewater treatment system with the capacity to treat at least 410 L per day of wastewater from the office building amenities to accommodate 10 workers; and
 - installation of 288 m² irrigation system for treated wastewater disposal.

Once the project has been given Development Consent, approval to install and operate the nominated sewage management systems will be sought from the Wingecarribee Shire Council in accordance with the Section 68 of the NSW Local Government Act 1993. The commercial facility will be installed and maintained in accordance with Section 5 of the Use of Effluent by Irrigation Guidelines (DEC 2004).

Four potential areas for commercial wastewater disposal and one potential area for domestic wastewater disposal have been identified as suitable and compliant with the relevant guidelines (SCA 2012; DEC 2004), including application of the viral die-off method to incorporate appropriate setback distances accounting for possible subsurface wastewater movement (Cromer et al 2001). The treated wastewater will be applied using spray irrigation and will not be re-used for any other purpose.

The commercial sewage management facility will be prioritised to be installed as early as practicable during construction. Prior to its installation, temporary facilities will be utilised and sewage will be trucked offsite during this initial stage. If there is still insufficient capacity at STPs within the shire at the time early construction works commence, Hume Coal will employ an appropriately licensed waste contractor to cart and dispose of the waste at the nearest STP with capacity.

8.3.7 Stockpile water management

One community member asked how much water will be required for the stockpiles and whether this volume has been included in the proposed water usage volume.

The volume of water required for stockpiles is incorporated in the HCP water balance model. The model was configured to simulate the daily operations of all major components of the water management system. This is presented in detail in the *Hume Coal Project Water Balance Assessment* (WSP PB 2016a), Appendix D of the *Hume Coal Project Water Assessment Report* (EMM 2017c).

8.3.8 Berrima Rail Project - erosion and sediment control

The NSW EPA comments that the Berrima Rail Project EIS does not specify the design storm sizing for the construction or operation of sediment basins. The NSW EPA recommends that, as part of a Soil and Water Management Plan, Hume Coal should ensure construction stage sediment basins are designed and managed to achieve the required water quality for storms up to at least the 80th percentile 5-day events, and that operation stage sediment basins are designed and managed to achieve the required water quality for storms up to at least the 90th percentile 5-day event.

A Construction Environmental Management Plan (CEMP) will be prepared and implemented during the construction phase of the Berrima Rail Project. The EIS states that the CEMP will include an Erosion and Sedimentation Control Plan that will be developed in accordance with the guidelines Managing Urban Stormwater: Soils and Construction - Volume 1 (Landcom 2004) ('Blue Book') and Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services (DECC, 2008). The Erosion and Sedimentation Control Plan will also form part of the Water Cycle Management Plan for the Hume Coal Project, as required by the guidelines Developments in Sydney's Drinking Water Catchment – Water Quality Information Requirements (Water NSW 2015).

Sediment basins will be sized based on the duration of disturbance and the receiving environment classification in line with the guidelines Managing Urban Stormwater: Soils and Construction - Volume 1 (Landcom 2004) ('Blue Book') and Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services (DECC 2008). Construction stage sediment basins will be sized for at least the 80th percentile 5-day event as per the Blue Book. Operational stage sediment basins will be sized for at least the 90th percentile 5-day event.

Operational stage sediment basins are only proposed for long term work areas, if required. Other operational stage water quality controls, such as constructed wetlands and vegetated swales, will be sized based on water quality modelling to achieve the neutral or beneficial effect (NorBE) on water quality requirements.

8.4 Surface water impacts

One special interest group paraphrased the potential surface water impacts identified in the EIS as:

- reducing streamflow or affecting surface water / groundwater connectivity as a result of groundwater depressurisation;
- impacting the catchment and drainage as a result of constructing surface water infrastructures;
- degrading water quality during construction and operations from surface infrastructure; and
- erosion, contamination or other negative impacts as a result of discharge of treated water to nearby watercourses or through the supply of water to others.

The submitter was concerned with the severity of these perceived impacts.

Another community member raised concerns that the claim of insignificant impact on surface water and groundwater is questionable.

A summary of the surface water impact assessment is included in Section 10.5 of the *Hume Coal Project Water Assessment* (EMM 2017c). The surface water assessment has been revised following receipt of submissions on the EIS; results are presented in Section 10.5 of the *Hume Coal Project Revised Water Assessment* (Appendix 2).

The assessment of project-related impacts to water resources and water users considers the requirements of the *WMA 2000*, the relevant water sharing plans, the NSW Aquifer Interference Policy 2012 (the AIP), the Commonwealth Department of Environment *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources* (DoE 2013) and the *Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals* (IESC 2015).

The revised surface water assessment concluded that predicted effects on sensitive surface water users are insignificant with respect to: changes to surface water flow and yield; changes to stream bank erosion; changes to surface water quality; and changes to flood levels.

8.4.1 Water supply

Numerous community members and several special interest groups submitted general concerns about potential impacts to Sydney drinking water catchments, Sydney water supply, and/or other local water resources and supplies, such as Southern Highlands, Goulburn, Illawarra, Robertson, Kangaroo Valley, Berrima, Sutton Forest. Many of these concerns claimed that the damage would be unable to be repaired. Some claimed that the volume of water required by the project would be at the detriment of existing users.

One community member made a suggestion the project should consider using the mined out voids as water storage for supply to augment stream flow (if the water is treated).

The project's impacts on surface water resources will be minimal. All potential impacts to surface water users and stream environments have been assessed as insignificant in accordance with the *Significant Impact Guidelines* (DoE 2013). Chapter 10 of Appendix 2 outlines the results of the surface water impact assessment.

The project will result in negligible changes in the volume and quality of water available for regional surface water supplies, including the Sydney drinking water supply, and for licensed and basic rights surface water users.

The Warragamba Drinking Water catchment is managed by WaterNSW and is part of Sydney's drinking water catchments. Around one quarter of Warragamba Dam's catchment comprises 'special areas' where public access and land use are carefully regulated to protect water quality. As stated in Section 2.1.4 of the *Hume Coal Project Water Assessment* (EMM 2017c) and Section 2.1.4 of the *Hume Coal Project Revised Water Assessment* (EMM 2018a), the project area is not within a special area, nor is the nearby Medway Dam. The surface facilities will be within the Medway Rivulet and Oldbury Creek sub-catchment areas, which form part of the Medway Rivulet Management Zone, flowing into the Wingecarribee River within the Upstream Warragamba and Upper Nepean Unregulated River Water Source.

The flow impact assessment undertaken for the Hume Coal Project EIS has been revised to include the revised baseflow reduction estimates from revised numerical groundwater modelling, including uncertainty analysis and climate sensitivity analysis, undertaken by HydroSimulations (2018). The flow impact assessment methodology (where the methodology differs from the EIS) and results are outlined in Section 4 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). Overall, there are negligible impacts to surface water flows as a result of the project, and artificial augmentation of surface water supplies is not required or proposed.

Yield impact assessment results for the Medway Dam catchment are provided in Section 4.2.2.1 Table 4.2 of the Hume Coal Project Response to Submissions Revised Surface Water Assessment report (WSP 2018). A 0.3% reduction in yield is predicted for the Medway Dam catchment during the 19-year mining period. The predicted annual maximum volumetric loss is 278.1 ML/yr under wet climatic conditions and 120.9 ML/yr under dry climatic conditions. These changes in the Medway Rivulet Management Zone would produce negligible changes in flow downstream in the substantially larger Lower Wingecarribee Management Zone, and therefore, negligible changes to the volume of water available for Sydney water supplies and other regional supplies.

The impacts of the project on surface water quality are addressed in Section 10.2 of the *Hume Coal Project Revised Water Assessment* (Appendix 2). The proposed water management system has been developed to prevent contamination of local waterways and will aim to use mine water as a priority to meet all demands (with the exception of potable water) over imported water. Surface water runoff from areas of the site in direct contact with coal will be fully contained within the mine water management system to prevent discharge to local waterways. A response to submissions relating to specific concerns of pollution of the Sydney drinking water catchment and local waterways is included in Section 8.4.2.

As described in Table 13.1 of the *Hume Coal Project Revised Water Assessment* (Appendix 2), the non-caving mining method and design of barrier pillars have been developed to incur zero caving, negligible subsidence and no surface cracking. This will result in no structural changes to the Hawkesbury Sandstone and no surface water losses from cracking of stream beds above the mine or elsewhere within the wider Sydney water catchment areas.

In accordance with the relevant Water Sharing Plan requirements, Hume Coal will hold Water Access Licences for the peak volume of water predicted to be taken as a result of the project.

The water balance model (Section 8.2 of Appendix 2) shows that project's operation water demands (apart from potable water) will be fully met by using:

- rainfall-runoff from the mine water dams;
- groundwater collected in the underground mine sump (where groundwater inflow to underground workings will be captured); and
- additional groundwater abstracted from behind the sealed mine void bulkheads as required.

As such, existing users' surface water supplies will not be accessed to meet the project's operation water demands.

Two main water management plans (WMPs) will be developed for the projects, one for the construction phase (CWMP) and one for the operational phase (OWMP). The WMPs will provide a framework for water management and will document the proposed mitigation and management measures for the approved project. They will include details regarding the surface and groundwater monitoring program, reporting requirements, spill management and response, water quality trigger levels, corrective actions, contingencies, and responsibilities for all management measures to mitigate or manage impacts to surface water systems. The WMPs will be prepared in consultation with DPI Water, EPA, and WaterNSW, and the local council.

As stated in Section 13.3 of the Revised Water Assessment (Appendix 2), monitoring during construction and/or operation of the project will likely include the following aspects as additional water supply management measures, on top of the existing baseline monitoring program, pending site access:

- groundwater seepage monitoring next to the PWD;
- groundwater monitoring next to landholder bores predicted to be impacted by the project;
- shallow groundwater monitoring next to Medway Dam;

- water quality monitoring of mine water dams (including the PWD which receives recycled water) and stormwater basins;
- water metering and recording of pumped volumes to/ from MWDs, SBs, PWD, sump and the void;
- real-time flow and water quality (TDS and pH) monitoring of the transfer pipe from SB03 and SB04 in accordance with the first flush threshold criteria;
- shallow groundwater monitoring in areas identified as having shallow groundwater and known ecosystems with possibly affected species;
- monitoring quality and metering the volume of water releases to Oldbury Creek from SB03 and SB04 or WTP (if required);
- monitoring water quality within temporary sediment basins during construction;
- monitoring of wastewater quality, soils and groundwater within the vicinity of the wastewater management infrastructure;
- monitoring of seepage around temporary reject stockpile;
- monitoring quality of water in sump and the rate and quality of water pumped into sealed voids; and
- additional surface water monitoring sites on Oldbury Creek (downstream of where releases from SB03 and SB04 will occur), and on Medway Rivulet downstream of the junctions with Wells Creek and Oldbury Creek.

8.4.2 Surface water quality

WaterNSW considers a detailed assessment is required of the impact of the construction, operation and decommissioning of the project on the quality of both surface and ground water. They request the opportunity to continue to be involved in any ongoing assessment and provide comments on the Response to Submissions report.

Following receipt of WaterNSW's submission, Hume Coal have consulted with WaterNSW on a number of occasions (refer to Chapter 4) to discuss the specific comments raised in their submission. WaterNSW have been provided with additional information and data, and have been briefed of additional surface water work, including modelling, prior to submission of the Response to Submissions. Hume Coal is committed to engaging in continued consultation with WaterNSW and other relevant stakeholders for the life of the project.

Two business groups, several special interest groups and numerous community members submitted concerns regarding mine water contamination of local rivers and streams, including the Sydney drinking water catchment and drinking water supplies. Some concerns related to the proposed controlled releases into Oldbury Creek, while other concerns related to potential uncontrolled releases during extreme weather events or as a result of accident, error or general concerns about contamination of water supplies. Many of these submissions claimed that the water being released would be toxic. Some concerns related to the lack of a water treatment plant. Some submissions were concerned with pollution or increase in sediment from stockpile runoff. One submission was concerned with the potential risk to surface water dependant ecosystems.

One submission was concerned with the lack of transparency regarding the frequency of controlled releases to Oldbury Creek and that if the frequency is greater than predicted then water quality impacts to watercourses could be greater than anticipated.

Three business groups and numerous community members raised concerns regarding the potential short and long term impact to Warragamba Dam, Medway Dam, Sydney drinking water catchments, local water supplies (including Berrima, Southern Highlands, Goulburn, Kangaroo Valley, Moss Vale, Munro Park) and/or water supplies and waterways/rivers in general as a result of pollution. Three community members were also concerned about potential resultant impacts on existing agricultural activities due to claims of water quality impact on surface water resources.

Two special interest groups and several community members were concerned with potential water quality impacts based on claimed experiences with other historic local mines (eg Berrima Colliery) polluting local waterways. One submission was concerned that "contaminated" coal contact water from the mine water management system would be released to the local waterways resulting in contamination and impacts on river biodiversity. One special interest group was also concerned that storage and treatment of mine workings and treatment of sewage on site would lead to surface and/or groundwater contamination.

Several community members were concerned with the water storages' abilities to retain runoff without preventing overtopping and flow into streams and potentially contaminating surface water supplies.

The surface water quality impact assessment is presented in Section 10.2 of the *Hume Coal Project Revised Water Assessment* (EMM 2018a). The proposed water management system has been developed to prevent contamination of local waterways and will aim to use mine water as a priority to meet all demands (with the exception of potable water) over imported water. Surface water runoff from areas of the site in direct contact with coal will be fully contained within the mine water management system to prevent discharge to local waterways.

Based on the impact assessment, the project poses no threat in the short or long-term to the water quality of regional water supplies, including Warragamba Dam or the Sydney drinking water supply. Where predicted, water quality changes as a result of releases from SB03 and SB04 can be mitigated by the implementation of release limits and criteria; releases that will occur are predicted to be compliant with NorBE criteria. With provision of vegetated swales and constructed wetlands, runoff from access roads outside of the water management system is predicted to be compliant with NorBE criteria. Although the overall annual loads are predicted to be reduced, potential increases in concentrations of certain components in surface water flow as a result of reduction in baseflow are not predicted to alter the beneficial use of the resource. The effects of baseflow reduction and, separately, coal dust deposition on streamflow water quality are predicted to have a neutral effect with respect to the existing beneficial use category.

Where predicted, water quality changes as a result of releases from SB03 and SB04 can be mitigated by the implementation of release limits and criteria; releases that will occur are predicted to be compliant with 'neutral or beneficial effect' (NorBE) criteria. With provision of vegetated swales and constructed wetlands, runoff from access roads outside of the water management system is predicted to be compliant with NorBE criteria. Although the overall annual loads are predicted to be reduced, potential increases in concentrations of certain components in surface water flow as a result of reduction in baseflow are not predicted to alter the beneficial use of the resource. The effects of baseflow reduction and, separately, coal dust deposition on streamflow water quality are predicted to have a neutral effect with respect to the existing beneficial use category. As per the *Significant impact guidelines* (DoE 2013), surface water quality changes within the project area and surrounding areas as a result of the project are considered insignificant.

The mine water management system has been designed to ensure that no water in contact with coal is released to the receiving environment (unless treated). Runoff from coal contact areas (including the CPP, ROM and product stockpiles etc) will be captured in SB01, SB02, MWD05, MWD06 and MWD07, and will be transferred to the PWD. The revised water balance has demonstrated that there will be no releases or overflows from SBs and MWDs capturing coal contact water (ie no releases or overflows from PWD, SB01, SB02, MWD05, MWD06 or MWD07). The results of the revised water balance modelling are provided in Section 3 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). The capacities of all the stormwater basins and mine water dams are designed so that the no overflows will occur when they are operated as part of the overall site water management system under a range of climate conditions, including historic wet and dry extreme climates. All coal contact water will be contained within the mine water management system and will not be released to the local surface water system (unless treated); as such, there is no threat to river biodiversity from coal contact water.

Excess supply of water will be managed by pumping to the void behind the bulkheads. The water balance modelling indicates that this method, along with temporary storage in the PWD, is a suitable management measure for excess water in any of the climate sequences tested. As such, there is no intention to release (treated) water to the surface water environment.

In the unlikely event that the void space is full and cannot take excess water, and the primary water dam (PWD) volume is also above the adopted capacity then the excess water will be treated in a water treatment plant (WTP) for release into Oldbury Creek, if required. A Water Treatment Plant and mine dam MWD08 are provisional infrastructure in the unlikely event that excess water stored in the PWD is predicted to need to be treated and released to Oldbury Creek. The water balance modelling indicates that this is not required for any of the climate sequences tested and therefore unlikely to be required during operation. As part of the Water Management Plan, the water balance model will be reconsidered and optimised for water efficiency throughout all years of mining. The optimising of the water balance model will focus on more efficient operation and the water level in the PWD as well as confirm predictions. Consideration for installation of the WTP and MWD08 provisional infrastructure would be revisited following review of water balance model revisions, if predictions indicate the PWD will have insufficient storage.

SB03 and SB04 will not contain mine water. Stormwater basins SB03 and SB04 capture runoff from areas where there is a low risk of coal contact (including the administration and workshop area and mine road and conveyor embankment). Releases from SB03 and SB04 to Oldbury Creek will only be made after the first flush to these dams is pumped to the PWD and water quality release limit criteria are satisfied.

Water quality release limits for releases from SB03 and SB04 will be developed in consultation with the Environment Protection Authority to protect the environmental values in the Hawkesbury-Nepean Basin and to achieve a NorBE on water quality.

Predicted releases from SB03 and SB04 are provided in Section 3.2.2.3 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). The maximum predicted annual releases to Oldbury Creek from SB03 and SB04 are 30.6 ML/yr and 41.1 ML/yr, respectively, based on 107 water balance realisations.

In the event that water quality in SB03 and SB04 does not meet the release limits, water will not be released to Oldbury Creek and will be contained within the mine water management system. The PWD has the capacity to store all runoff from SB03 and SB04 catchments, if required. Additional water balance modelling adopting predicts a peak stored volume of 714 ML in the PWD if there are no releases from SB03 and SB04 to Oldbury Creek based on the 107 water balance realisations. The predicted peak stored volume of 714 ML is lower than the modelled capacity for the PWD of 730 ML.

The change in the surface water salt balance as a result of the project is expected to be negligible, as the project is predicted to be a zero discharge site for most of the time. Releases to Oldbury Creek would only occur during times of high flow from post-first flush releases from SB03 and SB04 during times of high rainfall.

The location and design of the Berrima Colliery, which allows for groundwater to drain via gravity into the Wingecarribee River, is very different to the location and design of the Hume Coal Mine, where mine water will be progressively captured and stored behind bulkheads, and there will be no environmental releases. Schematic representations of both mines are shown in Figure 8.2; note the Hume Coal Project representation is post-mine closure. The Berrima and Canyon Mines were designed to access the coal seam using "adits" (ie horizontal passages accessing the coal from outcrop); while the Hume Coal Mine is designed to use drifts to tunnel down to the coal seam level and will not access the seam from outcrop at any location. The Hume Coal Mine will fill with groundwater following cessation of mining, all inflows will be contained and the overlying groundwater systems will fully re-saturate. Due to the mine design and location underground, regardless of the use of bulkheads to seal mined-out panels, water contained within the mine will be physically unable to flow out of the mine and into the surface water environment. Based on geochemical modelling, excess mine water contained within the sealed void will be comparable in terms of water quality with the surrounding natural groundwater (refer to Chapter 10 for more information). Given the substantial mine design differences and the water management measures proposed for the Hume Coal Project, the claimed surface water and biodiversity impacts observed as a result of Berrima Mine and Canyon Mine drainage will not occur as a result of the Hume Coal Project.

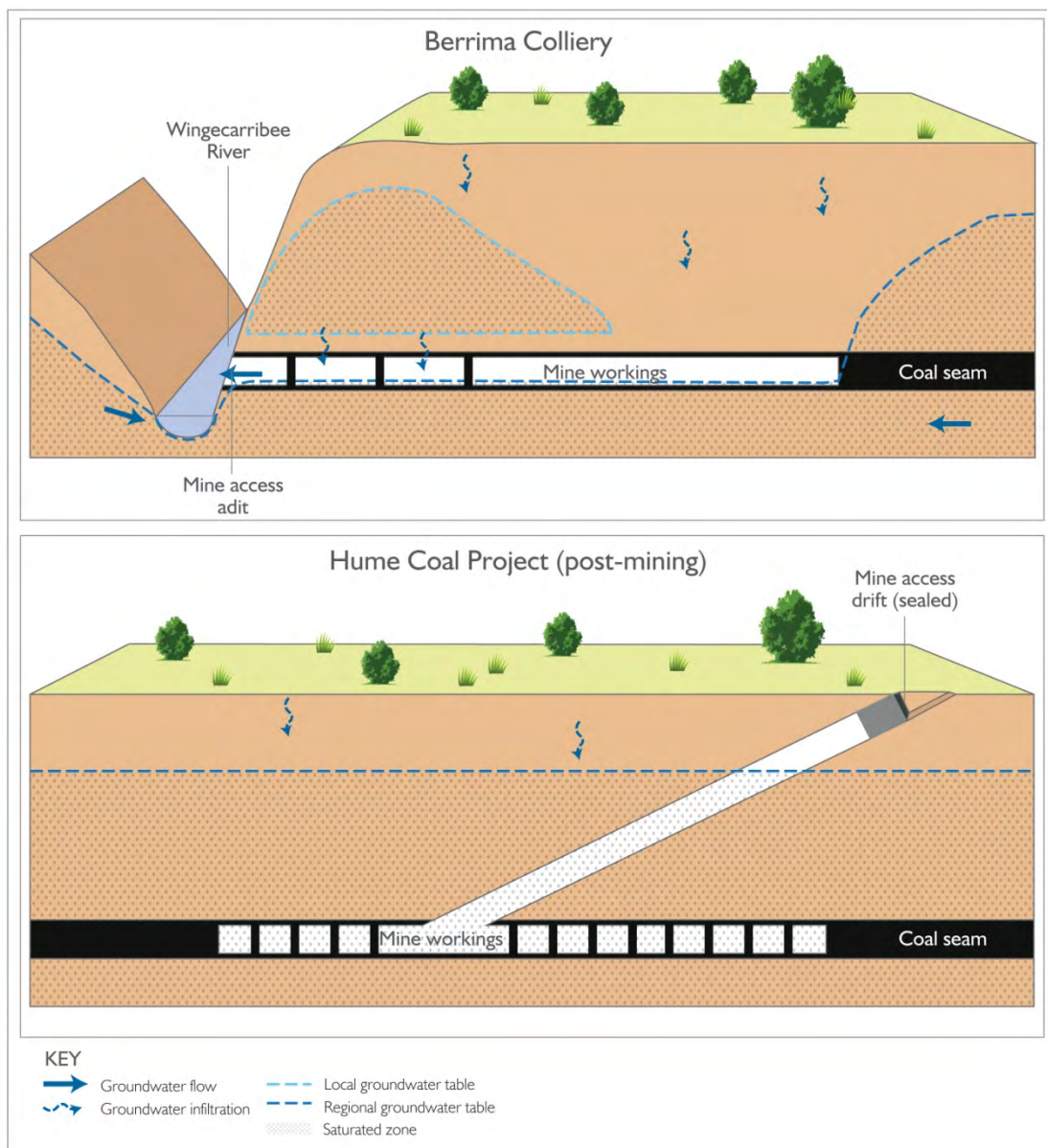


Figure 8.2 Schematic representation of Berrima Colliery and Hume Coal Project (post-mining)

In terms of potential for water quality contamination from underground emplacement of rejects, additional geochemical modelling (RGS 2018) indicates that, if the coal rejects are managed appropriately, the potential for adverse impacts on groundwater (and also surface water) is considered low as the water quality resulting from the reject emplacement is virtually indistinguishable from the natural groundwater quality of the Wongawilli Coal seam. Further details are provided in Section 8.7.2 and Section 11.2.2 of the Revised Water Assessment (Appendix 2).

Two main water management plans (WMPs) will be developed for the projects, one for the construction phase (CWMP) and one for the operational phase (OWMP). The WMPs will provide a framework water management and will document the proposed mitigation and management measures for the approved project. They will include details regarding the surface and groundwater monitoring program, reporting requirements, spill management and response, water quality trigger levels, corrective actions, contingencies, and responsibilities for all management measures to mitigate or manage impacts to surface water systems. The WMPs will be prepared in consultation with DPI Water, EPA, WaterNSW, and the local council.

As stated in Section 13.3 of the Revised Water Assessment (Appendix 2), monitoring during construction and/or operation of the project will likely include additional water quality management measures, on top of the baseline monitoring program, pending site access. These additional measures are also outlined in Section 8.4.1 above.

i Neutral of beneficial effect (NorBE) assessment

Numerous community members raised concerns that the project has failed to meet the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (the SEPP) requirements to have a neutral or beneficial effect (NorBE) on water quality in the Sydney drinking water catchment. One community member was also concerned about the reliability of the NorBE assessment on predictive models, which, they claim, are inherently uncertain.

One community member questioned the use of MUSIC to assess impacts on water quality in a non-urban environment.

The surface water quality assessment for the Hume Coal Project, including the MUSIC water quality modelling, has been revised to address matters raised in the WaterNSW submission. The surface water quality assessment for the Berrima Rail Project, including the MUSIC water quality modelling, has also been revised to address matters raised in the WaterNSW submission. The revised water quality modelling methodology (where the methodology differs from the EIS) and results are outlined in Section 5 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) and Chapter 8 and 10 of the Revised Water Assessment (Appendix 2). The assessments were undertaken in accordance with the NorBE guidelines (SCA 2015 and SCA 2012), which require MUSIC modelling for certain aspects of the assessment.

The revised MUSIC water quality modelling demonstrates that the NorBE criteria for TSS, TP and TN pollutants loads and concentrations is achieved for releases from stormwater basins SB03 and SB04 to Oldbury Creek; runoff from mine access roads; and runoff from the Berrima Rail Project.

Although the overall annual loads are predicted to be reduced, potential increases in concentrations of certain components in surface water flow as a result of reduction in baseflow are not predicted to alter the beneficial use of the resource. The effects of baseflow reduction and, separately, coal dust deposition on streamflow water quality are predicted to have a neutral effect with respect to the existing beneficial use category.

As such, the assessments have demonstrated both the Hume Coal Project and the Berrima Rail Project are predicted to have a neutral and/or a beneficial effect (NorBE) on surface water quality, in line with the SEPP requirements.

WaterNSW comments that the method used for assessing the neutral or beneficial effect on water quality (NorBE) is not considered appropriate. WaterNSW does not consider the comparison of groundwater and surface water quality results an appropriate method to assess the impact on stream water quality of baseflow reduction from depressurisation of groundwater. The method of NorBE assessment for the coal mining infrastructure and roads, although suggesting NorBE could be achievable, deviates from WaterNSW's recommended practice. This affects the quantum of water quality improvements and the applicability of the proposed improvements.

For infrastructure areas, nodes created from GoldSIM with daily flow volumes, classified all existing flow as pervious stormflow. Using modelled soil storage capacity for silty to clay loam soils on the sites where the mine infrastructure is being constructed, this shows that potentially a third of flow would have been baseflow. In MUSIC, baseflow has much lower pollutant concentrations than stormflow. This effectively makes the pre-existing case worse, reducing the level of post development treatment required to meet NorBE.

The use of MUSIC (principally as a water balance tool) to model NorBE and then estimate threshold levels for metals, suffers the same issue of reduced total flow volume, and increased pre nutrient load.

The assessment states that NorBE is achieved. WaterNSW questions the method and MUSIC assumptions used in this analysis and do not obtain the same result. It is likely that NorBE can be met for the development, but further analysis, different management practises and further stormwater quality devices will be required.

WaterNSW recommends that an appropriate NorBE assessment for both surface and groundwater quality, including impacts arising from the interaction of impacted groundwater on stormwater quality, should be undertaken.

The NorBE assessment undertaken for the Hume Coal Project EIS has been revised to address matters raised in the WaterNSW submission and additional consultation with WaterNSW. The revisions include the use of a GoldSim mass balance model (rather than a MUSIC model) for surface water quality metals assessment (in relation to baseflow reduction), revision of existing flow classifications to include a mix of pervious flow and baseflow, and modification of management measures.

The revised NorBE assessment for releases from stormwater basins to Oldbury Creek, including the results of revised MUSIC water quality modelling, is provided in Section 5.2 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) and Section 8.4 and 10.2 of the Revised Water Assessment (Appendix 2).

The revised NorBE assessment for mine access roads, including the results of revised MUSIC water quality modelling, is provided in Section 5.3 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) and Section 8.4 and 10.2 of the Revised Water Assessment (Appendix 2).

The revised NorBE assessment for the Berrima Railway Line, including the results of revised MUSIC water quality modelling, is provided in Section 5.4 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018).

Additional water quality assessments have been undertaken for impacts in the wider study area associated with baseflow reduction and coal dust deposition. The additional assessment for baseflow reduction is provided in Section 5.5 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) and Section 8.4 and 10.2 of the Revised Water Assessment (Appendix 2). The additional assessment for dust deposition is provided in Section 5.6 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) and Section 8.4 and 10.2 of the Revised Water Assessment (Appendix 2).

Following inclusion of the suggestions made by WaterNSW, the results of the revised surface water quality assessment demonstrate that both projects meet NorBE criterion.

ii Depressurisation of groundwater systems from underground mining

WaterNSW makes the following comments regarding the NorBE assessment for baseflow reduction:

- WaterNSW considers the method used for the NorBE assessment is inappropriate.
- The EIS compares baseline stormwater and groundwater quality data to assess impact on stream water quality of base flow reduction from depressurization of groundwater. This method of NorBE assessment is considered inappropriate by WaterNSW.
- Stormflow water pollutant concentrations (specifically nitrogen and phosphorus), are often an order of 10 times greater than baseflow pollutant concentrations.
- Oldbury Creek and Medway Rivulet (both receiving creeks) are predicted to experience 4.2 and 1.4% base flows reductions respectively compared to simulated stream flows (not actual stream flow).
- The low flow regime in Medway Rivulet is predicted to be significantly changed with the number of no flow days predicted to increase by up to 30%.
- WaterNSW considers the resultant stream water in Oldbury Creek and Medway Rivulet leaving the project site will have a higher concentration of nitrogen and phosphorous due to base flow reductions. An appropriate NorBE assessment for water quality impacts from baseflow reduction needs to be provided, prior the Department's assessment of the Project.
- Reductions in baseflows in streams above and around mined areas will result in less stream flow rates. Stormflow water nutrient concentrations are often an order of 10 times greater than groundwater-derived baseflow nutrient concentrations. Where these baseflow reductions are significant relative to storm flow components, stream water will therefore have a higher concentration of nitrogen and phosphorous, indicating NorBE will not be met.

The NSW EPA makes the following comment regarding the NorBE assessment for baseflow reduction:

- Baseflow reduction in Oldbury Creek will cause an increase in the concentration of dissolved substances. Dissolved metals are predicted to increase two to three times from existing levels and may exceed ANZECC (2000) water quality trigger values.

The *Hume Coal Project Surface Water Quality Assessment* (WSP PB 2016b) (Section 5.2.4) qualitatively assessed the impacts of baseflow reduction on water quality based on a comparison of contaminant concentrations in groundwater and surface water from baseline monitoring results.

An additional mass balance analysis has been undertaken as part of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) (refer to Section 5.5) to quantitatively assess potential water quality impacts associated with baseflow reduction for the Medway Rivulet Management Zone. Daily mass balance modelling was undertaken for parameters that have higher baseline concentrations in surface water than groundwater, as there is the potential for streamflow concentrations to increase for these parameters due to reduced dilution from baseflow.

The 80th percentile of the baseline surface water data for the Medway Rivulet Management Zone was compared to the 80th percentile of the baseline groundwater quality data for bores targeting the Hawkesbury Sandstone. The results indicate that concentrations are generally higher in groundwater than surface water, with the exception of nitrate, nitrite, calcium, sodium, sulfate and aluminium which were generally higher in surface water.

A daily mass balance model was developed in GoldSim to assess the change to nitrate, nitrite, calcium, sodium, sulfate and aluminium streamflow concentrations resulting from baseflow reduction. The GoldSim mass balance model was simulated at a daily time step for the 127-year period 1889 to 2015 using Data Drill sourced historical rainfall and evaporation data. The GoldSim mass balance model was used to predict daily pollutant loading and streamflow concentrations of the Medway Rivulet Management Zone for the existing and operational scenario with baseflow reduction.

Predicted mean annual pollutant loads from the GoldSim mass balance model are provided in Table 5.14 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). Mean annual pollutant loads for nitrate, nitrite, calcium, sodium, sulfate and aluminium are slightly reduced (between approximately 0.5% and 1.7%) for the operational scenario. This is because there is less pollutant loading from the reduced baseflow.

Predicted cumulative frequency graphs of streamflow concentrations from the GoldSim mass balance model are provided in Figures 5.21 to Figure 5.26 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). Concentrations for nitrate, nitrite, calcium, sodium, sulfate and aluminium are very similar for the existing and operational scenario. The change in concentration between the existing and operational scenarios is almost undetectable up to the 99th percentile of the results. There is a slight increase (< 3%) in concentrations between the 99th and 100th percentile.

Comparison of the predicted pollutant concentrations in the ANZECC (2000) and ADWG (2011) guidelines indicates that changes in surface water concentrations as a result of reduced dilution from baseflow reduction will have a neutral effect on the beneficial use of surface water in the project area:

- Nitrate, nitrite, calcium, sodium and sulfate are all well below the ANZECC (2000) and ADWG (2011) guideline values for both the existing and operation scenarios.
- Aluminium exceeds the ANZECC (2000) guideline value for aquatic ecosystems for both the existing and operation scenarios, but is below the ADWG (2011) guideline value for health and well below the ANZECC (2000) guideline values for irrigation or livestock for both the existing and operation scenarios.

As a new management measure to offset potential water quality impacts associated with reduced dilution from baseflow reduction, protection zones are proposed on the Evandale and Mereworth properties. These properties are both located within the Medway Rivulet Management Zone. The total protection area is 42.5 ha, comprising 19.6 ha on the Evandale property and 22.9 ha on the Mereworth property. Clearing, farming and industrial activities (including roads, infrastructure etc) will be restricted within the proposed protection zones. These restrictions within proposed protection zones will reduce pollutant loads and have a positive impact on water quality.

iii Controlled release from SB03 and SB04 to Oldbury Creek

WaterNSW makes the following comments regarding the NorBE assessment for releases from SB03 and SB04:

- The maximum allowable water quality proposed by Hume Coal in releases (after first flush) from stormwater basins (SB03 and SB04) into Oldbury Creek is of concern. It uses "threshold levels" for applicable metals at concentrations between 2 to 4 times higher than the maximum values of the published baseline stream water quality for Oldbury Creek. This estimation does not appear conservative and such releases have a negative effect on water quality.
- Water quality at site infrastructure should generally be able to be managed by the proposed strategies. However concern exists with releases (after first flush) from stormwater basins (SB03 and SB04) into Oldbury Creek. The assessment has used threshold levels for applicable metals, at concentrations between 2-4 times higher than the maximum values of the published baseline stream water quality. This would not meet NorBE.

One community member wanted further clarification regarding the approximately 90% reductions of annual loads of TSS, TP and TN as a result of a reduced catchment size.

The release concentration targets for other contaminants (ie other than TSS, TP and TN) in releases from SB03 and SB04 presented in the Hume Coal Project EIS (EMM 2017a) were preliminary pending post-approval consultation with the Environment Protection Authority during the detailed design phase to protect the environmental values in the Hawkesbury-Nepean Basin and achieve NorBE on water quality. The final limits will be based on the full suite of baseline data, including post-EIS baseline data.

In the event that water quality in SB03 and SB04 does not meet the release limits, water will not be released to Oldbury Creek and will be contained within the mine water management system. The PWD has the capacity to store all runoff from SB03 and SB04 catchments, if required. Additional water balance modelling adopting revised groundwater inflow estimates a peak stored volume of 714 ML in the PWD if there are no releases from SB03 and SB04 to Oldbury Creek based on the 107 water balance realisations. The predicted peak stored volume of 714 ML is lower than the modelled capacity for the PWD of 730 ML.

The results of the revised MUSIC modelling (Table 5.3 of WSP 2018) show that mean annual pollutant loads for TSS, TP and TN are reduced by significantly more than 10%, and therefore meet the NorBE criterion. This is achieved due to the significant reduction in agricultural catchment draining to Oldbury Creek sub-catchment during operation.

The EPA recommend that Hume Coal revise the water quality assessment using either ANZECC (2000) trigger values or site specific values based on 24 contiguous monthly samples from an appropriate reference site (such as SQW06).

The NSW OEH comments that the Hume Coal Project EIS has not defined either “an appropriate reference system” or systematically applied “default regional trigger values” as specified in ANZECC/ARMCANZ (2000). Assessment of water quality impacts and appropriate levels of treatment appear to be based largely on the water quality in Medway Rivulet and Oldbury Creek after they have already been impacted by STP discharges. This does not conform to the ANZECC/ARMCANZ (2000) approach to determining site specific guidelines using “appropriate reference systems”.

Ascertaining what are appropriate background levels in streams affected by the proposal needs far greater consideration than that provided in the EIS. A number of the “Guideline” values provided in Table 5.13 of the Water Assessment are not appropriate for the area.

The NSW OEH recommends further assessment of appropriate background levels in streams affected by the proposal, having specific regard to the standards contained in ANZECC/ARMCANZ (2000).

The WQOs presented in the Hume Coal Project EIS are preliminary only. Final WQOs and triggers will be developed using additional baseline surface water quality data collected as part of the ongoing baseline monitoring program prior to commencement of construction of the project. Final WQOs and triggers will be developed in accordance with the National Water Quality Management Strategy and in consultation with the relevant regulatory agencies.

v Berrima Rail Project

WaterNSW makes the following comments regarding the NorBE assessment for the Berrima Rail Project:

- WaterNSW questions the methods and MUSIC stormwater quality modelling assumptions used in this analysis when replicated, WaterNSW could not obtain the same result. WaterNSW considers that subject to further analysis different management practises including further stormwater quality improvement devices these is scope for NorBE to be met. WaterNSW considers Hume Coal should upgrade the level of detailed information supplied on this project including an updated water cycle management plan and NorBE assessment and associated MUSIC stormwater quality modelling.
- Notwithstanding the Berrima Rail Project EIS stating the MUSIC model meets WaterNSW standards, when WaterNSW assessed the supplied MUSIC model, the model did not accurately represent WaterNSW's standards. Auditing and revision of the electronic model by WaterNSW: for the railway corridor impervious area, more realistic future landuse classifications on batters and verges, appropriate sizing and modelling of proposed swales; show the proposed rail line development as proposed does not meet NorBE.
- Revision of the design to incorporate appropriate stormwater quality improvement devices should make NorBE achievable for the development.

The MUSIC water quality modelling undertaken for the Berrima Rail Project EIS has been revised to address matters raised in the WaterNSW submission. The revised water quality modelling methodology (where the methodology differs from the EIS) and results for the Berrima Rail Project are outlined in Section 5.4 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018).

The following changes have been made to the MUSIC parameters for the revised water quality modelling compared to the Berrima Rail Project EIS:

- swale exfiltration rate set to 0 mm/hr;
- swale side slopes set to 1:3.33;
- swale vegetation height set to 0.25 m; and
- industrial land use type adopted for railway cut/fill embankments.

Following consultation with WaterNSW, it is understood that the WaterNSW submission relating to quantification of the railway corridor area was based on an older set of engineering drawings for the railway. The infrastructure disturbance areas for the EIS were calculated using the latest engineering design drawings for the railway and have therefore not been changed from the EIS.

The following changes have been made to the proposed water quality treatment measures for the Berrima Rail Project in order to achieve NorBE (following the changes to the MUSIC parameters):

- proposed swale lengths increased.
- constructed wetlands proposed downstream of swales as an additional management measure.

The revised water quality treatment measures for the Berrima Rail Project are outlined in Section 5.4.1.3 Table 5.9 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018).

The revised water quality modelling demonstrates that the revised treatment measures for the Berrima Rail Project achieve NorBE. Mean annual pollutant loads for total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) are reduced by more than 10% for the operational scenario compared to the existing scenario. Pollutant concentrations for TP and TN for the operational scenario are equal to or better than the existing scenario between the 50th and 98th percentiles.

8.4.3 Surface water take and compensation

NSW DPI comments that further detailed assessment is required to quantify volumetric loss to surface water systems over the life of the project. The NSW DPI recommends that a concept compensatory flow regime be developed to mitigate impacts.

NSW DPI comments that the assessment provided does not clearly quantify the volumetric impacts for maximum or worse case scenarios, and advise whether this has been considered by Wingecarribee Council in future water supply planning.

NSW DPI comments that the annual maximum volumetric losses to the surface water systems should be quantified over the life of the projects impacts during dry and wet periods. Yield impacts identified in the EIS are currently expressed as a percentage.

WaterNSW comment that impacts of the project activities on stream flow regime was assessed for different climatic scenarios (including wet and dry years), but baseflow reductions were predicted separately by the groundwater model only for steady state conditions based on average rainfall; predicted stream flow changes during dry years are therefore likely to be underestimated.

NSW DPI and WaterNSW comment that mitigation measures such as compensatory flows require addressing and how affected surface water users and holders of basic landholder rights will be compensated for reductions in flows, and increases in zero flow day, and declines in groundwater levels within landholder bores. Implementation of compensatory flows to the surface water system would alter the water balance and the associated availability of water for mine use and aquifer recovery. Detailed review of the potential changes to water supply and drawdown impacts are required.

WaterNSW notes that their operating licence issued under the Water Management Act 2000 requires them to maintain minimum flows in the Wingecarribee River for environmental purposes and to supply downstream users. WaterNSW are concerned about potential detrimental impact to daily release volumes for the environment and downstream users, and inter dam transfers.

NSW DPI – Agriculture suggest that the licensing of baseflow loss and management of flows, where baseflows are affected, should consider replacement or replenishment options. These could include geomorphic rehabilitation to replace and/or improve channel and pool condition.

Wingecarribee Shire Council (WSC) is concerned that leakage from the Medway Dam is possible. A certain level of leakage has been calculated, but WSC is concerned whether the predicted amount is accurate. They are concerned whether the make good capabilities (if any are presented) are appropriate.

One business claimed that there is no guarantee that flow or quality of water will not be affected, and they are concerned about lack of compensation and loss of productive land as a result.

One community member raised a concern about compensation for loss of water supply from spring-fed dams.

The flow impact assessment undertaken for the Hume Coal Project EIS (WSP PB 2016c) has been revised to include the revised baseflow reduction estimates from post-EIS numerical groundwater modelling, including robust uncertainty analysis and climate sensitivity analysis, undertaken by HydroSimulations (2018). The flow impact assessment has also been revised to include the revised estimates of releases from SB03 and SB04 to Oldbury Creek as predicted by the revised water balance model. The assessment methodology (where the methodology differs from the EIS) and results are outlined in Section 10.1 of Appendix 2 and Section 4 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018).

The revised base case flow impact assessment adopts baseflow reduction estimates from the revised numerical groundwater model. The results of the base case flow impact assessment are provided in Section 10.1 of Appendix 2. A flow assessment climate sensitivity analysis has also been undertaken adopting baseflow reduction estimates using an average climate, as well as extreme wet climate scenario and extreme dry climate scenario from groundwater modelling climate sensitivity analysis. The results of the flow assessment climate sensitivity analysis are provided in Section 10.1.5 of Appendix 2. Flow impacts results are provided as a percentage change in yield and as an annual mean and annual maximum volumetric loss over the 19-year mining period.

The revised base case flow impact assessment predicts that local impacts on yield in the Oldbury Creek sub-catchment will be 4.3% (mean of 159.1 ML/yr) for wet conditions and 4.5% (mean of 71.9 ML/yr) for dry conditions. However, there are no known or probable stream water users in this sub-catchment except for the farming operation affiliated with Hume Coal. The predicted yield impact for the wider Medway Rivulet Management Zone (which includes the Oldbury Creek catchment) is 0.9% (mean of 433.9 ML/yr) under wet conditions and 1.6% (mean of 239.1 ML/yr) under dry conditions. Less than a 0.05% reduction in yield, ie negligible reduction, is predicted for the Lower Wingecarribee River, Upper Wingecarribee River, Lower Wollondilly River, Bundanoon Creek and Nattai River management zones under wet and dry conditions. With continued constant discharges from Moss Vale and Berrima sewage treatment plants, there are zero no flow days predicted for the Medway Rivulet sub-catchment and the Oldbury Creek sub-catchment. Given the low yield impacts predicted, compensatory flows are not considered necessary.

Given the low yield impact predictions, there will be minor to imperceptible impacts on downstream users, including impacts to productive land, and inter-dam transfers. The Council currently does not use the Medway Dam for water supply purposes.

Hume Coal holds sufficient licences to account for the volumetric take from the surface water system (as well as the groundwater system) and, as such, make good provisions are not required. Due to impacts being negligible, make good for surface water users is also not required. Refer to Chapter 11 for responses to submissions relating to water licensing. Harvestable Rights have been calculated and Hume Coal can manage and offset their baseflow impacts by removal or construction of existing farm dams as turkey nests (ie so they do not intercept overland flow).

Spring fed dams are unlikely to be impacted by the project, due to the likely water source for the spring being perched or shallow groundwater and is likely disconnected to the regional groundwater systems. However, local assessments will be required for each dam to confirm this. Landholders with existing spring-fed dams are invited to consult with Hume Coal in order to obtain baseline measurements and potentially negotiate make good agreements if located in an area where water table drawdown as a result of the mine is predicted to compromise the water supply within a spring-fed dam by more than normal seasonal variation.

Matters regarding compensation for declines in groundwater levels in existing landholder bores are addressed in Chapter 9 and in the Revised Water Assessment (Appendix 2, Chapter 13).

As described in Section 12.2.3 of the Revised Water Assessment (Appendix 2), for the Hume Coal project, most streams are classified as gaining streams which continue to be gaining streams throughout the project (ie even after the regional groundwater table is lowered). This is due to many streams overlying perched shallow groundwater systems that are not affected by the regional water table. As shown above, reduction in baseflow to streams results in minor to imperceptible impact to the flow regime as a result of drawdown in the water table. The main exception is Medway Dam, which transitions from a gaining to a losing system during mining (likely due to the artificial elevation of the water surface).

The numerical groundwater model has been revised following the EIS to account for matters raised during the exhibition process (HydroSimulations 2018). Along with robust uncertainty analysis, localised modelling for the Medway Dam has enabled more accurate predictions of surface water leakage from the dam as a result of the project. The volume of induced leakage from Medway Dam (a maximum of 19 ML/yr) will be accounted for with surface water licences already held by Hume Coal. This transition from a gaining to a losing system is temporary; Medway Dam is predicted to revert back to a gaining system approximately 25 years following cessation of mining and void filling. Refer to Section 12.2.3 of the Revised Water Assessment (Appendix 2) for further detail.

8.4.4 Geomorphology

NSW DPI Agriculture makes the following comments:

- Further disturbance to Wells Creek or Medway Rivulet may initiate further incision and degradation of these two rivers.
- Wells Creek is not mentioned in the assessment of waterway presence or protection.
- Medway Rivulet is classed as being moderately fragile over most of its length above Medway Reservoir and with moderate recovery potential. This implies higher sensitivity to alteration under disturbance, including subsidence.
- Medway Rivulet is discussed, but its geomorphic status and risks are not addressed in any meaningful way.
- The anticipated consequence of such subsidence on the river channels overlying the mining area is not specified, as the high fragility reaches of Medway Rivulet, Belanglo Creek and Wells Creek are not identified in Figure 5.2 of Appendix E of the Environmental Impact Statement compared to the 2012 Department of Primary Industries – Water assessment.
- Limited photographic records provide broad description of river character, but do not identify more fragile remnant river channel forms that have channelised into moderate fragility forms following European settlement.
- It is important that the assessment should identify and protect those remnant channel forms, such as Laterally Unconfined chain of ponds and valley fill, fine grained reaches, as these River Styles® provide refuge to frogs and other species where pool storage levels remain intact during dry periods (Hazell et al. 2003).
- The groundwater impact prediction (Appendix I, Section 7.1.1 of EMM 2017c) indicates less than 30 ML/yr baseflows will be lost from Wells Creek and other smaller watercourses due to differential groundwater drawdown. Although these figures appear to be small, they may have a significant effect on isolated pools or remnant chain of ponds located above the mine workings.
- Little work has been done on the ecosystem tolerance of loss of potential refuge due to pond level loss or drainage from a chain of ponds that has been affected by surrounding land uses or channelization.
- It is important that both the absolute level drawdown of affected ponds is well understood and a mechanism to arrest and remediate ponds level loss and physical degradation is properly constructed and implemented where broad scale impacts are likely.
- Response to pond drawdown in the remnant chain of ponds reaches identified from the DPI Water River Styles® is not discussed.
- No specific stream remediation or rehabilitation recommendations are provided, as the general assumption that no discernible impact will occur to streams or geomorphic features will occur.
- No specific commitment to remediation of streams, riparian zones or rare geomorphic features, such as remnant chain of ponds or partially saturated valley fills is made in the EIS.
- It is recommended further survey of unconfined River Styles® identified in the EIS and consistent with DPI Water's mapping assessment occur. This should focus on those reaches identified as possessing high fragility in the DPI Water 2012 River Styles® assessment. Surveys should include identifying remnant ponds features, extent and standing pond level and depth.

The potential for stream bank erosion associated with the project is negligible considering the predicted negligible subsidence impacts and minimal change in the flow regime.

Scour protection will be provided around the conveyor crossing pilings on either side of Medway Rivulet and if appropriate at the upstream and downstream end of the culverts under the road across Medway Rivulet to prevent impacts to bed and bank stability. Scour protection will also be provided at the point where releases from the SB03 and SB04 catchments to Oldbury Creek will occur.

No coal mining will occur directly beneath Medway Rivulet and no subsidence impacts are predicted for any streams or creeks in the project area.

Further geomorphic field surveys will be undertaken for unconfined River Styles® identified in the EIS and consistent with the NSW DPI Water 2012 River Styles® assessment during the detailed design phase of the project. Surveys will focus on reaches identified as possessing high fragility in the NSW DPI Water 2012 River Styles® assessment, subject to land access. Surveys will include identifying remnant pond features, extent and standing pond level and depth. A detailed geomorphic assessment report will be prepared at the detailed design phase of the project to outline the current geomorphic condition and projected recovery trajectories under current management regimes, potential subsidence conditions and with rehabilitation actions in place. Wells Creek, among others, will be considered in this assessment.

Assessment of the impact of pond level loss or drainage from a chain of ponds on ecosystems may be considered during the detailed design phase of the project in areas of ecosystems with known affected species. As part of the groundwater monitoring program, it is intended that shallow monitoring bores will be installed in areas identified as having shallow groundwater and known ecosystems with possibly affected species (subject to land access), and to also monitor groundwater-surface water connectivity and any changes that may occur (subject to land access).

Post-mining geomorphic field surveys will be undertaken in areas likely to have differential settlement, subject to land access. There are no areas predicted to have material levels of differential settlement, with vertical subsidence movements predicted to be less than 20 mm. As stated above, no mining is proposed to be undertaken directly beneath Medway Rivulet. Post-mining surveys will focus on identifying likely or potential disturbance and channelisation within or downstream of remnant ponds and valley fills. Where areas are classed as swampy meadows, surveys will incorporate catenary survey lines to detect drawdown within the fill sediments, subject to land access.

Where channelisation impacts resulting from mining are identified, specific remediation programs will be developed to identify controls to prevent further channelisation within and between chain of ponds. Remediation programs will be developed in accordance with existing rehabilitation standards (eg Rutherford et al. 2000) and recent research on processes related to geomorphic recovery in high fragility river channels (eg MacTaggart et al. 2006, Mould and Fryirs 2017).

8.4.5 Streams

The NSW OEH recommends that the EIS include reference to the following traits raised by the Bulli Seam Operations Project Planning Assessment Commission (PAC) report with regard to characterising impacts upon streams:

- importance to catchment yield;
- significance to water supply;
- scale of the watercourse;
- permanence of flow;
- water quality;
- ecological importance;
- environmental quality (pristine, modified, severely modified);
- visual amenity (eg cascades runs, pools etc.);
- community value (value the community attributes to protection); and
- regional significance.

Although the EIS does not specifically reference the list of stream traits raised by the Bulli Seam Operations PAC report, the traits have been addressed in the following sections of the Hume Coal Project EIS (EMM 2017a):

- Importance to catchment yield: EIS Water Impact Assessment Report (EMM 2017c) (Surface Water Flow and Geomorphology Assessment (WSP PB 2016c));
- Significance to water supply: EIS Water Impact Assessment Report (EMM 2017c) (Surface Water Flow and Geomorphology Assessment (WSP PB 2016c));
- Scale of the watercourse: EIS Water Impact Assessment Report (EMM 2017c) (Surface Water Flow and Geomorphology Assessment (WSP PB 2016c));
- Permanence of flow: EIS Water Impact Assessment Report (EMM 2017c) (Surface Water Flow and Geomorphology Assessment (WSP PB 2016c));
- Water quality: EIS Water Impact Assessment Report (EMM 2017c) (Surface Water Quality Assessment (WSP 2016b));
- Ecological importance: EIS Biodiversity Assessment Report (Appendix H of EMM 2017a);
- Environmental quality: EIS Water Impact Assessment Report (EMM 2017c) (Surface Water Quality Assessment (WSP 2016b));
- Visual amenity: EIS Visual Amenity Assessment Report (Appendix N of EMM 2017a);
- Community value: EIS Social Impact Assessment Report (Appendix R of EMM 2017a), EIS Economic Impact Assessment Report (Appendix Q of EMM 2017a); and

- Regional significance: EIS Water Impact Assessment Report (EMM 2017c) (Surface Water Flow and Geomorphology Assessment (WSP PB 2016c)).

8.4.6 Flooding

i General

WaterNSW comments that the operational road proposed over Medway Creek (from the main amenities to the Ventilation shaft) and Oldbury Creek (from the CPP to coal loader), will both be impacted by the greater than 5 year ARI floods. The roads should either be suitable constructed to deal with these events or alternatively relocated.

Some community members were concerned with potential climate change affects and an increase in flooding risk.

Operational roadways predicted to be impacted by frequent flooding will be suitably designed and constructed to protect against additional scour damage associated with flooding as a result of the project. This will include selection of appropriate pavement and embankment batter protection, where appropriate. It is noted that all proposed mine tracks are existing farm roads and, as such, are already subject to impacts during flooding.

The EIS flooding assessment (WSP PB 2016d) was undertaken with consideration of the following guidelines (among others):

- Wingecarribee Local Environmental Plan (WLEP) (WSC 2010); and
- Practical considerations of Climate Change (DECC 2007).

The WLEP aims to minimise flood risk to life and property associated with the use of land, allow development that is compatible with the land's flood risk (taking into account projected climate change), and avoid significant adverse impacts on flood behaviour and the environment. The DECC (2007) document outlines current advice on how to incorporate climate change impacts into flood assessments.

The flooding assessment included analysis up to the 100 ARI flood extent (equivalent to a 1 in a 100 year event) and incorporated historical climate data. As such, potential climate change affects have been considered in the flooding assessment. The risk of flooding for the project is considered as low risk, and therefore the assessment as undertaken is adequate.

With regard to flooding risk in flood prone land, NSW OEH recommends that:

- The following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) are mapped: (a) extent of probable maximum flood for the unnamed creek at Berrima Junction and the Wingecarribee River, (b) the area below the flood planning level for all watercourses, and (c) the hydraulic categorisation (floodways and flood storage areas) for all watercourses.
- For all watercourses, a description of the 1 in 10 year design flood level is provided.
- The effect of the Berrima Rail Project (including any fill) on the flood behaviour under the 1 in 200 and 1 in 500 year flood events for all watercourses as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change is assessed.
- The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood and impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land be modelling for the unnamed creek at Berrima Junction and the Wingecarribee River.
- An assessment of the impacts of the Berrima Rail Project on flood behaviour be provided for all watercourses, including (a) whether there will be detrimental increases in the potential flood affection of other properties, assets and infrastructure (b) compatibility with the flood hazard of the land, (c) compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land, (d) whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site and (e) whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

NSW DPI Agriculture comments that most of the properties to be affected by surface flooding for the Berrima Rail Project during the operational phase is on Hume Coal owned land. However, there are a number of private properties that will be affected by surface flooding which will reduce their stocking capacity.

One community member was concerned with potential increased flood risks as a result of the Berrima Rail Project.

The flooding and drainage assessment undertaken as part of the *Berrima Rail Project EIS Surface Water Assessment* (WSP PB 2017, Section 2) provides an assessment of the impacts of the project on flooding in the local catchments and mitigation measures required to minimise potential impacts and protect the rail infrastructure during flood events. The assessment considers floodplain risk matters for the Berrima Rail Project.

Although flood modelling was not undertaken for the 10 year ARI event, modelling was undertaken for the 5, 20 and 100 year average recurrence interval (ARI) events and the probable maximum flood (PMF).

The flooding and drainage assessment found that the impacts on flooding for the operation and rehabilitation scenarios are within proposed acceptability criteria, with the exception of five discrete locations for the operational phase. At all five locations the impacts are confined to land owned by either Hume Coal or Boral and generally are removed for the rehabilitation phase, with the exception of an impact east of the Berrima Cement works where the rail infrastructure is to be retained under the preferred option.

Predicted afflux at private properties is less than the proposed acceptability criteria of 250 mm for flooding events up to the 100 year ARI. Flood impacts at private properties are minor and short-lived and unlikely to affect stocking capacity. Nonetheless, consultation will be undertaken with affected private landowners where flood impacts, although minor, are predicted.

As the flooding and drainage assessment has demonstrated that impacts are low with the exception of localised impacts on Hume Coal or Boral owned land, additional flood modelling or mapping is not considered necessary.

8.4.7 Berrima Rail construction

The NSW EPA comments that the EIS does not adequately assess the potential impact of construction stage discharge for the Berrima Rail Project. The NSW EPA recommends that the EIS should characterise construction phase discharges, should assess the impact of construction stage discharges on environmental values of the receiving environment. They also request that additional/alternative measures be proposed if 'non-trivial' impacts to waters are identified, and they recommend the EIS proposes discharge criteria for key pollutants.

A CEMP will be prepared and implemented during the construction phase of the Berrima Rail Project. The CEMP will include an Erosion and Sedimentation Control Plan, as specified in Section 13.3.2 of the Berrima Rail Project EIS, developed in accordance with the guidelines *Managing Urban Stormwater: Soils and Construction - Volume 1* (Landcom 2004) ('Blue Book') and *Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services* (DECC 2008). The Erosion and Sedimentation Control Plan will also form part of the Water Cycle Management Plan for the Hume Coal Project, as required by the guidelines *Developments in Sydney's Drinking Water Catchment – Water Quality Information Requirements* (SCA 2015).

Potential impacts on surface water quality during construction are qualitatively assessed in Section 13.5.1 of the Berrima Rail Project EIS, including identification of project activities with the potential to cause impact, catchment, potential contaminants, potential contamination pathway, and likelihood of impact. Water quality modelling has not been undertaken to quantitatively assess potential impacts during construction as the potential impacts and associated water quality management measures are dependent on the construction methods and staging, which would be determined at the detailed design phase of the project. Water quality modelling will be undertaken at the detailed design stage to estimate expected pollutant concentrations and loads, to size management measures, to demonstrate that management measures meet the Blue Book criteria, and to set discharge criteria for key pollutants if applicable. Typical management measures for the construction phase are provided in Section 13.5.7 of the Berrima Rail Project EIS. Final management measures will be determined at the detailed design stage.

A surface water quality monitoring program will be implemented for the receiving environment during construction. The monitoring program, including monitoring locations, monitoring frequency, key parameters, water quality objectives and exceedance response, is outlined in Section 13.5.7 of the Berrima Rail Project EIS (EMM 2017b). The program will involve monitoring in Oldbury Creek and Stony Creek upstream and downstream of working areas during construction. Monitoring results will be compared to site specific water quality objectives to assess impacts to surface water quality in the receiving environment associated with construction of the project and trigger the implementation of mitigation and remediation measures if required. Preliminary WQOs are provided in Section 13.5.7 of the Berrima Rail Project EIS. Final water quality objectives will be developed in accordance with the ANZECC (ANZECC and ARMICANZ 2000) guidelines prior to commencement of construction works.

8.4.8 Stormwater releases

The NSW EPA comments that the Hume Coal Project EIS does not assess the potential construction stage stormwater releases on receiving waters. The NSW EPA makes the following recommendations:

- characterise construction stage discharges in terms of the expected concentrations and loads of all pollutants that may be introduced into the water cycle by source and discharge point, including residual discharges after mitigation measures are implemented;
- assess the significance of any identified impacts including considering the relevant ambient water quality outcomes consistent with the practices and principles of the ANZECC (2000) guidelines and relevant trigger values;
- demonstrate how the proposal will be designed and operated to:
 - protect the WQOs over time where they are not being achieved;
 - contribute to achieving the WQOs over time where they are not being achieved;
 - propose additional or alternative treatment measures if non-trivial risks to waters are identified; and
 - propose discharge criteria for key pollutants.

A CEMP will be prepared and implemented during the construction phase of the project. The CEMP will include an Erosion and Sedimentation Control Plan, as specified in Sections 6.1 and 6.2 of the EIS Surface Water Quality Assessment, developed in accordance with the guidelines Managing Urban Stormwater: Soils and Construction - Volume 1 (Landcom, 2004) ('Blue Book') and Managing Urban Stormwater: Soils and Construction - Volume 2E Mines and Quarries (DECC, 2008). The Erosion and Sedimentation Control Plan will also form part of the Water Cycle Management Plan for the project, as required by the guidelines Developments in Sydney's Drinking Water Catchment – Water Quality Information Requirements (WaterNSW 2015).

Potential impacts on surface water quality during construction are qualitatively assessed in Section 5.1.1 of the EIS Surface Water Quality Assessment, including identification of project activities with the potential to cause impact, catchment, potential contaminants, potential contamination pathway, and likelihood of impact. Water quality modelling has not been undertaken to quantitatively assess potential impacts during construction as the potential impacts and associated water quality management measures are dependent on the construction methods and staging, which would be determined at the detailed design phase of the project. Water quality modelling will be undertaken at the detailed design stage to estimate expected pollutant concentrations and loads, to size management measures, to demonstrate that management measures meet the Blue Book criteria, and to set discharge criteria for key pollutants. Soil and water management principles for the construction phase are provided in Section 6.2 of the EIS Surface Water Quality Assessment (WSP PB 2016b). Specific management measures will be determined at the detailed design stage.

A surface water quality monitoring program will be implemented for the receiving environment during construction. The monitoring program, including monitoring locations, monitoring frequency, key parameters, water quality objectives and exceedance response, is outlined in Section 6.4 of the EIS Surface Water Quality Assessment. The program will involve monitoring in Medway Rivulet and Oldbury Creek upstream and downstream of working areas during construction, subject to land access. Monitoring results will be compared to site specific water quality objectives to assess impacts to surface water quality in the receiving environment associated with construction of the project and trigger the implementation of mitigation and remediation measures if required. Preliminary WQOs are provided in Section 6.4.4 of the EIS Surface Water Quality Assessment. Final water quality objectives will be developed in accordance with the ANZECC and ARMCANZ (2000) guidelines prior to commencement of construction works.

8.4.9 Baseflow reduction

Office of Environment and Heritage (OEH) comment that the assumptions linking predicted groundwater drawdown and subsequent baseflow loss are not adequately described/explained in the Hume Coal Project EIS. OEH states that there has been no detailed assessment of the impact of baseflow losses on the majority of affected streams, particularly those in forested areas. OEH states the EIS should be updated to provide predicted linkages between groundwater drawdown and subsequent baseflow loss. OEH comment that there has not been an assessment of the ecological impacts of water loss/groundwater drawdown to the streams of the area. It is noted that while there are “make good” provisions for landholder bores, there are no “make good” provisions for any of the streams in the area. Depressurisation of shallow aquifers and subsequent baseflow loss is likely to have the greatest impact on surface water resources.

DPI stated that an assessment is required of the potential impacts to aquatic ecosystems posed by aluminium concentrations exceeding guideline values for aquatic ecosystems, with respect to baseflow reduction potential impacts on water quality.

Several special interest groups raised concerns regarding the affect and uncertainty of baseflow reduction on surface water courses. One group was also concerned about some streams permanently losing baseflow as a result of fracturing and subsidence due to mining. Another group claimed that the EIS did not adequately describe or assess the impact of baseflow reduction on water quality and the change in low flow days.

Two community members raised concerns regarding impacts on riparian zones as a result of water quality and/or water level changes in stream.

Baseflow reduction predictions for surface watersources, management zones and sub-catchments within those zones have been revised following additional post-EIS numerical groundwater modelling, including robust uncertainty analysis (HydroSimulations 2018).

The flow impact assessment undertaken for the Hume Coal Project EIS has been reworked to include the revised baseflow reduction estimates from post-EIS numerical groundwater modelling, including uncertainty analysis and sensitivity analysis, undertaken by HydroSimulations (2018). The flow impact assessment methodology (where the methodology differs from the EIS) and results are outlined in Section 4 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018).

Flow duration curves for the existing and operational scenarios for the Medway Rivulet and Oldbury Creek catchments, including discussion of impacts to no-flow days, are provided in Section 4.2.1 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). Yield impact assessment results are provided in Section 4.2.2 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). Results are provided as a percentage change in yield and as an annual mean and maximum volumetric loss over the 19-year mining period.

Section 11.4 of Appendix 2 summarises the predicted impacts as a result of water table drawdown and/or baseflow reduction on groundwater users. There are no predicted impacts to groundwater dependent ecosystems (as listed in the relevant Water Sharing Plans) as a result of the project. Predicted impacts on potentially groundwater dependent ecosystems as a result of water table drawdown and/or baseflow reduction has been assessed as insignificant. Baseflow reduction is expected to occur in most drainage lines near the project. The rate of reduction is not constant over time. The maximum rate of reduction is expected to be a minor proportion of the total baseflow. The impact on baseflow has been assessed (WSP 2018) and is expected to be minimal on surface water uses during a range of climatic conditions.

Refer to Chapter 13 for matters concerning the predicted impacts of water table drawdown on potentially dependent ecosystems and to Chapter 9 for matters concerning the predicted impacts of drawdown on landholder bores.

Given the predicted impacts on ecosystems that potentially rely on groundwater and on watercourses, creeks, drainage lines and swamps that receive baseflow are assessed as insignificant, no make good provisions apply in accordance with the NSW Aquifer Interference Policy (NOW 2012a).

An additional mass balance analysis has been undertaken as part of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018, Section 5.5) to assess potential water quality impacts associated with reduced dilution from baseflow reduction. GoldSim mass balance modelling was undertaken for the Medway Rivulet Management Zone for parameters that have higher baseline concentrations in surface water than groundwater, as there is the potential for streamflow concentrations to increase for these parameters due to reduced dilution from baseflow. GoldSim mass balance modelling demonstrated that the cumulative frequency graphs of nitrate, nitrite, calcium, sodium, sulfate and aluminium concentrations in streamflow are very similar for the existing and operational scenarios. The change in concentration between the existing and operational scenarios is almost undetectable up to the 99th percentile of the model's results. There is a slight increase (<3%) in concentrations between the 99th and 100th percentile. For example, for aluminium, the predicted change in concentration as a result of the project is 2.9% or 0.004 mg/L higher than baseline values (ie 0.142 mg/L compared with 0.138 mg/L). Comparison to guideline values for aquatic ecosystems, drinking water, irrigation and livestock suggest that changes in surface water concentrations as a result of baseflow reduction will have a neutral effect on the beneficial use of surface water in the project area. Given the results of this quantitative assessment, further assessment of the potential impacts to aquatic ecosystems posed by aluminium is not considered to be necessary.

The EIS states that worst case estimates of subsidence associated with the proposed mining method predict 'imperceptible' surface disturbance due to mining, with predicted settlement of less than 20 mm (EMM 2017i; Mine Advice 2016).

8.4.10 Coal dust

WaterNSW is concerned about coal dust emissions from the proposed mining ventilation shaft near Wells Creek and the Coal Processing Plant (CPP) and transportation operations near Oldbury Creek. The submission claimed that approximately 25 hectares adjacent or over Oldbury Creek are predicted to receive 1 g/m²/month (120 kg/ha/yr) dust from CPP and transportation operations; additionally the ventilation shaft near Wells creek, approximately 10 hectare below MWD07 dam, has no protection from coal dust. WaterNSW are concerned that runoff from these areas is likely to deteriorate water quality in Oldbury Creek and Wells Creek.

Several community members also raised concerns regarding the potential for coal dust to contaminate their domestic water supplies, which rely on rooftop rainwater harvesting.

An additional analysis has been undertaken as part of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018, Section 5.6) to assess potential water quality impacts associated with coal dust deposition in the Oldbury Creek and Wells Creek catchments.

The coal dust deposition analysis has applied the results of water extract testing of coal samples (RGS 2016) to predicted annual catchment average dust deposition rates and runoff volumes to estimate the concentration of contaminants in surface water runoff resulting from dust deposition. The estimated surface water runoff contaminant concentrations in the Oldbury Creek and Wells Creek catchments resulting from dust deposition are provided in Table 5.17 of the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018). The estimated surface water runoff contaminant concentrations resulting from dust deposition are significantly lower than the mean baseline concentrations and the guideline values. The surface water quality impact associated with dust deposition in the Oldbury Creek and Wells Creek catchments is therefore considered to be insignificant and will have a neutral effect on the beneficial use of surface water in the project area.

8.5 Monitoring and management

NSW DPI state that, post-approval, Hume Coal should prepare and implement management plans to manage and mitigate water related impacts during construction, operation and rehabilitation to manage and mitigate water related impacts during construction, operation and rehabilitation. They state that the operational Water Management Plan should detail the water balance, monitoring and mitigating measures for the project, and that it will be required to include a comprehensive surface water and groundwater monitoring program and a contingency response plan which would need to include accepted trigger levels and viable mitigating measures. Detailed make good provisions would be a key element to this plan.

NSW DPI suggests the following in relation to the proposed water quality monitoring plans (both construction and operation):

- The plans need to be designed and developed to test the predictions made in the EIS in relation to NorBE water quality outcomes and changes to base flow.
- The plans should include regular and event based monitoring, at monitoring sites within the footprint and at upstream and downstream locations so practical comparisons can be made.
- There should be clear definition of how determination will be made of whether impacts to riparian and aquatic ecosystems occur as a result of mine activity.
- The monitoring regime should include both regular (eg monthly) as well as event based (eg following more than 25 mm of rain in 24 hours) sampling.

NSW EPA recommends Hume Coal include monitoring sites on Wells Creek and Medway rivulet downstream of the project boundary in the surface water monitoring project.

OEH comment that the details of the proposed monitoring design need to be carefully considered, yet they acknowledge that the plans are not expected to be developed until a post-approval Water Management Plan is developed. OEH comment that flow monitoring is inadequate in many areas, needed to assess how baseflow losses will affect flow exceedance and cease to flow probabilities for affected streams (and their resulting ecological consequence). They recommend that a monitoring program, including flow monitoring, be implemented to verify the predicted shallow groundwater drawdown and baseflow loss.

WaterNSW state that they require to be consulted with, post-approval, on future operational and construction environmental management plans, incident plans, monitoring plans and rehabilitation plans to ensure that development is constructed to a suitable standard, and also maintained, operated and then rehabilitated to an appropriate standard to meet NorBE.

WaterNSW comments that it will be extremely difficult to identify meaningful performance measures to confirm whether predicted stream flow and catchment yield impacts have been exceeded, particularly baseflow reductions for the Medway Rivulet and the Lower Wingecarabee Management Zones. They also state that it will also be difficult, if not impossible, to accurately measure, assess and verify that the impacts are consistent with the predictions.

WaterNSW recommends that the proposed potential additional monitoring sites referenced in Section 13.3 of the *Hume Coal Project Water Impact Assessment* (EMM 2017c) should be incorporated as definite sites along with the continuation of baseline monitoring, if the project is approved.

One community member raised concerns regarding the appropriateness of monitoring network's design for detecting impacts.

One community member raised a concern about using water quality guideline values as trigger reference points as it doesn't account for cumulative impacts from other operations nearby.

As stated in the EIS Water Assessment, two main water management plans (WMPs) will be developed for the project, one for the construction phase (CWMP) and one for the operational phase (OWMP). The CWMP will be developed prior to the construction phase. A rehabilitation WMP will also be considered. The WMPs will be a sub-plan of the environmental management system. The WMPs will document the proposed mitigation and management measures for the approved project, and will include the surface and groundwater monitoring program, reporting requirements, spill management and response, water quality trigger levels, corrective actions, contingencies, make good measures, and responsibilities for all management measures.

The WMPs will be prepared in consultation with DPI Water, EPA, WaterNSW, and the local council, and will consider concerns raised during the submissions and approvals process for the project. With regard to the Water Management Plans, this will include consultation regarding the design (location, frequency and monitored parameters) of the monitoring network. The construction and operation water monitoring network will be designed with the purpose of enabling early detection of impacts (predicted or otherwise) to sensitive receptors (including, but not limited to, aquatic ecosystems, drainage lines, riparian land, groundwater dependant ecosystems, and surface water and groundwater users).

The WMPs will include details of the surface water and groundwater monitoring program, which will incorporate and update the existing monitoring network, monitoring frequencies and water quality constituents, and physical water take and pumping volumes between water storage structures (including the void, the sump, mine water dams and stormwater basins). Reporting frameworks for the above will be prepared in accordance with licensing and agency requirements. Contingency response plan including accepted trigger levels for water quality parameters will be developed as part of the WMPs to assist in early identification of water quality trends and to assist in providing confirmation (or otherwise) of the NorBE predictions. The monitoring program will be prepared in accordance with the approved project's environment protection licence (EPL), once enacted. Further details regarding the Water Management Plans and ongoing monitoring are included in Chapter 13 of Appendix 2.

As stated in the *Hume Coal Project Water Impact Assessment* (EMM 2017c) and the Revised Water Assessment (Appendix 2, Chapter 13), baseline data will continue to be collected from the water monitoring network throughout the life of the mine. Expansion of the network may be considered once the project starts construction and then operation. The ongoing development and expansion of the monitoring network will occur in consultation with WaterNSW and DPI Water, and as per the guidelines for the GMMP, which will evolve as the project progresses. Consultation will include details regarding the monitoring site location, frequency of monitoring and monitored parameters.

Monitoring each component of the water management system will form the basis of how and when management responses are required. The monitoring network is fundamental to achieving effective management and early detection of project impacts and as such has been designed (and will continue to be designed) with this objective.

To help analyse monitoring data, triggers and thresholds will be developed to provide context when and what management measures are to be implemented. Water quality monitoring will be undertaken both within and outside of the mine water management system, including in upstream and downstream environments to account for impacts observed at sensitive receptors. Triggers will be designed with respect to cumulative impacts on sensitive receptors.

The baseline stream gauging program is ongoing with the purpose of better establishing baseline flow conditions prior to mining. Additional data will be available in the future. Appropriate trigger levels and response actions to address measured flow impacts will be developed using the additional baseline stream gauging data, prior to construction of the project. Triggers and response actions will be developed in consultation with the relevant regulatory agencies.

A surface water flow monitoring program will be implemented in local catchments during construction, operation and rehabilitation stages of the project. The surface water flow monitoring program will involve monitoring of stream gauges on Medway Rivulet and Oldbury Creek upstream and downstream of surface infrastructure areas and monitoring of the volume of water released from SB03 and SB04 to Oldbury Creek, subject to site access. The results of the monitoring program will be compared to the pre-mining baseline flow statistics. The objective of the program will be to confirm the predicted flow impacts.

As part of the groundwater monitoring program, it is intended that shallow monitoring bores will be installed in areas identified as having shallow groundwater and known ecosystems with possibly affected species (subject to site access), and to also monitor groundwater-surface water connectivity and any changes that may occur.

The Hume Coal Project water balance model (Appendix 2, Section 8.2) will continue to be refined over the life of the project and will be used as an operational tool for site water management and to verify predicted stream flow impacts. The operational water balance model will incorporate the AWBM rainfall-runoff model that was developed for the Hume Coal Project EIS. The AWBM model calibration will be refined prior to construction of the project using the additional baseline stream gauging data. The operational water balance model will utilise site monitoring data (such as rainfall data, demand data, groundwater inflow data, surplus water pumping in to void data etc). The operational water balance model will also include a pre-mining scenario to allow for comparison between simulated flows from the SW04 and SW08 catchments for the mining and pre-mining scenarios.

8.6 Conditions of approval

Secure yield analysis

The NSW DPI recommends that a secure yield analysis be undertaken in consultation with Wingecarribee Council to further assess the impact on town water supply. This would need to be in accordance with the draft guidelines Assuring Future Urban Water Security – Assessment and Adaption Guidelines for NSW Local Water Utilities (NSW DPI 2013).

Geomorphology

The NSW DPI - Agriculture and NSW DPI comments that areas likely to have differential settlement should have post-mining surveys conducted. These should focus on identifying likely or potential disturbance and channelisation within or downstream of remnant ponds and valley fills. Where these may be classed as swampy meadows, surveys should incorporate catenary survey lines to detect drawdown within the fill sediments.

The NSW DPI and NSW DPI - Agriculture comments that specific remediation programs should be developed to identify likely controls and where constructed controls may be required to prevent further channelization within and between chain of ponds. These should be consistent with existing rehabilitation standards (eg Rutherford et al. 2000) and recent research on processes related to geomorphic recovery in high fragility river channels (eg MacTaggart et al. 2006, Mould and Fryirs 2017).

The NSW DPI - Agriculture comments that reporting of current geomorphic condition and projected recovery trajectories under current management regimes, potential subsidence conditions and with rehabilitation actions in place should be presented. These should be compared to ongoing management where management intervention is deemed necessary.

Flood criteria

The NSW DPI - Agriculture comments that the EIS has set acceptability criteria for flood events at less than 250mm afflux for a 1 in 100 year flood based on previous project experience. However, it is unclear where the previous project experience is drawn and may not be applicable to this region. Hence, individual consultation with affected private landowners should take place to ensure flooding impacts are acceptable and mitigation measures required to reduce the impacts are identified and implemented if ensuing discussions with landholders consider it appropriate.

Scour protection

The NSW DPI - Agriculture comments that if a Project Approval is issued, the conditions should require that the final design for the crossing and associated scour protection at location FG / GEO01 – Stony Creek and at location FG21 / GEO04 – Oldbury Creek be provided to NSW DPI for review and comment prior to construction.

NSW DPI recommend all works associated with watercourse crossings to be in accordance with the DPI Water “Guidelines for Controlled Activities on Waterfront Land (2012)”.

WaterNSW also state that adequate and appropriate erosion and scour measures, that deal with any potential flooding impacts at the crossing and be easily maintained for the life of the project, need to be constructed for each waterway type being crossed.

Erosion and sediment control measures

The NSW DPI - Agriculture supports Hume Coal's primary principle for surface water management to minimise erosion and sediment generation at the source. To ensure minimal impacts are achieved, all measures outlined in Section 13.5.7 of Appendix D - Berrima Rail Project EIS need to be fully implemented.

A series of watercourse crossings are proposed on watercourses, including the replacement of a bridge on Stony Creek (5th order stream) with a series of culverts. The associated road embankments are predicted to concentrate flows and increase the risk of erosion and scouring at all crossings. NSW DPI comment that part of the post project approval, Hume Coal must prepare an Erosion and Sedimentation Control Plan in consultation with DPI Water prior to the commencement of activities.

Secure yield analysis

Medway Dam is a third tier water supply and receives treated effluent from the Moss Vale sewage treatment plant via Medway Rivulet. It does not currently supply water into the Wingecarribee Shire Council's (WSC) drinking water system.

A secure yield analysis will be undertaken in consultation with WSC at the detailed design phase to further assess the impact on town water supply subject to cooperation by WSC. The analysis would be in accordance with the draft guidelines Assuring Future Urban Water Security – Assessment and Adaption Guidelines for NSW Local Water Utilities (NSW DPI 2013).

Geomorphology

Details regarding further geomorphic field surveys to be undertaken during the detailed design phase and post-mining, and remediation programs, where appropriate, are discussed in Section 8.1.1.

Flood criteria

As discussed in Section 8.4.6, consultation will be undertaken with affected private landowners where flood impacts, although minor, are predicted.

Scour protection

The NSW DPI will be consulted during the design phase of the waterway crossings and associated scour protection at location FG / GEO01 – Stony Creek and at location FG21 / GEO04 – Oldbury Creek. The NSW DPI will be provided with the detailed design for these crossings for review and comment prior to construction.

Erosion and sediment control measures

Mitigation and management measures to be implemented for the Berrima Rail Project to avoid impacts on surface water quality are outlined in Section 13.5.7 of the Berrima Rail Project EIS and in Section 5.4 of the Revised Surface Water Assessment (WSP 2018). These measures will be implemented during construction and rehabilitation as well as during operation of the rail line. An Erosion and Sedimentation Control Plan, in consultation with DPI Water and WaterNSW, will be prepared prior to the commencement of activities.

NSW DPI outline the following be implemented for post project approval:

- Specialist monitoring of the bulkhead integrity and pillar stability is to be included as part of the water management plan and subsidence management plan to identify whether future irregular and unpredictable subsidence (resulting from periodic support failure) will have an impact on groundwater availability for licensed users and the potential for aquifer damage.
- A subsidence expert should consider the long-term stability of the pillars, potential for failure to occur and impact on groundwater resources.
- Ongoing verification of impacts on surface water and groundwater sources should be completed. This will include regular updates of the surface water and groundwater models, and discussion with relevant agencies where impacts are diverging from original impact and water take predictions. Where variations in predictions occur, consideration would need to be given as to the consistency of the approved project in consultation with Department of Planning and Environment and relevant agencies.
- Where the project proposes the use of WALs currently linked to water supply works not associated with this project consultation with DPI Water will be required to confirm licensing amendment requirements.
- Management of flows should be presented, where baseflows are affected, to consider replacement or replenishment options. These could include geomorphic rehabilitation to replace and/or improve channel and pool condition.
- Obtain confirmation from affected private landholders that afflux impacts, relating to flood extent increase, are acceptable or appropriate mitigation or compensation arrangements be developed.

In response to the above submissions by NSW DPI, post-project approval Hume Coal will commit to the following:

- Ongoing verification of the prediction groundwater and surface water models with respect to monitoring data. Results will be discussed with the relevant agencies where impacts and/or water take significantly diverge from original predictions.
- Consultation with DI Water regarding Water Access Licences planned to be associated with the project to confirm licensing amendment requirements, if necessary.

- In drainage lines where baseflows are shown to be affected significantly by the project, Hume Coal will consider management measures in consultation with the relevant agencies.
- Consultation with potentially affected landholders where flood affluxes are predicted to increase during operation of the project, even though the increase is considered acceptable with respect to the assessment criteria.

There is no linkage between bulkhead integrity and subsidence outcomes. Pillar stability and subsidence are addressed in Chapter 16.

9 Groundwater

9.1 Existing environment

9.1.1 Baseline geological, hydraulic and groundwater level data

Concerns raised by NSW Government agencies are summarised as:

- NSW DPI (including DI Water) and WaterNSW raised concerns in regard to the adequacy of baseline data particularly having sufficient data to understand the water table surface.
- Concerns were raised about some data gaps in the period of record and more explanation of this was requested as well as commentary regarding the adequacy of the data to inform the assessment.
- Feedback is sought from Hume Coal in relation to the conceptual understanding of the hydrogeological system, and changes to baseflow, considering gaps and adequacy of the baseline data.
- DI Water commented on the lack of analysis on the effect of stresses on hydrographs.
- A question was posed on whether there was compensation for barometric effects and density.

Concerns raised by interest groups are summarised as:

- Concerns that the presentation of baseline data as collective plots (ie rather than all individual samples).
- The stratigraphical distribution of groundwater monitoring bores, with most monitoring bores in the Hawkesbury Sandstone and not other geologies was questioned. It is suggested that more monitoring of the Wianamatta Group Shales would be beneficial.
- Concerns that raw data (chemistry, levels, pumping test data and analysis – ie both pumping bore and monitoring bore) is not presented in the EIS.
- The large scatter of hydraulic parameters is raised as a concern.
- The accuracy of the DI Water database is questioned, particularly in relation to the average yield of bores in the area.

Concerns from the community generally aligned to those raised by government agencies, interest groups and the business community, and included:

- Clarification was sought on whether baseline sampling in monitoring bores yielded mixed samples of shallow and deep Hawkesbury Sandstone water.
- Community concerns with baseline data questioned the surface water quality baseline and the strict adoption of the ANZECC guidelines and comparison between model results and baseline data.
- Two of the community submissions praised the extensive monitoring network.

The water monitoring network for the project was developed in consultation with DI Water (and their predecessors). The staged installation of the network allowed for information gathered to be analysed and then extra monitoring sites added to address spatial gaps in the conceptual understanding. Over time, the network has expanded to include 54 conventional groundwater monitoring bores at 22 nested locations, 11 vibrating wire piezometer (VWP) sensors at three locations, three private landholder bores, 11 stream gauges, and 24 water quality monitoring sites.

Groundwater monitoring began in 2011 and surface water monitoring began in 2012. Baseline data has been collected continuously for over seven years across Hume Coal's many monitoring locations within and surrounding the project area. As such, there is sufficient data to contour the (Hawkesbury Sandstone) water table surface in the vicinity of the mine.

Monitoring bores are designed to target particular depths within a formation, with clear targeting of specific permeable intervals within the Hawkesbury Sandstone aquifer (ie using 6 m length of screen with remaining bore annulus fully sealed). This design provides for the measurement of water levels and groundwater chemistry at discrete depths within the Hawkesbury Sandstone, and prevents mixing of shallow and deep groundwater within this regional aquifer.

The groundwater level logger data collected, and calculation of summary statistics, for the Hume Coal Project was compensated for barometric pressure to accurately represent the natural climatic fluctuations. The data was not corrected for density with variations in water quality (across different hydrogeological units) as groundwater salinity was generally fresh, and there was insufficient variability to alter the groundwater levels/pressure or flow gradients.

The baseline data is considered adequate for the purpose of the assessment and the modelling work that underpins this assessment. Coffey (2016a) describes the baseline data set as 'extensive', with up to 5 years of continuous data in some monitoring bores. The recommended requirement from the NSW Government is 2 years of baseline data, so the project has more than double the required duration at most sites compared to the recommended requirement. The understanding of surface and groundwater connectivity, and baseflow contributions is considered in detail using baseline monitoring of surface and groundwater as well as robust statistical and analytical techniques (Coffey 2016a).

The conventional groundwater monitoring network (54 in total) is constructed within the different geological units across the area with 2 monitoring bores constructed in the basalt, 1 monitoring bore constructed in the Wianamatta Group shale, 27 monitoring bores constructed in the Hawkesbury Sandstone and 24 monitoring bores constructed in the Illawarra Coal Measures. For the VWP installations (11 in total) there are 8 in the Hawkesbury Sandstone and 3 in the Illawarra Coal Measures (Wongawilli Coal Seam). This has enabled the hydrogeological characteristics of the primary units to be established and contributed to an understanding of connectivity between each unit. The conceptualisation of the hydrogeology at the site, coupled with the results of the groundwater modelling that predicts the impacts of the project, suggest that the main geological units impacted by mining are the Hawkesbury Sandstone and the Wongawilli Seam. This provides a valid explanation to the dominance of monitoring bores in these two units, and the dominance of baseline data for hydraulic parameters also sourced from within these two units.

The Wianamatta Group shale is a low permeability formation that rarely contains useful aquifers while the basalt usually only occupies the ridgelines and generally forms a perched aquifer system disconnected from the Hawkesbury Sandstone.

Once mining commences, and monitoring of landholder bores becomes important, additional monitoring at other locations may be required. If required an expanded monitoring network will be established in both the Hawkesbury Sandstone and other geological units (potentially the shale and basalt landscape areas). These additional sites will be selected in accordance with the objectives of the water monitoring and management plan Chapter 13 in Appendix 2 (Revised Water Assessment) and the NSW Government conditions of approval for the project.

The volume of baseline data is considered sufficient, and of sufficient accuracy, for developing a 'fit for purpose' numerical model. The groundwater model has been endorsed as 'fit for purpose' by the NSW Government appointed independent peer reviewer for groundwater, Hugh Middlemis.

Once mining and construction commences, a more expansive surface and groundwater monitoring network will be in place to assess natural and mining induced changes to these water sources. Additional monitoring sites are likely to be required at specific locations to consider and monitor aspects such as baseflow, and potential impacts to private water supply bores, subject to site access. This expanded monitoring network and additional monitoring data requirements will be scoped in detail with the relevant NSW regulators and in consultation with landholders to ensure the network is adequate for the next phase of the project.

ii NSW DI Water database

The DI Water database contains the information on registered bores across NSW. This database is maintained by the NSW Government and is derived from 'Form As' received directly from drillers upon construction of water bores. Also included are records of monitoring bores drilled by DI Water (and their predecessors) and private companies. The data in this database is referenced in the conceptualisation and assessment of the project impacts. It is known that the yield data from bores in the database is not directly transferrable to formation hydraulic conductivity as the bore yield captured in the database is dependent on a number of variables (bore depth, screen type and size, bore diameter, driller experience, diligence, accuracy of reporting yield (ie how it is measured), and the local geology). However, it is and remains a good reference database for the project, and is therefore considered in the assessment.

iii Hydrograph analysis

A detailed analysis of bore hydrographs was undertaken by Coffey (2016a); in summary, it was stated that hydrographs indicate that the groundwater levels in the Hume Coal Project area are relatively stable, but that monitoring bores do show periodic drawdown that is induced by landholder pumping. Slow recovery from sampling events as monitored in bores is noted.

Bores in the vicinity of the Berrima mine show depressurisation effects of the mine and significant hydraulic head gradients (ie significant differences in head between shallow and deep monitoring bores).

A detailed analysis of the hydrographs and in particular the vertical head gradients has been undertaken (Coffey 2016a), and results suggest a desaturated zone beneath the shale in the southern part of the lease. The vertical head gradients in the vicinity of the Hume Coal project, particularly in areas overlain by Wianamatta Group Shales are small, suggesting minimal recharge from rainfall and a distance from existing mining areas and escarpments. In areas proximate to escarpments, the overlying shale is absent and rainfall recharges directly to Hawkesbury Sandstone. Discharge from escarpment features also occurs, causing an increase in the vertical head gradients in a westerly direction from the mining lease area.

iv Hydraulic parameters and pumping tests

The Hume Coal water assessment considered a range of options for hydraulic testing and compared to similar mining projects, the data and field testing for the Hume Coal Project is considered to be more than adequate. Hydraulic testing undertaken for the Hume Coal Project includes:

- in situ pumping tests (step drawdown and constant rate pumping tests);
- packer tests at bores within the project area,
- data from core laboratory tests, and
- specific capacity data from government records.

All of this data is presented in graphs and charts in Coffey (2016a), and allows for a comprehensive assessment to be made of hydraulic conductivity (K) across the different hydrogeological units in the project area (Coffey 2016a).

Hydraulic parameters for the key geological units are derived from field, laboratory and in-situ testing techniques and are presented on graphs and charts in Coffey (2016a). The data distribution on these graphs (particularly for the Hawkesbury Sandstone) is indicative and typical of a dual permeability aquifer system (ie represents both primary and secondary permeability). Measurements are also typical of the range of field and in-situ testing techniques adopted in the program. Having data from different testing methods and across a wide selection of geologies strengthens the baseline dataset for the project.

Two step drawdown tests and two constant rate pumping tests were undertaken for the project. One was a 24 hour test and the other a 7 day pumping test. The constant pumping rate selected for each test was determined based on the results of the initial step drawdown test at each site. The pumping test rates were deemed applicable and were determined following analysis of the step testing results.

v Summary

In summary, the baseline water dataset is extensive for the project and has been openly discussed with the NSW Government – DI Water over the past 7 years. The initial meeting on the monitoring network design was with the then NSW Office of Water in July 2011, and a second detailed meeting to discuss the monitoring network and baseline data was a year later in June 2012. At both these meetings the monitoring network, conceptual models and available data from the network were discussed and presented. The monitoring network was developed in strict accordance with the guideline developed by the NSW Office of Water ‘Groundwater Monitoring and Monitoring Plans (GMMP) – Information for prospective mining and petroleum exploration activities’, and is best practice.

A GMMP was prepared for the project, and was reviewed by the then NSW Office of Water for adequacy of the network in May 2013 and then again in September 2014. Subsequent reviews of this document have occurred, but have been more focused on the modelling aspects and the results of this modelling.

The groundwater baseline data for the project is considered more than adequate to inform the impact assessment of the project and this is demonstrated by the model deemed to be ‘fit for purpose’ by the NSW Government independent peer reviewer, Hugh Middlemis, who assessed the input baseline data for the groundwater model as “suitable for an impact assessment purpose” (refer to Table 1 of Hydrogeologic (2018)).

9.1.2 Baseline groundwater quality

WaterNSW requested better presentation and interpretation of the baseline groundwater geochemistry data.

They also requested clarification in the terms of efficient recharge: many groundwater samples collected outside the project area would be classified as sulfate-type waters, with low pH and low (on non-detected) concentrations of chloride and bicarbonates. It is noted that this sulfate dominance (unusual in Hawkesbury Sandstone pore water) may be associated with areas subject of particularly efficient rainfall recharge.

They also questioned the method for calculation of summary statistics excludes below detection limit data.

There is a significant volume of groundwater chemistry data available for the project. Presentation of all raw data has not been provided within the EIS (due to the large volume of data). However, presentation of all analysed data as well as summary maps, tables and graphs has been provided. Graphs and tables show key concepts, trends and consolidated results. It is not practical, required, or industry standard to include every piece of raw field data collected during the development of the EIS (frequency of baseline groundwater quality data is shown in Figure 9.1).

Presentation of the data has been considered following submissions and some of the key areas of concern have been reworked and re-presented in the revised Water Assessment, with some examples provided below (Figure 9.2 to Figure 9.6).

The summary statistics for the groundwater baseline data is assessed and does not include non-detect (ie below detection limit) data points, which is a suitable approach for assessment of the data.

The following additional graphical presentation of the baseline groundwater geochemistry results has been provided to assist with the interpretation of the data:

- piper diagram (Figure 9.2) including all of the baseline groundwater samples, rather than just the averages for each monitoring location (rainfall data have also been added to the plot for reference); and
- box plots of pH, electrical conductivity, sulfate and total alkalinity (as CaCO₃) for each of the major geologies (Figure 9.3 to Figure 9.6).

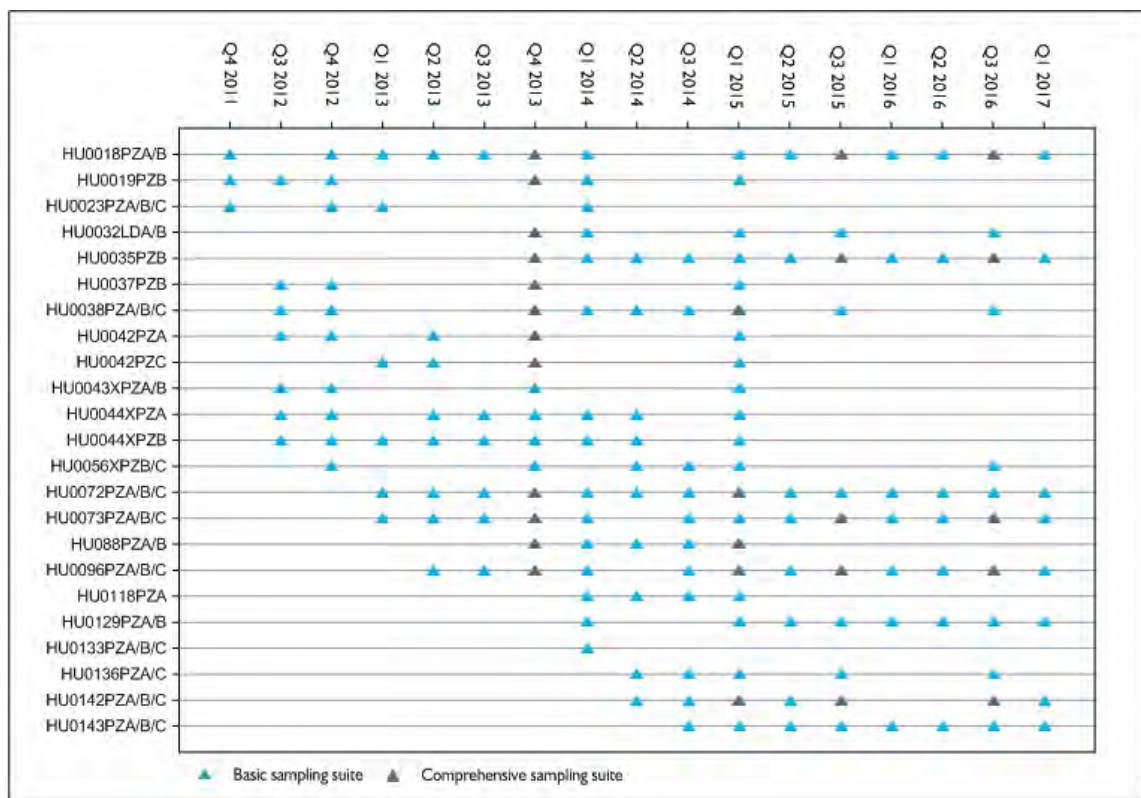


Figure 9.1 Number and frequency of groundwater quality samples analysed in preparation of the EIS

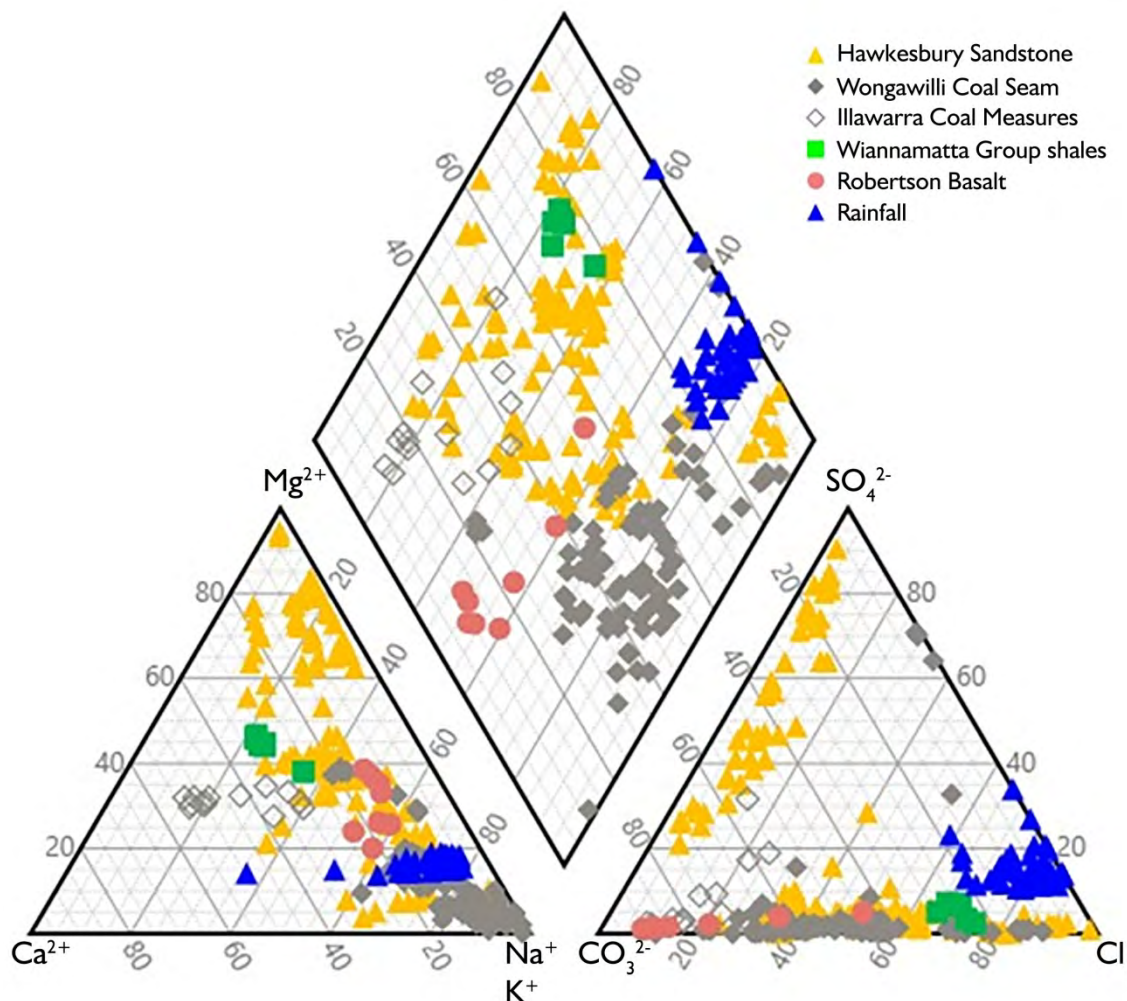


Figure 9.2 Piper diagram for all baseline groundwater samples

Figure 9.2 presents a Piper diagram of the baseline groundwater samples collected from wells targeting the various geologic formations within the project area.

A Piper diagram is a graphical representation of the chemistry of water samples. The two trilinear (triangle) diagrams represent the concentrations of major cations (calcium (Ca), magnesium (Mg) and sodium (Na) + potassium(K)) and anions (chloride (Cl), sulphate(SO₄) and bicarbonate (HCO₃) + carbonate(CO₃)). The diamond portion of the Piper diagram is used to characterise different chemical compositions. Samples that plot towards the top of the diamond are rich in Ca, Mg, Cl and SO₄. The samples that plot towards the left corner are rich in Ca, Mg and HCO₃. The samples that plot in the lower portion of the diamond are primarily composed of alkali carbonates, including Na+ K and HCO₃ + CO₃. The samples that plot in the right corner are considered Na + K, Cl and SO₄ dominant.

Figure 9.2 shows that water within the Hawkesbury Sandstone can be variable. The cation trilinear diagram presents a continuous range of Mg-rich to Na+K-rich groundwater. None of the samples were Ca-rich. The anion trilinear diagram shows two very distinct distributions of groundwater types in the Hawkesbury Sandstone:

- base of triangle – HCO₃ and Cl rich water with very low SO₄; and
- upper left – SO₄ and HCO₃ rich water with very low Cl.

Projections onto the diamond show that the water from the Hawkesbury Sandstone dominates the upper half, implying that the water samples range between Mg-HCO₃, Na-Cl, and Mg-SO₄ type water. Geosyntec (2016) completed a review of the locations of these samples relative to their types. The review indicated that the samples did not have a clear distinctions based on the depth of the screened interval within the formation, or based on the location within the study area. The exception was in bores within outcrop areas. The recharge beds of the Hawkesbury Sandstone tended to show a more dominant Na-Cl signature, consistent with rainwater in the area. Bores installed in outcropping shale tended to be more Mg-CO₃ dominant.

Figure 9.2 does not display a distinct difference between the groundwater in the Hawkesbury Sandstone, the Wongawilli Seam or the Illawarra Coal measures, although water within the coal seam is more Mg and Ca-rich and rich in HCO₃. Water within the Wongawilli seam is more alkali, being predominantly Na+K and HCO₃ type water.

The predominant water type of the Wianamatta group is Mg-Ca-Na-Cl-HCO₃. Geosyntec (2016) attributed the high TDS of the shale to be reflected by the relatively high chloride content, and that the presence of Cl is likely associated with connate salts from its original marine deposition (Geosyntec 2016). The predominant water type of the Roberston Basalt is Ma-Ca-HCO₃, representing rainfall recharge that has been influenced by mineral dissolution within a basalt matrix. Rainfall is presented as being Na and Ca-rich, which is typical of rainfall close to the coast.

Box plots have been developed with reference to the different geological units, and provide baseline information on the similarities and differences between the various geological units. The box plots show typical and expected hydrochemical signatures of the various geologies very clearly. Figure 9.3 demonstrates the expected neutral to slightly acidic Permo Triassic rocks of the Sydney Basin (Hawkesbury Sandstone, Wianamatta Shales and Illawarra Coal Measures) and the slightly basic Tertiary basalt.

The salinity of the geologies (as measured by electrical conductivity, EC) is also as expected (Figure 9.4), with the Wianamatta Group Shales being quite high in salinity (as expected based on their depositional estuarine/low energy marine environment and high clay content). There is some similarity in the freshness of the Triassic Hawkesbury Sandstone and Permian and Wongawilli Seam and Illawarra Coal Measures, which do show a slightly increased but still very similar salinity signature.

Alkalinity and sulfate of the geologies are very similar (Figure 9.5 and Figure 9.6) with the main difference being the Wianamatta Group Shales, which are slightly higher than underlying geologies and is to be expected.

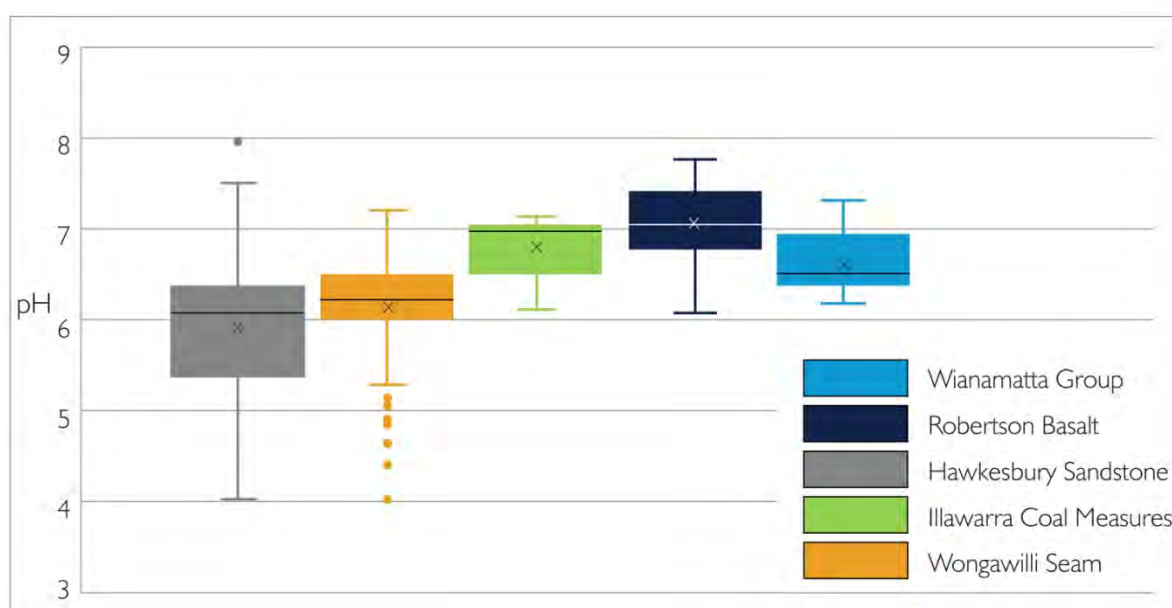


Figure 9.3 Box plot of pH of major groundwater formations

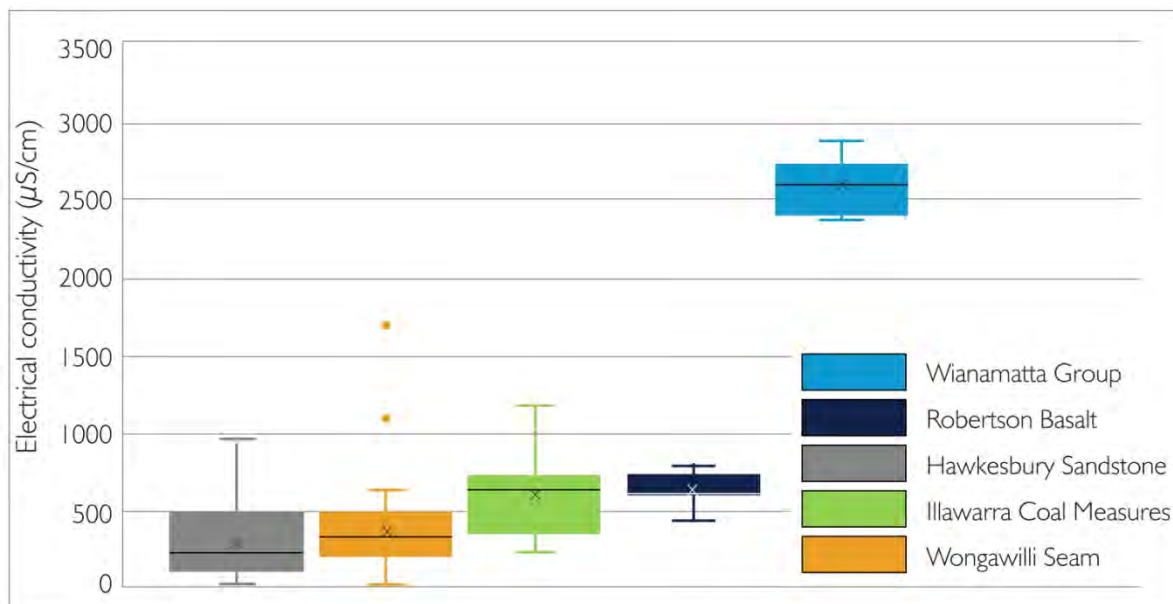


Figure 9.4 Box plot of EC of major groundwater formations

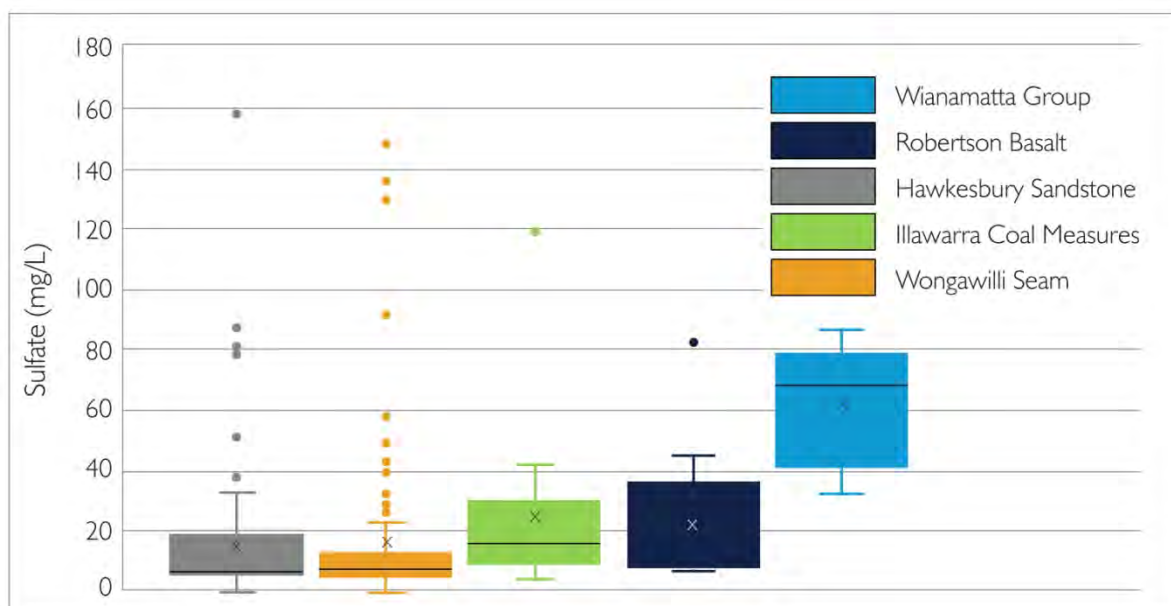


Figure 9.5 Box plot of sulfate concentration in major groundwater formations

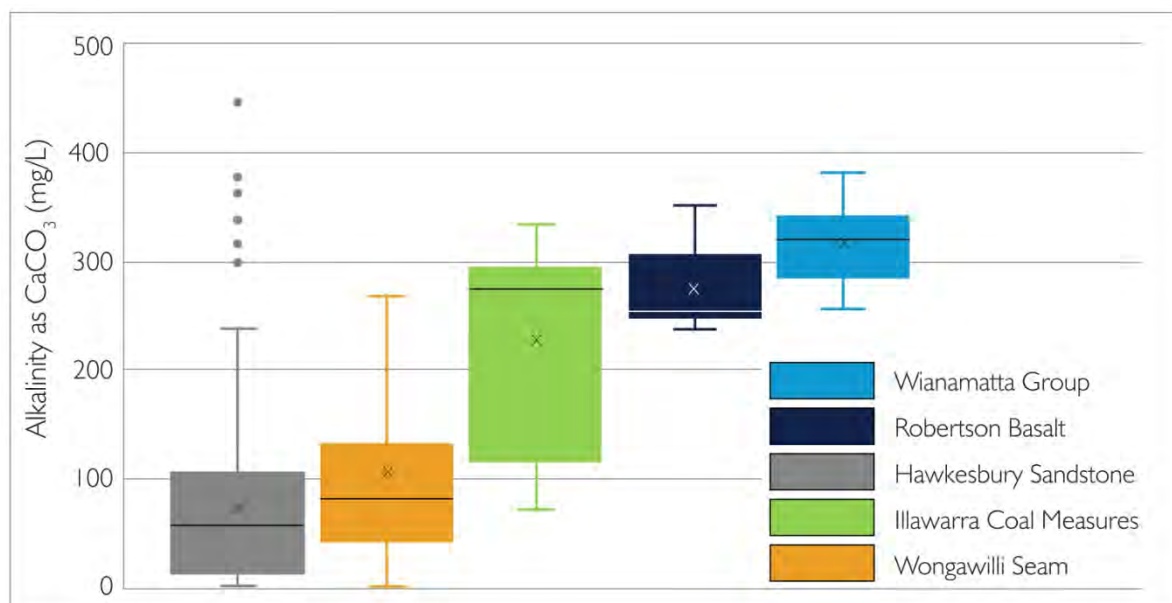


Figure 9.6 Box plot of alkalinity in major groundwater formations

i Groundwater with elevated sulfate

The baseline groundwater monitoring program indicated several monitoring locations that were either sulfate-dominant geochemical water types or contained sufficient sulfate to be recognised for classification purposes. The majority of these were collected from monitoring bores screened in the Hawkesbury Sandstone, a formation in which elevated sulfate in groundwater is not commonly encountered.

The sulfate water types can broadly be characterised as follows, based on the relative proportion of sulfate to other anions:

- Sulfate dominant – sulfate comprises 50-90% of total anions, on a milliequivalents per litre (meq/L) basis. Sulfate dominant water was present at H37B, H43B and H44B.
- Sulfate-bicarbonate waters – sulfate comprises 40-50% of total anions, on a meq/L basis, and is present in approximately equal proportions to bicarbonate. Sulfate-bicarbonate water was present at H38C, H42C and H56B.
- Bicarbonate-sulfate waters – There is sufficient sulfate to be recognised for water classification purposes (~30% on a meq/L basis), however bicarbonate is the dominant anion. Bicarbonate-sulfate water was present at H23C and H32LDB.

The sulfate groundwater types also shared the following geochemical traits:

- Slightly lower pH values relative to other monitoring locations (<pH 5 in sulfate dominant water types), which increased with increasing bicarbonate alkalinity.
- Lower TDS values relative to other monitoring locations (~50-120 mg/L, versus ~250 mg/L in other locations).
- Lower proportions of sodium and chloride relative to other monitoring locations (generally <10% each on a meq/L basis, compared to 50-60% each in other locations). The sulfate-dominant water types were classified as Mg-SO₄.

In the original hydrogeochemical groundwater report, it was suggested that higher sulfate groundwaters may be associated with zones of enhanced or rapid recharge, based on the lower TDS values, the presence of sulfate-dominant groundwater in bores in sandstone outcrop areas (the primary recharge zone for the sandstone), and a general pattern of higher sulfate concentrations in the shallowest bores in nested monitoring bore installations. However, with further investigation this original assumption is not the only reason for the elevated sulphate for the following reasons:

- Many of the elevated sulfate bores are installed in the sandstone outcrop areas to the west of the project area, and others are in the basalt and shale outcrop areas. There are also other bores installed in the upgradient sandstone outcrop areas with negligible sulfate content, in proximity to the elevated sulfate bores.
- The geochemical signature of rainfall close to the coast is typically Na-Cl dominant (refer to the Piper diagram (Figure 9.2)) whereas there is a clear trend of these constituents being negligible in the bores where elevated sulfate is present.

The source(s) of the sulfate is therefore uncertain, and potentially due to a number of reasons, explained below. Traditional sources of sulfate in groundwater include: oxidation of pyrite minerals (which would be consistent with the correlation with lower pH values); seawater intrusion (or connate salts in formations deposited in a marine environment); and dissolution of sulfate-bearing mineral phases in the aquifer.

a. Pyrite oxidation

Pyrite oxidation is likely a contributing process for elevated sulphate, but potentially not the only or dominant process, as the Hawkesbury Sandstone is not particularly known for its pyrite content. However, it is possible that there is pyrite associated with overlying shale cap and organic shale interbeds located towards the base of the sandstone in the transition to the underlying coal measures. Pyrite oxidation is commonly associated with coal seams, and some of the sulfate-dominant bores (such as H43B and H44B) are located close to the edge of the escarpment where the coal measures outcrop and diffusion of atmospheric oxygen may promote pyrite oxidation.

The spatial distribution of this process is inconsistent, and there is little correlation between sulfate and iron concentrations in the groundwater samples. Also, the vertical hydraulic gradient in the sandstone was interpreted to be flat or downward across the project area and surrounds, with no interpreted upward flow from the coal seams, so this seems less plausible as a broad source of sulfate in the sandstone aquifer.

b. Seawater source

The project area is too far from the coast for seawater intrusion to be relevant, but the Wianamatta Group Shales were deposited in a shallow marine environment and therefore contain connate salts with a seawater signature. However, the groundwater quality data from H35B, screened within the shale formation, indicates negligible sulfate, and most of the bores installed immediately beneath the shale also have negligible sulfate. Accordingly, the shale formation is unlikely to be a significant contributor to the elevated sulfate in selected monitoring bores.

c. Dissolution of sulfate minerals

It is possible that sulfate mineral phases are present within the Hawkesbury Sandstone, although there is no mineralogical data to support this, and the mineral 'cement' in the sandstone matrix is typically reported to comprise carbonate mineral phases such as calcite, dolomite and siderite. As with the other processes, this process would be difficult to reconcile with the spatial inconsistency of the high sulfate bores.

d. Summary

The presence of elevated sulfate in groundwater in certain monitoring bores in and around the project area is recognised, and the source of the sulfate is likely to be trace pyrite, but may include other sources. It is unclear why sulfate is selectively present in certain monitoring bores and absent in others nearby.

9.2 Conceptual hydrogeological model

Regarding the conceptual model, concerns raised by interest groups are summarised as:

- Concerns regarding that fractures and faulting in the area provide for large bore yields that drive high yield bores capable of pumping in excess of 50 L/sec. The overall conceptual model that is presented in the EIS is questioned. The presence of the vertical flow barrier in the model is questioned.
- Concerns that the hydraulic conductivity in the numerical model appears lower than some high yielding bores suggest.
- The conceptualisation of inflow to the Berrima Mine was raised.

There were many submissions of community concerns suggesting that bore yields in the area are very high, and questions are posed as to whether this has been appropriately considered in the assessment. The absence of a retarding layer between the Coal Seam and the Hawkesbury Sandstone (sometimes referred to as the Bald Hill Claystone or Narrabeen Group sediments) is raised, and concerns that the absence of this layer will mean that groundwater in the overlying Hawkesbury Sandstone will be 'lost' to the underlying mine.

i Conceptual model

The conceptual model has been developed in accordance with the Australian Groundwater Modelling Guidelines (AGMG) and is based on geological and hydrogeological data collected as part of this project, data from government sources and publicly available data from other industrial projects in the region. The conceptual model is a strong data driven representation of the different groundwater systems that has been developed over the past six years. The conceptual model in the EIS was developed collectively by project hydrogeologists and was peer reviewed by highly respected hydrogeological experts (Dr Frans Kalf and Dr Noel Merrick). Subsequent to the submissions process, NSW Government appointed an independent peer reviewer, Hugh Middlemis, who also reviewed the conceptual model, and agreed it is a suitable conceptualisation (Hydrogeologic 2017).

The conceptualisation of the geological layers is developed from geological mapping, historical geological logs and exploratory and monitoring bore drilling for the project. The geological formations and layer depths thicknesses (and local variations) is considered in substantial detail and all information has been included in the development of the conceptual model and then transitioned into the geological conceptualisation for the numerical model.

Information on layer thickness (ie interburden between the mined coal section and the overlying Hawkesbury Sandstone) is considered, analysed and then used to inform the conceptual model on a local scale. Therefore, the presence or absence of horizontal layers (and their relative and indicative hydraulic conductance) is based on regional knowledge, historical records and localised data collected and analysed during the various drilling programs.

The conceptual model in the Hume EIS is adequate, and has been developed in accordance with the Australian Modelling Guidelines (Barnett et al. 2012). The NSW Independent peer review comments that:

"conceptualisation is sound..... report describe previous investigations and data sources, with revires at many stages, along with reference to relevant papers..." (Hydrogeologic 2017)

Hume Coal has a data driven geological conceptualisation that accurately represents the coal seam, the overlying interburden and the Hawkesbury Sandstone. In respect to the specific issues raised around the conceptualisation of the interburden between the Wongawilli Coal Seam and the Hawkesbury Sandstone, the NSW Government Peer review states:

"This review has found that the Hume Coal model has been set up with an appropriate representation of the interburden properties (e.g. appropriate thickness and no low permeability parameters to limit the potential connection between the coal seam and the Hawkesbury Sandstone)." (Hydrogeologic 2017)

ii Structural geology

Concerns were raised that the sub-vertical flow barrier underlying the basalt in the southern area was included in the groundwater modelling to assist numerical model calibration without geological evidence for its existence. This is not the case. The conceptual cross section of this area referenced data from monitoring bores either side of this basalt, and this data confirms that there is a flow barrier at this location (as observed by a significant difference in groundwater elevations between the bores on either side of the basalt).

The numerical groundwater model was built and tested with both a flow barrier in this location and also without, which allowed testing of different conceptualisations as per the AGMG guiding principles. The model that included the flow barrier more closely aligned to the water level data and therefore had a better calibration; and this therefore is further evidence of the flow barrier's existence.

The groundwater conceptual model identifies the following structural elements:

- stratigraphy regionally dips to the east and has few structural features;
- faults that have been inferred have small displacement (5–10 m), with the exception of the Cement Works Fault north of the project area;
- basalt caps that cover many of the ridgelines; and
- numerous igneous intrusions, including dykes and diatremes.

Local knowledge of the hydrogeology within and across most individual structures is not specifically known. However, monitoring across the site, specifically monitoring conducted during pumping tests, has not indicated that any barriers or conduits to flow exist at a measurable scale. The only exception is the identified barrier underlying the basalt to the south (discussed above). All other structures were considered in detail as to whether data provided sufficient evidence to characterise them hydrogeologically. With the exception of the barrier to the south, there is no clear evidence to suggest that other geological structures are obvious conduits or barriers. They are therefore assumed not to have significant influence on regional hydrogeology, and/or their influence will be minor in comparison to the more regional flow system that the numerical model is designed to consider.

A thorough search of information on structural discontinuities was undertaken and considered during the model design process, and collectively with the project's exploration geologists. Hydrogeological information was also available from other mining activities in the immediate area (such as the Berrima Mine). Vertical exploration boreholes rarely intersect significant sub-vertical features. Results from hydraulic testing of structural features such as these are not known to exist, and the best possible use of available information has been made.

iii Hydrogeology

The Hawkesbury Sandstone is a known dual permeability groundwater system, with yields from water bores a combination of primary permeability (the permeability of the rock matrix), and secondary permeability (the permeability of intercepted fractures) (Ross 2014). Secondary permeability is localised, and this is demonstrated conclusively with the results of the Sydney Catchment Authority's Kangaloon borefield drilling investigation, undertaken in the Hawkesbury Sandstone systems at a distance of approximately 25 km from the Hume Coal project (eg DoC 2005 & 2006). Table 9.1 compares yields from paired bores just a few hundred metres apart, many with the same diameter and similar depths. In several locations, bores located less than 500 m apart have yields with an order of magnitude difference. For example Sites 1A and 1B are 305 m apart, but the air-lift yield difference was 6 L/s at 1A compared to 30 L/s at 1B.

Table 9.1 Differences in Permeability and Yield for Paired Test Bores - Kangaloon Borefield Investigations

Paired Bores	DI Water Reg No	Test Type	Distance Apart	Tested Yield	Transmissivity	K	Comments	Reference
			(m)	(L/s)	(m ² /d)	(m/d)		
1B-1A	40969-40955	Airlift on Completion	305	6/>30				DoC, 2005 - Area 2 Upper Nepean Completion Rpt
1A*-1B	40955-40969	Short term PT	305	17/0	42	0.6	T and K are for the pumping bore	DoC, 2005 - Area 2 Upper Nepean Completion Rpt
1B-1C*	40955-40981	Long Term PT (32d on 1C)	390	0/32	67	0.6	T and K are for the pumping bore	PB, 2009 - SW-GW Interaction in Sandstone Aquifers in the Upper Nepean Catchment
2A-2B	40970/2-40971	Airlift on Completion	420	~10/~30				DoC, 2005 - Area 2 Upper Nepean Completion Rpt
2A-2B*	40970/2-40971	Short term PT	420	0/18	nd	nd		DoC, 2005 - Area 2 Upper Nepean Completion Rpt
2A-2C*	40970/2-40982	Pumping Trial (114d on 2C)	560	0/16	7	nd		URS, 2007 - Kangaloon Borefield Trial (Tourist Rd) End of Trial Rpt
2L*-2C*	41049-40982	Pumping Trial (114d on 2L and 2C)	460	4/16	4/7	nd	T and K are for the pumping bores	URS, 2007 - Kangaloon Borefield Trial (Tourist Rd) End of Trial Rpt
2I-2J	41052/41045	Airlift on Completion	650	6/>25				URS, 2007 - Area 2 Completion Rpt
2J* #	41045	Short term PT		18	325 ^	3 ^	T and K are for the pumping bore	URS, 2007 - Area 2 Completion Rpt
3A-3B	40972/40973	Airlift on Completion	360	15/30				DoC, 2005 - Area 2 Upper Nepean Completion Rpt
3A-3B*	40972/40973	Short term PT	360	0/17	43	0.4	T and K are for the pumping bore	DoC, 2005 - Area 2 Upper Nepean Completion Rpt
3Z-9A	75174(273007)-40992	Airlift on Completion	150	25/7				DoC, 2006 - Detailed Pilot Investigations and URS, 2008 - Area 3 Completion Rpt
3Z*-9A	75174(273007)-40992	Pumping Trial (92d on 3Z)	150	15/0	32	0.23	T and K are for the pumping bore	URS, 2008 - Kangaloon Borefield Trial (Stockyard Swamp) End of Trial Rpt

Notes: * - pumping bore.

nd - not determined.

^ - this test bore obtained the highest T and K for the whole program (highly fractured SS with basalt sills).

- test bore did not reach base of HS - yield could have been 50 L/s plus at this site.

The Kangaloon borefield investigation was focused on one of the areas identified within the Sydney Basin as having the highest degree of faulting, fracturing and associated secondary permeability. The results of the drilling and investigation program clearly demonstrated the variable nature of secondary permeability. Therefore, although high yielding bores intercepting open fractures do exist, they are localised, with the area immediately adjacent to these high yielding bores often demonstrating lower permeability typical of unfractured Hawkesbury Sandstone.

In an agricultural situation, it is common that drilled water bores may not intercept fractures and if the yield is insufficient the bores are backfilled and a new site chosen. The test bore may or may not be reported via the Form A to the NSW Government (as the water bore is not completed). Therefore, it is highly likely that there is an under-reporting of low yielding bores in the groundwater database, and the data is likely to overestimate average bore yields in an area.

The reality of this for the Hume Coal project is that project field testing for permeability, hydraulic conductivity and porosity, and reported private water bore data will display a very broad range of results. Because of localised secondary permeability, the hydraulic parameters adopted in the numerical model are significantly less than those measured for high yield water bore sites. The model parameters need to accurately represent the average hydraulic conductivity across the region, which for all strata is a combination of both primary permeability and secondary permeability.

iv Berrima Mine

The Berrima Mine is conceptualised in detail in Coffey (2016a), and in earlier closure studies (David 2015). The conceptual model of inflow to Berrima Mine is summarised as "void inflow rate being approximately proportional the area of seam roof exposed, with no obvious lateral inflow from the Wongawilli seam" (Coffey 2016a).

Groundwater from the Berrima Mine discharges to the Wingecarribee River at a rate of approximately 2 ML/day and this is actively monitored. It is noted that the EPA licence for discharge to the Wingecarribee River is 10 ML/day, demonstrating that the NSW Government is aware of the discharge, and the potential for increased discharges. It is understood that groundwater levels overlying the mine started to recover following cessation of mining in 2015 (David 2015), despite a continual inflow to the workings and discharges to the Wingecarribee River of 2 ML/day. The following excerpt is from the conceptual model section (Chapter 3.7) of the David (2015) report for the Berrima Colliery:

"All groundwater bores show full and quick recovery following pumping period. Groundwater levels in these bores have stabilised and reached new equilibrium since the cessation of mining.

Close to the mined workings the lower Hawkesbury Sandstone unit has been dewatered however re-pressurisation is occurring in this unit to the north of the workings. The upper Hawkesbury Sandstone in the vicinity of current workings has been partially depressurised."

The location and design of the Berrima Mine, which allows for groundwater to drain via gravity into the Wingecarribee River, is very different to the location and design of the Hume Coal Mine, where mine water will be progressively captured and stored behind bulkheads, and there will be no environmental releases (refer to Figure 8.2). The Hume Coal Mine will fill with groundwater following cessation of mining; all inflows will be contained and the overlying groundwater systems will fully re-saturate.

9.3 Numerical groundwater model

9.3.1 Design

Additional reporting on some model design features was requested by NSW DPI. They also questioned whether the numerical model design adequately considered all available data and was properly reviewed.

Interest groups raised a lack of full reporting and disclosure of all modelling results. There were concerns that the time taken to undertake the modelling was too short.

Concerns were also raised that fracturing of overlying strata would prevent full recovery of groundwater levels if longwall mining methods were allowed to be used.

Some interest group submissions stated that regardless of the mining technique, the inflows are too high and mining methods are of 'little consequence' in predicting impacts.

Community concerns aligned with interest groups and they also raised that modelling did not consider droughts.

Community members raised concerns regarding the 'untested' mining method proposed with respect to the impact of such a mine on the overlying groundwater resources.

Community members raised concerns that the model appears to assume a 'semi-impermeable' strata immediately above the coal seam. The concern here is that it will constrain water inflow to the mine workings. The sensitivity analysis is considered inadequate in that it does not assess the full range of possibilities. There is a comment that the model is designed to minimise inflow and a general belief that inflows will be much larger than the EIS model predicts.

Community submissions also stated that the model was initially developed by Parsons Brinckerhoff (over 3 years), then handed to Coffey (for 18 months) and that this was too long a period and that the results of the model are therefore debateable.

i Numerical model architecture

Both the conceptual model, and the numerical model design and calibration presented in the EIS are data driven with field data from the site itself as well as data, results and learnings from nearby mines within the Sydney Basin. The numerical model was designed in accordance with the Australian Modelling Guidelines (Barnett et al. 2012) and the boundaries were developed in consultation with the NSW Government. The NSW Government independent peer reviewer, Hugh Middlemis also concluded that:

"The model software, design, extent, grid, boundaries and parameters form a good example of best practice in design and execution." (Hydrogeologic 2017)

Consultation with regulators regarding the model and the monitoring network has followed industry best practice guidelines, and the long period of baseline data collection (well in excess of 2 years for groundwater levels) is a strong positive for the project and model calibration.

The numerical model has been updated and improved for this response to submissions, with the following important design changes:

- upgraded model software;
- testing of model assumptions and alignment to baseline data (including interburden thickness, model layers, drain conductance, specific yield, storativity and relaxation height);
- adoption of pseudo soil function;
- climate sensitivity analysis;
- climate uncertainty analysis;
- parameter sensitivity analysis; and
- hydraulic conductivity uncertainty analysis using monte-carlo simulations using cloud-based processors.

The geological and hydrogeological conceptualisation is critical to ensuring that the model accurately predicts the extent and depth of mine induced drawdowns in the various groundwater systems, and predicts any losses from changed surface water-groundwater interaction. Of particular importance are the interburden layers between the Wongawilli Coal Seam and the Hawkesbury Sandstone, which are the subject of much debate raised in submissions. Interburden thicknesses are variable in the model to reflect the field data collected. This issue has been clarified in the Hume Coal Project Revised Groundwater Modelling Report (Revised Model Report) (HydroSimulations 2018). Of relevance, HydroSimulations (2018) states:

"HydroSimulations conducted an examination of the model geometry and has shown that the interburden between the bottom of the Hawkesbury Sandstone and the top of the working section of the Wongawilli Seam is spatially variable, and closely matches the interpolated interburden thickness figure shown in the EIS groundwater report; (Coffey 2016a, Figure 4.3).

".....the modelled thickness in metres of the interburden surrounding the proposed Hume Coal Project Area, it is comprised of the cell-by-cell sum of the thickness of the top of model layer 8 to the base of model layer 10.

".... the EIS model, therefore, was a correct representation of the conceptual model, but this aspect had not been fully explained or reported in the accompanying report."

The Triassic interburden layer is layer 8 in the groundwater model and has a minimum thickness of 0.4 m. This layer does not unduly constrict vertical groundwater flow into the mine workings. The Permian interburden is represented by layers 9 and 10, and these have a minimum thickness of 0.29 m each and a maximum thickness of 4 m each. Layers 9 and 10 do not unduly restrict inflow into the mine workings.

ii Mining method

The mining method is non-caving, with no intended roof collapse and no fracturing of overlying strata. This method of mining, being a non-caving method, is similar to the very old and traditional mining method, 'bord and pillar', which was common in Australia up until the 1960's (Commonwealth of Australia 2014). This bord and pillar method (and therefore impacts to the overlying groundwater resource have been 'tested' significantly, with reference to this as one of the two methods historically adopted for mines in the Southern Coalfields (NSW DoP 2008a).

There are no material levels of subsidence predicted for the Hume Coal Project. Therefore, the long term structural integrity of the overlying formations, namely the Hawkesbury Sandstone should remain intact. The use of drifts to access the coal seam rather than freely-draining adits allows for groundwater levels to fully recover post-mining and explains why there are no irreversible changes that impact the groundwater system.

Once the mining is completed in a panel, the panel will be sealed and allowed to fill with water. Once the panel is full, groundwater levels immediately overlying the mined panel will begin to recover. Overlying strata is not fractured because the mining method results in negligible subsidence and, therefore, full recovery of overlying groundwater levels are expected post-mining.

Once all mining has ceased and the mine is sealed, full re-saturation of the workings will occur within 2-3 years. Bulkhead seals are designed to last indefinitely, but regardless, once the mine is sealed and fully saturated, the bulkheads are no longer important for managing groundwater inflows in the mine due to the use of drifts, rather than adits, to access the mine. The full recovery of groundwater levels and pressures in the overlying Hawkesbury Sandstone is not dependent on bulkheads once the mining is concluded and the workings are fully sealed from the surface.

The inflow to the mine workings are predicted in the numerical model on an annual basis and are based on the predicted overburden movements. The predicted inflows are considered accurate by the NSW independent peer reviewer (Hydrogeologic 2017), and are not considered 'too high' in terms of the ability to manage the water volume on site, effects on the groundwater resource or ability to licence the volume in accordance with the NSW Government AIP (NOW 2012a).

Submissions that suggest the mining method is "of little consequence" to inflows, are considered irrelevant, as the model is based on the proposed mining method, and this is the mining method that will be adopted, so therefore the predicted inflows are accurate.

iii Numerical modelling evolution

The water assessment work was initially commenced by Parsons Brinckerhoff (PB) in 2011, and at that time they had a large team of hydrogeologists with demonstrated strength and experience for the design and installation of the monitoring network and preliminary analysis of data and preliminary concept modelling. As the project evolved from a focus on data collection across to analysis of that data and modelling, it was decided that a specialist more experienced modeller, with significant experience in modelling underground mining, was required. Therefore in 2015, a decision was made to engage a highly experienced modeller with underground mining experience; Paul Tammetta from Coffey Geotechnics. To ensure consistency of the team and to facilitate knowledge transfer, Parsons Brinckerhoff (and now WSP) have remained involved in the project data collection and in particular the surface water assessment and modelling components. Dr Noel Merrick and Dr Frans Kalf remained the peer reviewers for the groundwater modelling. Paul Tametta of Coffey Geotechnics undertook the modelling and reporting for the Hume Coal Project EIS.

Following submission of the EIS, and upon receipt of the submissions from the NSW Government, additional modelling work was commissioned. A detailed EIS groundwater model audit was undertaken by Dr Noel Merrick of HydroSimulations, which evolved into a model revision, using upgraded software and solvers, and a detailed uncertainty analysis. HydroSimulations are one of the few companies within Australia that can undertake comprehensive uncertainty analysis. Paul Tammetta remained integrally involved with this process and provided information and assistance to HydroSimulations as they undertook their review, and he also provided advice and information to the NSW appointed independent peer reviewer in addressing his questions. Paul has a long history of involvement with the project and model development. His experience was invaluable with the revised work that was undertaken.

The length of the period for development of the model is considered suitable. The development of the model spanned seven years, from 2011 through to 2018. Over this period, the model evolved and additional data was included, analysed and conceptualisations considered. This is a thorough period of time for development of a model and is considered to be a major strength in its development. The timeframe allowed for a thorough consideration of the conceptualisation, data and model results. It also means that the baseline data period adopted in the model is excellent, with in excess of the minimum requirement of two years for baseline data. The opportunity to develop the model over this length time is a positive aspect of the groundwater assessment for the project.

iv Drain conductance parameters

Concerns were raised in the submissions that the adopted conductance values for mine inflow in the model are too low. The drain conductance was therefore subject to reconsideration in conjunction with the overall model audit.

During the model audit some discussion between the modeller (Noel Merrick), the NSW Government (DI Water) and the independent peer reviewer (Hugh Middlemis) was undertaken and it was agreed that the conductance values adopted in the EIS model are valid with the drain conductance values calibrated and matched with site data (ie mine water inflow at Berrima Mine, groundwater pressures over time and stream baseflow calculations).

Middlemis (Hydrogeologic 2017) states in his review:

"Pells [and Pan] (2017) and Anderson (2017) contend that the drain conductance parameter value is calculated incorrectly and is very low, with the implication that mine inflows may be underestimated. The modelling guidelines (Barnett et al. (2012), section 11.3.5) state the following:

"Conductance as a model parameter cannot be measured directly. It is a surrogate for the combination of hydraulic conductivities and geometries that occur in the near field of the water body. A number of analytical solutions give guidance for this kind of conductance, but values are generally either assumed or chosen during model calibration."

While this statement is made in the usual context of a model drain feature representing a water body, it is also applicable to a mine inflow feature. The analytical solutions mentioned include the methods applied by Pells to incorrectly infer that the mine workings are "sealed or surrounded by a thick layer of compacted clay" with an equivalent hydraulic conductivity of 2×10^{-5} m/d. Such an analogy may be hypothetically valid if one accepts the riverbed conceptualisation, but this review finds that concept is not applicable in this case, and is inferior to the best practice history match calibration methods applied to the Hume Coal model."

To fully consider the drain conductance suitability a more detailed sensitivity analysis was undertaken, which is explained in detail in Chapter 7.2 of the revised groundwater modelling report (HydroSimulations 2018).

The EIS model adopted a $0.05 \text{ m}^2/\text{d}$ conductance value, which was calibrated on drainage and discharge volumes from the Berrima Mine void, and considered the relative area of the cell sizes between Berrima Mine and Hume Coal within the model domain (Coffey 2016b). The EIS modelling report highlights that similar drain conductance values ($0.1 \text{ m}^2/\text{day}$) were used to simulate non-collapsing development headings for proposed mining at Dendrobium Area 3B (Coffey 2012).

As part of the groundwater model revision, a parameter sensitivity run increased the drain conductance value by a factor of ten to $0.5 \text{ m}^2/\text{d}$.

Increasing the drain conductance tenfold resulted in doubling of the mine inflow 'to the sump'. Other key parameters such as total mine inflow and increases to the number of impacted bores show much lower increases, demonstrating the model not particularly sensitive to changes in mine drain conductance.

If this order of magnitude increase in drain conductance was similarly applied to simulating mine inflows at Berrima, the modelled inflow would far exceed the observed discharge from Berrima Mine, and the conductance value would no longer be calibrated. Therefore, drain conductance values greater than 0.05 m²/d are considered unrealistic for the proposed mining method.

The similarities in the conductance values for other models within the Southern Coalfield simulating non collapsing strata, as well as inflows not being calibrated with order of magnitude changes, show that the calibrated conductance values used in the EIS model are reasonable and fit for the purpose of predicting the mine inflow volumes to the mine.

v Relaxation zone

The relaxation zone above the mined panels is estimated at less than 3 m above the workings. The model considered the sensitivity of this zone, and considered both 2 m and 4m and undertook sensitivity analysis of both options. The final thickness of 2 m was adopted based on observational databases suggesting a thickness of 2.5 m is commonly seen for non-caving mines, but there is a need to apply the relaxation zone across the entire mine footprint (when in reality many areas are fully supported by pillars). A sensitivity analysis was undertaken on both 2 m and 4 m relaxation zones and there was a relatively small difference of 4.3% (ie 4.3% increase in inflow with a doubling of the relaxation zone). A zone of 2 m was deemed appropriate (Coffey 2016b).

vi Drain conductance

The model in the EIS (Coffey 2016b) applies drain cells to the relaxation zone in layer 10. Therefore the inflow to the mine workings is managed via the drain conductance (ie not the hydraulic conductivity). These model cells (ie the 2 m layer above the mine workings) have a drain conductance of 0.05 m²/d.

The model audit and model software upgrade by HydroSimulations (2018) provide a more robust approach for the numerical modelling of this aspect of the mine. The 'time varying materials' aspect (available in this later version of the software) allows for hydraulic parameters in the layers (10, 9 and 8) above the mined workings to change over time. The 0.05 m²/d conductance value used in the EIS model was based on the calibration of drain cell conductance to discharge volumes from the Berrima Mine void, but considered the relative area of the cell sizes between Berrima mine and Hume Coal within the model domain (Coffey 2016b). The EIS modelling report also highlights that similar drain conductance values (0.1 m²/d) were used to simulate non-collapsing development headings for proposed mining at Dendrobium Area 3B (Coffey 2012).

Drain conductance of 0.05 m²/d can be converted to more meaningful terms such as hydraulic conductivity (K) or leakage coefficient (K/b) by taking into account the dimensions of plunges and roadways relative to model cell dimensions, and allowing for the area of seeps from the roof or sidewalls being much less than roof or wall face areas. When this is done, the effective leakage coefficient adopted in the Hume model is 5x10⁻⁵ d⁻¹ at Hume and 2x10⁻⁵ d⁻¹ at Berrima, where drain conductance has been calibrated. This compares favourably with estimates applied at other Southern Coalfield mines which range from 4x10⁻⁵ to 1x10⁻³ d⁻¹. Consultation on this matter with DPI Water occurred on 25 August 2017.

As part of the groundwater model revision, a parameter sensitivity run that increased the drain conductance to 0.5 m²/d (a factor of 10) was conducted.

Importantly, if this increase in conductance was similarly applied to the drains simulating mining at Berrima, the modelled inflow would far exceed the observed discharge from the Berrima mine void and the conductance values would no longer be calibrated, indicating that this is an unrealistic mine conductance value.

Increasing the drain conductance by an order of magnitude has resulted in a near doubling of the 'to sump' mine inflow within the sensitivity run. This is the inflow intercepted by drains at the Hume Coal Project. Other key parameters such as total mine inflow and increases to the number of impacted bores are much lower, showing the model is overall not particularly sensitive to changes in mine drain conductance.

The similarities in the conductance values for other models within the Southern Coalfield, as well as the indication that conductance can become uncalibrated with an order of magnitude change, serve to show that the calibrated conductance values used in the EIS model are reasonable and fit for the purpose of predicting the impacts of the mine.

vii Numerical model calibration

The groundwater model is calibrated based on the long term rainfall for the area, which includes both drought and non-drought sequences. Monitoring records for NSW Government groundwater monitoring bores were used in the model calibration as there is an 18 year period of record for these bores (1999 and to 2017). The dataset represents the end of a very dry/drought sequence for the area that extended from 1992 through to approximately 2008, followed by a return to a more normal rainfall pattern over the last decade.

This long climatic sequence provides an acceptable period of both dry and wet sequences, and associated rainfall recharge responses to effectively calibrate the model.

viii Sensitivity and uncertainty analysis

The sensitivity analysis described in the EIS tested the key parameters that were found to be sensitive in the model. However, given the submissions on the EIS raise both sensitivity and uncertainty analysis, this aspect has been more thoroughly addressed in the revised model and post EIS report (HydroSimulations 2018). A detailed and very thorough uncertainty analysis has been undertaken, as well as additional sensitivity runs (see sections 9.3.5 (ii) and (iii) and HydroSimulations (2018)). The revised model has also been peer reviewed and accepted by the NSW Government independent peer reviewer (Hydrogeologic 2017).

ix Presentation of modelling results

Modelling results and data from the model is presented as per the requirements outlined the SEARs, and respective policies such as the AIP and the IESC Guidelines. All data required to be provided has been provided in the Hume Coal EIS. The Revised Water Assessment (Appendix 2) contains a revised groundwater model report as well as revised data and outputs to address concerns raised in the submissions process are presented in detail in these reports.

x Audit and review

The model audit and subsequent rework of the model provided very similar results to the original EIS model. A detailed independent peer review was commissioned by the NSW Government, and this review covered both the EIS model, and the subsequent rework. The independent peer review stated that the original EIS model and the subsequent model revision are 'fit for purpose' for predicting impacts of mining (Hydrogeologic 2017). The EIS predicted mine water inflows, drawdown predictions in both the EIS model and the revised model accurately reflect the expected mine impacts.

9.3.2 Conceptualisation

NSW DPI submissions suggested that a conceptual model be prepared to reduce uncertainty in model parameters. The submissions suggest that the model should both replicate observed/reported values of K and hydraulic heads, groundwater discharge (baseflow to streams), deep groundwater discharge (discharge to mine voids) during calibration to provide a suitable basis for predictive simulation of the proposed mining methods, as well as used in a predictive capacity to assess impacts.

The NSW DPI submissions state that the replication of heads, shallow discharge (baseflow) and deep discharge (Berrima measured discharge) have been met, but it considers the large (unacceptable levels) of water balance errors of the model mean the calibration was 'accidental'.

An interest group submission raised concerns about the model base case (null scenario). They also questioned whether it was an unbiased representation of the available field data. In addition, a formal calibration constrained by an uncertainty analysis was requested to be performed.

The EIS model was prepared in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012) and a conceptual model was prepared and revisited based on field data as it was collected and analysed. Aquifer parameters that were uncertain in the model were subject to a tailored uncertainty analysis, aimed at considering those parameters that were unknown and those that were likely to influence the drawdown and mine inflow results (ie those that were considered most sensitive to the model results).

The mass balance for the original EIS model was recalculated based on the revised model. With the updated software, a more elaborate numerical simulation was completed and this has led to a reduction in the mass balance error without the need to recalibrate the model. The calibration for the original EIS was robust and remains valid. This is confirmed by the NSW Government peer reviewer (Hydrogeologic 2017).

9.3.3 Class, SRMS, mass balance and convergence

Some of the NSW DPI (including DI Water) submissions stated that they consider the groundwater model has a confidence level of Class 1, not Class 2-3 as stated in the EIS. These comments are based on a literal reading of the Australian Modelling Guidelines that any Class 1 attributes render the model to be Class 1, and the final mass balance and scaled root mean square errors being higher than the guideline values of 1% and 5% respectively.

NSW DPI raised concerns that there are various shortcomings with the compliance checklist in the Australian Groundwater Modelling Guidelines and there are inherent risks with groundwater modelling and assumptions made for models generally.

Due to DI Water's consideration of the model being ranked as Class 1 (instead of Class 2/3), they claim that the model is not fit for purpose and is not suitable for the intended purpose of predicting the impacts, or that its predictions will not be sufficiently accurate.

The NSW DPI state the model should be reworked and recalibrated to reduce SRMS and final mass balance to improve impact predictions, and a detailed discussion on model convergence.

Comparison of modelled heads to measured heads is recommended to provide additional justification for the claimed success in model calibration (ie demonstrate it is not 'accidental').

The water balance errors reported are also questioned in regard to model accuracy performance and class. One business group claimed the model is not suitable to predict impacts of mining.

Classification of the model as Class 2, with elements of a Class 3 was not accepted by some interest groups. Certain sections of the Australian Groundwater Modelling Guidelines are cited as the reasons for this, in particular the mass balance error. Industry groups quote the 2014 Pritchard et al report as stating the groundwater resources as 'highly valued' and as such a Class 2 model is required. They also raised the alleged lack of model convergence as a potential concern, and the modelling was generally labelled inadequate. They stated that model calibration is based entirely on the Berrima mine inflow, and therefore the class should be considered lower (Pells and Pan 2017).

Many community members raised concerns aligned to the above concerns of the adequacy of the modelling and the confidence of the model (ie not a class 2). They made claims relating to the model inadequacy, based on alternate (ie not in the Australian Groundwater Modelling Guidelines) model calibration references of Moriasi et al. (2007), and the Nash-Sutcliffe coefficient of model efficiency (Nash and Sutcliffe 1970).

i Model Class

The EIS groundwater assessment report (Coffey 2016b) states the model confidence level is Class 2/3 based on the Australian Groundwater Modelling Guidelines (Barnett et al. 2012) and that is it suitable for impact assessment. Several submissions, including NSW DI Water and interest groups, contested this claim on various grounds. The EIS model has therefore subsequently been audited and revised by Dr Noel Merrick (HydroSimulations 2018).

The model classification in the modelling guidelines was developed to provide a non technical term and a 'benchmark' or 'yardstick' for which to consider the reliability or confidence of predictions for a given model (Barnett et al. 2012). However, for responses to the Hume Coal EIS, model class has become a key factor in answering the submissions due to the heavy reliance from both NSW DI Water and interest groups on this classification in terms of model adequacy, accuracy and reliability.

In the audit review, HydroSimulations (2018) maintains that the original EIS model is indeed a Class 2 model based on the Australian Groundwater Modelling Guidelines (Barnett et al. 2012). The independent peer review by Hugh Middlemis (Hydrogeologic 2017) also concluded that the original EIS model a Class 2 model based on a holistic interpretation of these same guidelines. Middlemis (Hydrogeologic 2017) states that the original EIS model is 'improperly labelled as a Class 1' by some critics, and further states:

"cherry-picking one guideline comment rather than considering all the attributes suggested in the table does not constitute a valid agreement to support the claims by others of poor model performance."

The development of the original EIS model and impact predictions are in accordance with best practice guidelines. The Middlemis (Hydrogeologic 2017) review of the original EIS model states that:

"the Hume Coal model itself is suitable for the mining impact assessment purpose (Class 2 confidence level)' and 'the EIS presents reasonable predictions of dewatering volumes and drawdown extent/magnitude."

"it is my professional opinion that the Hume Coal model is fundamentally consistent with best practice in design and execution, although the EIS documentation is deficient (not sufficient clear on some details). It is fit for mining project impact prediction purposes".

This statement from the independent peer reviewer that the model is 'best practice' and 'fit for purpose' should provide reassurance to the NSW Government and the community that the predicted mine inflows and drawdowns are the best available predictions.

Although the original EIS model is suitable for impact assessment purposes, there were some comments in submissions that prompted a model review. The combination of submissions; the report from independent peer reviewer, (Hydrogeologic 2017); and the EIS model audit (HydroSimulations 2018), have been used to refine the model.

The HydroSimulations (2018) audit and proposed refinements involved consultation with the EIS modeller, Paul Tammetta. The amendments were then endorsed by both the independent peer reviewer engaged by the NSW Government, Mr Hugh Middlemis, and the DI Water technical specialists in a consultation meeting in August 2017.

The model revisions have meant that the model now has even more Class 2 and 3 attributes such as a significant reduction in the mass balance error, and less Class 1 attributes.

ii Calibration, Scale Root Mean Square percent (SRMS) and mass balance

Middlemis (Hydrogeologic 2017) states that based on the model audit by Merrick and refinements subsequently made, the SRMS has been reduced to less than 10%, and the water mass balance less than 1%, thereby removing the grounds for the Class 1 claim by others. The model calibration has been undertaken in accordance with the Australian Modelling Guidelines (Barnett et al. 2012), was reviewed by HydroSimulations and the model calibration as undertaken by Coffey in the EIS remains valid.

The model calibration statistics are improved following the audit and subsequent revised modelling. The uncertainty analysis by HydroSimulations 2018 also provides improved calibration and mass balance errors from the original EIS model. The use of the Berrima mine inflow volumes for calibration of the EIS model is appropriate, and disputing the use of this data set is unjustified. Middlemis (Hydrogeologic 2017) provides comments directly on this calibration approach in his review, stating:

“Calibration of aquifer property values (Kh, Kv, S, Sy) has been well constrained by pumping test estimates of property values, and by simultaneously honouring observed groundwater levels, along with the measured Berrima mine inflow (deep system) and inferred stream baseflows (shallow system).

This is a best practice approach that reduces model non-uniqueness problems (that many different sets of model inputs can produce nearly identical aquifer head distributions). Uncertainties remain, and as the evapotranspiration discharge (a riparian zone flux) is unconstrained by measurement or estimates, sensitivity testing is warranted on the maximum ET rate and extinction depth (especially in high relief areas, including parts of the riparian zone).”

The model is calibrated in accordance with best practice for groundwater modelling, as outlined in the Australian Modelling Guidelines (Barnett et al. 2012). Submissions on the EIS suggest the calibration should be undertaken in accordance with alternative methods and refer to Moriasi et al. (2007) and Nash and Sutcliffe (1970). These methods, although considered good practice, are not directly applicable to the calibration of a groundwater model.

Moriassi (2007) refers to model evaluation and verification methods for watersheds, focussing on surface water volumes, surface water quality and soil quality, and is considered suitable for agricultural settings. The Moriassi (2007) method is not suitable for model calibration of a groundwater model; rather, its use is for model verification (ie following project development) and applies to surface water/watershed models in agricultural settings – ie not generally applied to mining or groundwater.

The Nash and Sutcliffe (1970) coefficient of model efficiency is used to assess the predictive power of a hydrologic model. The researchers, techniques and the principles presented are technically sound, but again, are not directly applicable to the groundwater modelling and the calibration of the Hume Coal model. The paper by Nash and Sutcliffe (1970) referred to in the submissions is titled *River flow forecasting through conceptual models part 1 – A discussion of principles*, and the paper focuses on conceptual principles for modelling river flow. The paper presents valid findings. It is noted that the Hume Coal model follows the more recent Australian Groundwater Modelling Guidelines (Barnett et al. 2012), and also follows many of the overarching principles for model development outlined in Nash and Sutcliffe (1970), being:

- develop a simple model that can be elaborated on (this is how the Hume Model has evolved);
- optimise parameters and study their stability (this is how the Hume Coal model was calibrated – ie optimising parameters, study their sensitivity and the overall stability of the model);
- measure the efficiency (this is done in the Hume Coal model by measuring SRMS and other calibration statistics)
- modify the model (this is what has occurred throughout the Hume Coal modelling process);
- choose desired modifications (as was undertaken for Hume Coal with the upgraded software and solvers selected for the revised model following the EIS submission);
- compare model revisions against one another (this was done as the Hume Coal model evolved and these comparisons are outlined in detail in Appendix 2)

In summary, the model is calibrated to best practice for groundwater modelling, using the Australian Groundwater Modelling Guidelines (Barnett et al. 2012) and, although other methods for model verification and validation exist and are potentially valid, the most appropriate method for calibration and verification of the model has been adopted for the Hume Coal model.

iii Model convergence

The model convergence was improved with the model revision due to a combination of the following alterations:

- updated solver settings (allows tighter convergence from 1 m to 0.1 m;
- upgraded software engine to MODFLOW-SURFACT v4 and then to MODFLOW-USG; and
- adoption of pseudo soil function.

The updated solver settings and upgrade to the latest software, MODFLOW-USG, allows for the use of more elaborate and tighter numerical solvers which provides for much better convergence in the model (see revised model report in Appendix 2).

The detailed uncertainty analysis also considered the required number of runs to ensure acceptable levels of convergence of results and this successful model convergence result is concluded in the HydroSimulations (2018) report as follows.

“A new approach to uncertainty analysis has been introduced in this study which is compliant with directions advocated in a recent Explanatory Note issued by the IESC. In particular the approach (using AlgoCompute software in the cloud) demonstrates that convergence has been achieved for key outputs of interest by quantifying the uncertainty in nominated percentiles as the number of Monte Carlo runs increases.”

9.3.4 Input data

NSW DPI (including DI Water) and WaterNSW raised concerns that input data is not sufficiently supported by evidence, and question whether actual or modelled data is used for the starting heads. Concerns related to consideration of impact predictions under certain climatic sequences (ie not just use the average) were raised.

Concerns with consideration of baseflow to streams under dry climate conditions were raised as was the general concerns that the impact predictions only considers average climate conditions. One response suggested that considering impacts during a drought period was not a conservative approach for baseflow and groundwater drawdown in landholder bores.

They also included suggestions that all the all raw data should have been provided in the EIS.

The NSW DPI would like to see more information on the groundwater flow pattern and model boundary for the outcropping Wongawilli Seam in the vicinity of Black Bobs Creek and associated discharge/baseflow volumes.

The business community questioned the integrity of the data used in the model and also claimed the data was incorrect and not suitable.

Interest groups made claims that some parameters and assumptions in the model are not supported by field observations. Concerns that raw data is not made available to the public and therefore it cannot be verified. Concerns that the average layer hydraulic properties are established via 'trial and error' and not sufficiently justified by site data, logs and testing.

Concerns that model boundaries and model layer elevations are not provided therefore model could not be replicated, and that the model boundary conditions are 'unrepresentative' and therefore potentially underestimate groundwater inflows. There were requests for model files and all raw data to be made publically available. Clarification of the source of surface topography mapping and streambed elevations was requested.

Concerns that the one 7 day, and one 24 hour pumping tests is insufficient and longer term pumping tests are required. It is suggested that there should be more reliance on the pumping test data in the model. It was suggested that the pumping test raw data and analysis should be presented. Claims that data collected at distant sites was adopted in preference to the local pumping test data.

Comments that the model permeability decreases with depth but does not change spatially (which is inconsistent with detailed field data), and the model will not therefore predict potentially larger inflows to specific mining panels. It is suggested that spatially variable hydraulic conductivity should be modelled. Comments with respect of comparison between the Berrima and Hume Coal mine inflows were made, and suggested that if the Berrima Mine inflow is scaled up linearly, the Hume Coal inflow should be much higher than the EIS model is predicting.

Concerns with the linear data drift and the overall error margin measuring stream flow was raised in relation to the Berrima mine outflow data, and concerns that Figure 4.6 in Coffey 2016b does not match raw data submitted in the EPL returns for Berrima Mine – suggestions that the filter used for this data is be declared. Questions over model calibration to Berrima Mine only were raised.

The calibration hydrograph for Piezometer HU_38 was questioned and with the model revision this bore there is now a closer alignment between the model predictions and the actual monitoring data (Hydrosimulations 2018).

It was requested that field estimates of rainfall recharge collected in the model domain should be documented. Available tracer tests, or mass balance analyses used in the model domain to support the 1.8% value is requested to be documented. Further water table fluctuation analyses, other than the one reliable observation point (H44XB) reported by Coffey (2016a) for which a groundwater recharge rate of approximately 3.5% of rainfall was calculated, is requested to be provided.

It was suggested that confined aquifer water storage values (specific storage) in Hawkesbury Sandstone are one order of magnitude lower than the best field measurements presented by the proponent and inconsistent with mathematical equations applied to typical rock porosity and compressibility data for the Sydney Basin (Pells and Pan 2017).

It was suggested that unconfined water storage values (specific yield) in the Hawkesbury Sandstone should be verified with field data and observations and not just literature review. Clarification on the relaxation height is sought and more information on drain conductance is also requested as it is suggested it is too low.

Hydraulic conductivity values adopted for the Hawkesbury Sandstone appear to be based on matrix (primary) permeability and not consider secondary permeability in the model. The horizontal hydraulic conductivity (K_h) to vertical hydraulic conductivity (K_v) ratio in the model is questioned.

The model layers, in particular the interburden thickness and associated hydraulic parameters, adopted for each layer is questioned. Details of the raw data used to develop the conceptual model (particularly interburden layers between the Hawkesbury Sandstone and the Wongawilli Seam were requested to be provided so that independent verification could be undertaken. The selection of layers within the Hawkesbury Sandstone is questioned.

The community raised concerns relating to the time it takes for the aquifer to recharge during drought conditions and questioned the ability of the model to accurately predict impacts during drought if recent years had been wet in the area. The lack of metered usage in the area was raised as a concern for model calibration.

General concerns that the model may have general deficiencies due to insufficient data. Suggestions that the analysis is not justified by the data presented. Suggestions that data has been 'hidden' are made. Comments that the pumping tests, and groundwater testing in general were insufficient.

Comments that the Robertson Basalt should be considered a 'major aquifer within the southern Sydney Basin' due to its fractured nature and spring discharges.

Questions are raised about impacts to the Wongawilli Coal Seam and the concern that it is a 'significant aquifer' in the area. Clarification on how the Wongawilli Seam recharges (ie is it recharged from outcrop and will it recharge the mining void horizontally), and what long term impacts this may have.

Questions are raised on the hydraulic conductivities adopted in the EIS model. Questions as to whether these represent vertical and horizontal hydraulic conductivity. In some submissions it is suggested that the hydraulic conductivity values adopted for shale and the coal are too high, but in other submissions the suggestion is that they are too low.

Questions and concerns are raised in regard to the modelled thicknesses and hydraulic parameters of the interburden overlying the Wongawilli Coal Seam. Comments that there is no evidence that flow rates vary with depth in the Hawkesbury Sandstone.

Comments that the failure to benchmark all bores (assumed this means landholder bores) is a major deficiency in the EIS.

i Geology

The major geologies within the project area are Wianamatta Group shales, Hawkesbury Sandstone, and Illawarra Coal Measures, which includes the target Wongawilli Coal Seam. Minor geologies include the Robertson Basalt and several older igneous intrusions. The groundwater within all these formations is managed as one water source known as the Sydney Basin Nepean Groundwater Source under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources*.

The minor geologies are not considered to be significant 'aquifers' or systems in their own right and are not managed as separate water sources by the NSW Government in legislation. They are not defined as separate water sources, unlike the more significant Orange Basalt, Young Granite or Alstonville Basalt that have been designated water sources under their respective Water Sharing Plans that allows them to be managed separately.

The Robertson Basalt is a reliable perched aquifer system (but is not a major aquifer) that is recharged by rainfall then discharges locally as springs and stream baseflow. Consequently some water users rely solely on this resource and these features for their water supply. This shallow groundwater resource is disconnected from the deeper regional aquifers, and is therefore unaffected by the mine development and is not explicitly included in the model.

Similarly, the Illawarra Coal Measures and the individual Wongawilli Coal Seam are not major aquifers across the project area. Water bores always target the Hawkesbury Sandstone in preference to drilling deeper into the coal measure sediments because of higher bore yields and lower salinity water. The recharge mechanism for the Wongawilli Coal Seam includes both vertical and horizontal leakage from the overlying formations plus a component of horizontal flow within the coal seam from up hydraulic gradient areas. Horizontal flow is thought to dominate over vertical flow within the coal seam, but recharge into the Wongawilli Seam in this area initially occurs vertically.

The outcrop of the Wongawilli Coal Seam in the vicinity of Black Bobs Creek to the west of the project area is typically associated with groundwater discharge from the system and not recharge to it.

ii Berrima Mine

Data from the Berrima Mine was adopted and considered in the development of both the conceptual and numerical model for the Hume Coal Project. As discussed in Section 9.2, the Berrima mine is within the same geological unit as the Hume Coal mine, but geological settings are slightly different between Hume and Berrima, and the mining method is different. There was full pillar extraction at Berrima and consequential fracturing of overlying strata in parts of the mine, but at the Hume Coal Project there is no material overburden deformation predicted, and certainly not enough to induce any significant levels of new fracturing or opening of existing joints. Therefore, there are differences in hydrogeological characteristics (recharge, mine inflow, discharge etc), however the data and information from the Berrima Mine can still be used to assist with model calibration and provide a better understanding of hydrogeological impacts. These differences explain why up-scaling from Berrima to Hume is not linear in terms of inflow and drawdown.

The measured discharge from Berrima Mine is adjusted based on improved flow measurement methods used in later years and applied to more accurately represent the long term measured inflow volume as demonstrated in HydroSimulations (2018).

iii Model layers and thicknesses

The EIS model has six layers in the Hawkesbury Sandstone (Layers 2-7) and this is considered appropriate by the independent peer reviewer Hugh Middlemis to delineate impacts across this unit (Hydrogeologic 2017). The model layers are considered an appropriate representation of the conceptual hydrogeology at the site, and this is confirmed by Middlemis (Hydrogeologic 2017) who claims that the model conceptualisation is sound and that the "model software, design, extent, grid, boundaries and parameters form a good example of best practice in design and execution."

The Pells and Pells (2013) report did not have access to the data collected as part of the geological mapping and evaluation at the project prior to and post 2013, and relied upon a three layer conceptualisation of the Hawkesbury Sandstone that is not evident in the data collected from the project area (EMM2018b).

The EIS model layers are data driven with detailed analysis of the geological model for the area being used as the basis for the model layer thicknesses and parameters. Layers 6, 7, 8, 9 and 10 of the model (Lower Hawkesbury Sandstone and interburden above the mined coal seam) all have the same hydraulic conductivity and hydraulic parameters.

Layer 10 of the model (the layer immediately above the mined coal seam) is not a uniform thickness in the model. It is reported as having an average thickness of 2 m, but it ranges from 0.4 m to 4 m in the model (and is based on field data). On the subject of the model layers, the peer review by Middlemis (Hydrogeologic 2017) concluded:

"In summary, this review has found that the Hume Coal model has been set up with an appropriate representation of the interburden properties (e.g. appropriate thicknesses and no low permeability parameters to limit the potential connection between the coal seams and the Hawkesbury Sandstone)."

iv Model boundaries

Model boundaries are discussed and illustrated on maps in the EIS, and are selected sufficiently distant from the mine area. The model boundaries are deemed by the project peer reviewers (Noel Merrick and Frans Kalf) to be appropriate. The NSW Government independent peer reviewer, Hugh Middlemis, also agrees that the model boundaries are adequate and fit for purpose (Hydrogeologic 2017).

The model boundary along the escarpment is a discharge zone, with a line of drain cells to simulate consumption of groundwater at the escarpment by seepage and evapo-transpiration. This is the case along Black Bobs Creek, where the Wongawilli Seam outcrops.

v Stream bed elevation

Data used for the stream bed elevations is derived from high resolution (2 m digital elevation model) LIDAR captured data.

vi Relaxation height

The model audit considered the relaxation height of strata immediately overlying the mined coal seam. The model audit and independent peer review raised some questions on how the layers accommodate roof relaxation, which was to a maximum of 2 m, but only if the immediate overlying layer was sufficiently thick. This has been addressed in the revised model, which extends the roof relaxation zone to 2 m in all locations, regardless of the layer thickness.

vii Initial heads

The initial heads in the model are estimated using a nominal 32 year period of data. This dataset generated for initial starting heads is compared to actual levels in monitoring bores in 2011. The effect of initial conditions is not further assessed in the model. Initial heads in landholder bores across the project area could not be measured due to an inability to survey most properties. The DI Water database cannot be used to determine initial heads in water bores due to the extremely variable time scale for the data (ie over decades and different climatic conditions) and the inability to quality assure or check the validity of the standing water level data at the time of bore completion.

A detailed landholder bore census was proposed and attempted for the project, but without landholder consent this was not possible to complete. Regardless, the initial heads, as produced in the model from the expansive monitoring network, are considered more than adequate for model calibration. It is acknowledged that the starting point for drawdown as predicted in landholder bores will be important for determining mitigation and management (ie 'make good') options. This data will be collected post EIS approval if landholders are willing to work with Hume Coal on collecting baseline (pre-mining) water levels so that drawdown impacts (during mining) can be properly assessed and appropriate 'make good' options proposed.

viii Climate

The assessment of 'impact' from mining needs to consider the difference in water levels/water quality with and without the mine irrespective of climate; hence, the use of average climate is appropriate for this purpose. This is not to say climate variability is not considered, it is. Consideration of climate (both wet and dry periods) is included in the model as climate sensitivity analysis. Climate considerations are important and considered in detail for surface water, however, it is not as critical for large groundwater systems with a high storage volume to recharge volume ratio, and where project impacts are largely the same for groundwater, irrespective whether climate is wetter or dryer than average.

In extended dry periods, groundwater levels will be depressed and this is often due to increased pumping and not necessarily just lower rainfall recharge. Access to groundwater is still available given the large storage to recharge ratio for the groundwater source; however, shallow bores occasionally need to be deepened. Landholders pump more groundwater due to the lack of rain and less surface water availability; this increased landholder extraction occurs irrespective of whether the mine is operating or not. With lower water levels there may be slightly lower inflows to the mine compared to average and wet seasons. The typical experience for other mines in the Southern Coalfield is that slightly higher inflows are experienced during and immediately after rain.

The natural groundwater baseflow contribution to surface water systems in dry periods is also lower due to depressed groundwater levels, and the model predicts that the mine's impact to baseflow (in terms of volume removed from the system) is less in dry periods than in wet periods.

Drought conditions were experienced in the area during much of the climate record period used for calibration (with the average climate statistics based on data between 1889 and 2014). Therefore, both wet and dry periods are already considered as they are included as part of the baseline data set for the model calibration.

ix Rainfall recharge

Rainfall recharge for this area was suggested in Pritchard (2004) to be 5% for exposed sandstone and 0.5% for non sandstone areas. The Berrima Mine is located mostly beneath exposed sandstone, with very little shale in the area. The Hume Coal mine model is approximately 50% exposed sandstone and 50% shale cover so it stands to reason that the rainfall recharge percentage across the Hume Coal model area will be slightly lower than the value adopted for the Berrima Mine model.

Rainfall recharge adopted in the EIS model (1.8%) is based on literature reviews, hydrograph analysis, and nearby mine data. No change to the rainfall recharge was considered necessary for the revised model as the value was constrained by calibration to baseflows.

x Hydraulic conductivity

Field data for aquifer parameters was derived from various methods, locations and depths across the project area. Different field testing methods provide different data, and therefore the results and testing methods need to be carefully analysed and considered holistically prior to selecting final model parameters. Hydraulic testing (including: in-situ pumping and packer tests at bores across the project area; data from core laboratory tests; and specific capacity data from government records) has been presented and allows for a comprehensive assessment of hydraulic conductivity (K) for the different hydrogeological units across the project area (Coffey 2016a).

The final parameters for the model are based on field data and logical hydrogeological principles. The independent peer review of the model considered the field approaches and the data used to inform the final adopted hydraulic conductivity and other aquifer parameters to be suitable (Hydrogeologic 2017).

Compared to similar projects, the volume of hydraulic testing and field data for the Hume Coal project is robust and more than adequate, and the methods and number of tests undertaken is comparable to similar mining projects across NSW that have been approved in recent years (refer to Table 9.2).

Table 9.2 Mining project comparison of on-site hydraulic testing

Project	Stage	Date	Airlift tests	Slug tests	Packer Testing	Laboratory Core permeability	Pumping tests	Notes
Wallarah 2 Coal Project	EIS (approved)	2018	-	16 bores	170 tests (31 bores)	59 samples		
Rocky Hill Coal Project	EIS (refused)	2017	-	15 bores	-	-	-	Also reference data from nearby investigations (AGL)
Wilpinjong Extension Project	EIS (approved)	2017	-	y	-	y	y	Reference to tests but no details on locations and number of tests
Drayton South Coal Project	EIS (refused)	2017	-	3 tests				References numerous historical tests but no details on location on number of tests
Airly Mine Extension Project	EIS (approved)	2016	-	5 bores	9 tests (9 bores)	-	1 test	
Nyngan Scandium Project	EIS (approved)	2016	-	-	-	-	1 test (36 hr)	
Mount Owen Continued Operations Project	EIS (approved)	2016	y	y	y		y	Reference to tests but no details on locations and number of tests
Balranald Mineral Sands	EIS (approved)	2016	-	-	-	-	Numerous tests (6 hr to 48 day)	Testing focused on reinjection trials. 4 tests (6 hr); 7 tests (15 hr - 7 day); numerous injection/production bores (48 day)
Warkworth Mt Thorley Continuation Project	EIS (approved)	2015	-	6 bores	y	-	-	Packer testing referenced - details not provided
Mandalong Southern Extension Project	EIS (approved)	2015	-	-	5 tests (1 bore)	-	-	Reference to other tests but no details on locations and number of tests
Springvale Mine Extension project	EIS (approved)	2015	-	y	22 tests (2 bores)	-	y	Reference to numerous slug and pump tests - appear to be at one bore
Tasman Extension Project	EIS (approved)	2013	-	23 tests (historical)	9 tests (1 bore)	10 samples (historical)	3 (historical)	
Chain Valley Colliery Mining Extension 1			-	-	-	y	-	Cores analysis from other local projects referenced - no details of number of tests
Springvale Western Coal Services	EIS (approved)	2014	-	2 bores	-	-	-	Reference to hydraulic properties derived from 2 other studies in the area (undefined sources)
Atlas-Campaspe Mineral Sands Project	EIS (approved)	2014	-	-	-	-	1 test	
Vickery Coal Project	EIS (approved)	2014	-	9 bores	-	29 samples (5 bores)	Low flow CRT at 4 bores	Reference to hydraulic properties derived from 2 other studies in the area
Bulga Optimisation Project	EIS (approved)	2014	-		63 tests (11 bores)	37 samples (2 bores)		Reference to hydraulic properties derived from prior modelling

Table 9.2 Mining project comparison of on-site hydraulic testing

Project	Stage	Date	Airlift tests	Slug tests	Packer Testing	Laboratory Core permeability	Pumping tests	Notes
Watermark Coal Project	EIS (approved)	2015	31 recovery tests	82 bores	60 tests (12 bores)	59 samples (8 bores)	8 tests	
Stratford Extension project	EIS (approved)	2015	-	5 bores	-	31 samples (5 bores)	1 test (6 days)	Reference to hydraulic properties derived from other studies in the area
Hume	EIS (RTS)	2017	-	42 bores	28 tests (3 bores)	39 samples (16 bores)	2 test locations (one 24hr, one 72hr)	

Notes:

1. Information sourced from a review of Groundwater Assessments for EIS (for projects where a determination has been reached).
2. Details only provided for tests performed as part of the EIS Groundwater Assessment.
3. In addition, most projects reference hydraulic properties derived from literature review of historical or neighbouring site studies.

Due to the quantity of the data gathered for the project, data analysis is summarised in graphs and figures in the EIS reports and appendices. Hydraulic conductivity data considered for the Hume Coal EIS model is presented in Figure 9.7 (from Coffey 2016a), which compares all data (including nearby studies, Government records and Hume Coal baseline data), and testing methods, against the depth below ground.

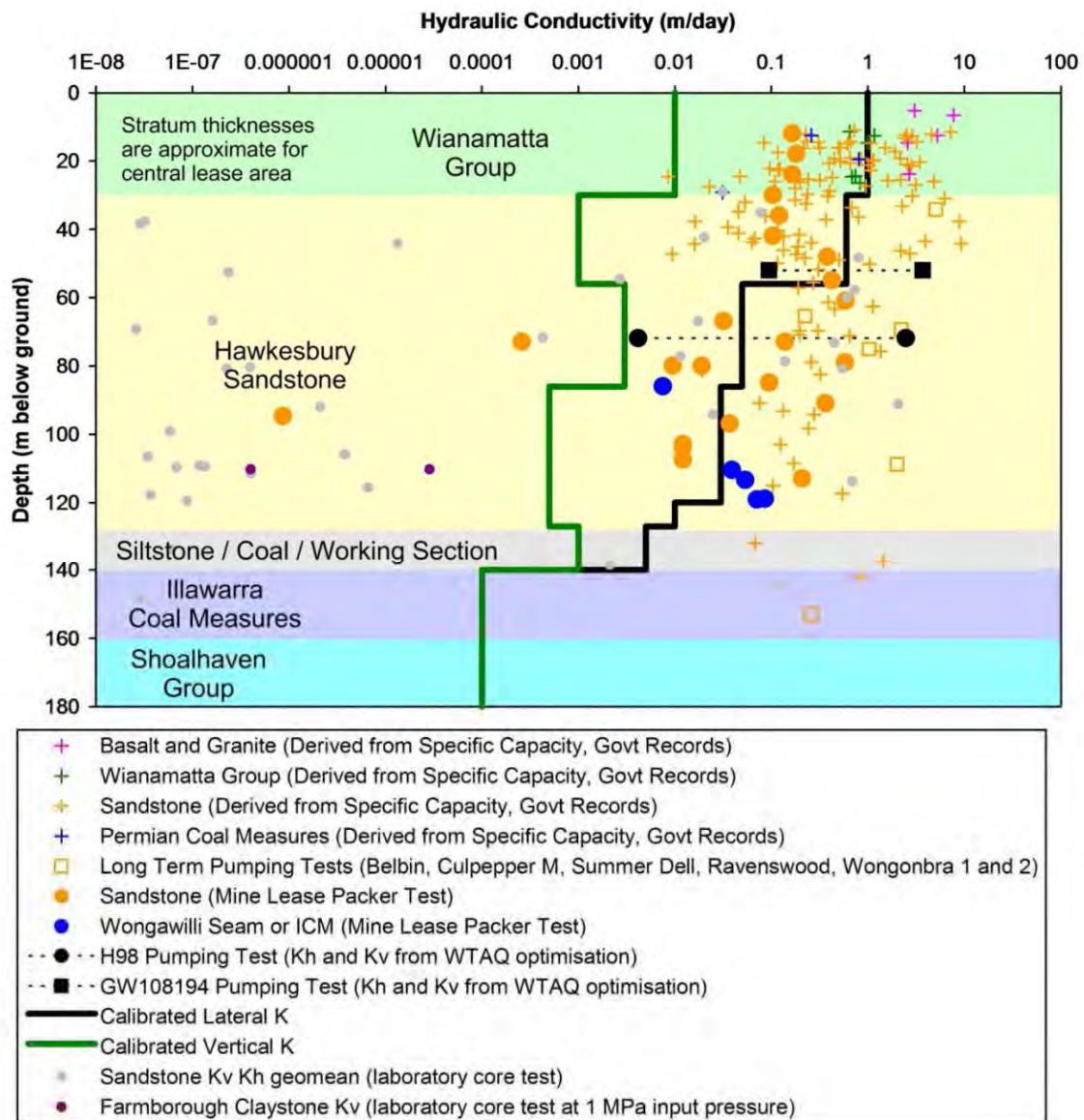


Figure 9.7 Comparison of measured versus calibrated hydraulic conductivity (from Coffey 2016a)

The data presented in Figure 9.7 clearly shows a decreasing trend in hydraulic conductivity with depth in the Hume Coal project area and this part of the Southern Sydney Basin. The EIS numerical groundwater model has adopted parameters within the ranges of measured data for each depth, from the variety of tests undertaken. The Hume Coal EIS model adopted parameters for horizontal and lateral hydraulic conductivity are also illustrated on Figure 9.7.

The hydraulic conductivity values used in the model have been reviewed again and considered within the model audit review, model rework and the independent peer review by Hugh Middlemis. Some submissions suggested the hydraulic conductivity values used for the coal and shale layers in the model were too high, and other submissions suggested it was too low for the coal seams, interburden and Hawkesbury Sandstone. Hydraulic conductivity values adopted by Pells and Pells (2013) are not supported by regional data or sufficient pumping test analyses. Their model conceptualisation relies heavily on a three layer stratification of the Hawkesbury Sandstone that is not supported by data from drilling and testing programs undertaken across the Hume Coal site. There is no evidence of a consistent high hydraulic conductivity layer in the lower Hawkesbury Sandstone from the field investigations, and therefore there is no justification for inclusion of such in the Hume Coal model.

After a more detailed review of the model parameters used in the model, the parameters are considered appropriate for this impact assessment phase of the project. The independent peer review by Hugh Middlemis also agrees that the parameters are appropriate (Hydrogeologic 2017).

The ratio between the vertical and horizontal hydraulic conductivity was reviewed as part of the model audit, revision peer review, and uncertainty analysis. The values used and subsequent ratios are considered to be appropriate as they are based on field data and literature review, and have been peer reviewed. The uncertainty analysis looked at this aspect in detail and concluded that the original EIS model was indeed very accurate, and this aspect has also been peer reviewed and agreed by Middlemis (Hydrogeologic 2017):

“The modelled Hawkesbury Sandstone Kh values are reasonable in that they lie in the middle of the range of observed values (Figure 9.7); clearly not at the high end of the range as suggested by Pells [and Pan] (2017), but also not at the low end of values (mainly from core testing, indicated by grey dots in Figure 9.7). Most of the pumping tests on individual bores (open square symbols in Figure 9.7) do indicate higher range Kh values, but that is for tests mostly in the higher elevations of the Hawkesbury Sandstone, including the two tests on bores on the Hume lease (H98 and GW108194 indicated by the solid black symbols). Again, the model reflects this effect of higher Kh in shallower units. The exception is the high Kh for the (un-named) bore at about 110m depth.”

It is understood that there is some dispute regarding reduced hydraulic conductivity with depth, which is driven by the high yields often associated with deeper water bores. Claims by community that there is “no evidence that flow rates change with depth” is noted. It is proposed that irrespective of the stated flow rates in bores (which is not physically measured in most instances), the permeability (which is specifically measured) clearly does decrease with depth based on available data for the project, and peer reviewed studies elsewhere in the southern Sydney Basin.

This field observation of higher yields in deeper bores is not disputed, but these yields are due to the interception of secondary permeability (fractures), and the deeper the bore the more chance additional fractures are intercepted. There is also suspected bias in the water bore dataset with over estimated yields of deep bores based on airlift tests, and under reporting of low yield bores and failed bores. Locally high bore yields are encountered with depth, but regionally, the hydraulic conductivity data suggests that on average, the deeper portions of the Hawkesbury Sandstone are mostly lower hydraulic conductivity.

Subsequent to the EIS model, there was a very detailed uncertainty analysis undertaken on the horizontal hydraulic conductivity and the ratio between horizontal and vertical conductivity (Section 9.3.5 (iii)). The revised groundwater model (HydroSimulations 2018) also considered spatial variability of hydraulic conductivity. Results are provided in the Revised Water Assessment (Appendix 2). The model considers measured permeability from field data and predicts a more regional overall impact from the mine (ie not per individual fracture or panel inflow). This approach is appropriate to predict the overall yearly mine water inflow and also to predict drawdown and depressurisation of the regional groundwater system.

The specific storage values adopted in the EIS model (Coffey 2016b) were questioned in some submissions, which stated that these values were inconsistent with pumping test data and outside the bounds of what was physically possible for the aquifer material present in the area of the Hume Coal Project. Comments from interest groups that values used were 'not appropriate', 'too low' or 'mathematically untenable' are disputed by Hume Coal. The specific storage values adopted in the EIS model (Coffey 2016b) are supported by literature review.

A detailed analysis of specific storage was therefore undertaken as part of the post EIS model audit by Noel Merrick (HydroSimulations 2018). The values were also varied and underwent sensitivity analysis in the model; and the predictive impacts were found not to be overly sensitive to these values. Changes to these values did not greatly impact the mine inflow volumes or the drawdown in landholder bores.

A replication of the figure from the interest group submission was undertaken where the storage values are challenged as being not mathematically possible (refer to Figure 9.8). Consideration of the Poisson's Ratio found that the values used for the Hume Coal model were consistent with literature values (represented as orange symbols in Figure 9.8), incompressible values (represented as red symbols in Figure 9.8) and pumping test results (represented as yellow symbols in Figure 9.8). This demonstrates that the values adopted in the Hume Coal model are appropriate.

Despite the specific storage values being deemed suitable, in the revised model these parameter values were increased to align more closely with the pumping test results and to ensure that concerns raised in the submissions process were duly considered. The overburden, coal seam and basement model layers (Layers 6 to 13) underwent a multiplication of the original specific storage values by a factor of 4 while shallower Hawkesbury Sandstone layers and shale layer above (Layers 1 – 5) were increased by a factor of 3. The values adopted within the model revision are now much closer to the average optimised value provided by the pumping tests.

Increasing the specific storage values made no practical difference to the SRMS statistic or the RMS statistic within the revised calibration model. However, the updated values are more closely aligned to field measurements and are therefore retained in the revised model.

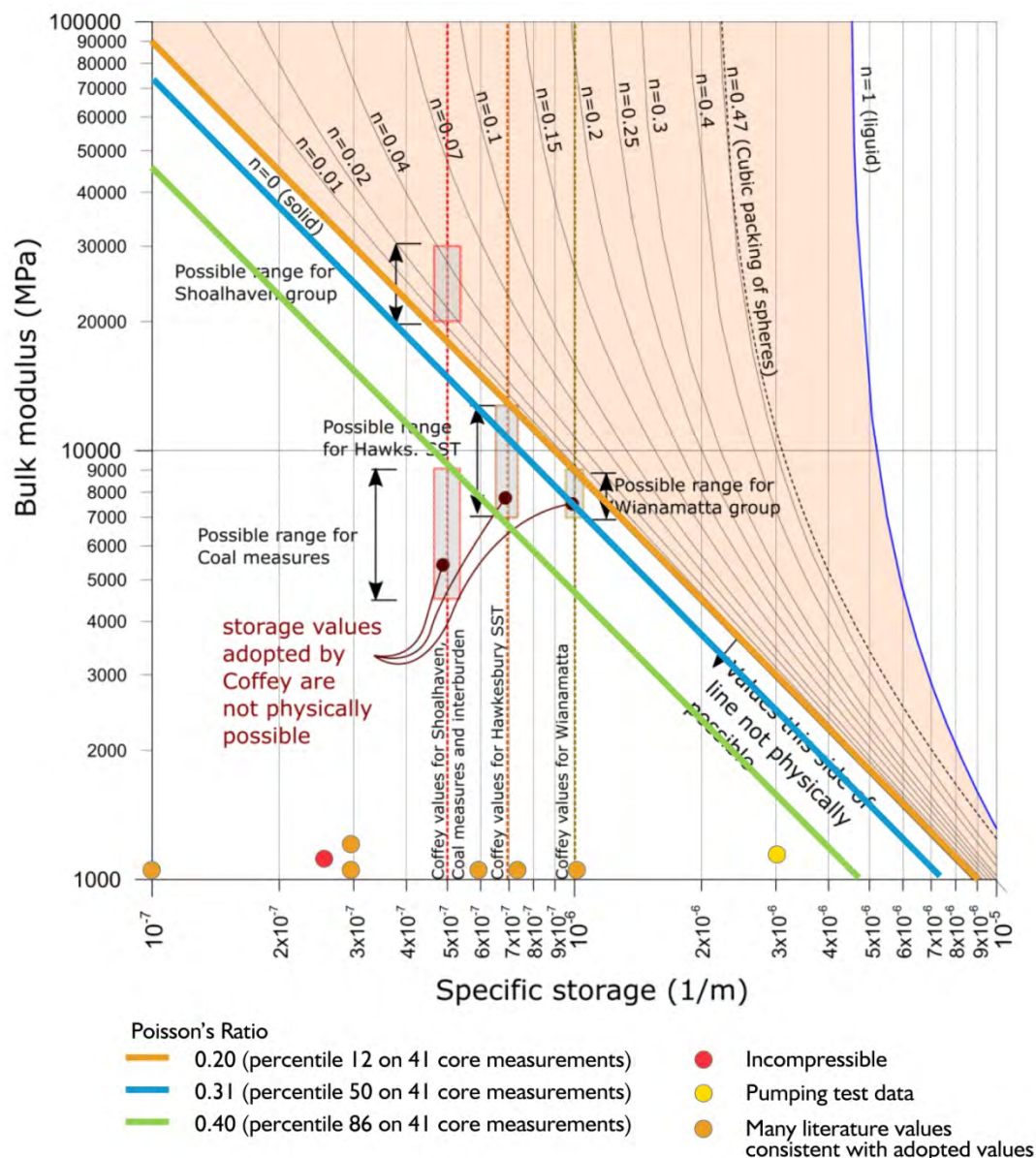


Figure 9.8 Comparison of adopted versus theoretical storage values (revised from Figure 2.8 of Pells and Pan (2017))

xii Mass balance

The reported mass balance and concerns raised in regard to it were considered by NSW Government independent peer reviewer Hugh Middlemis (Hydrogeologic 2017). His concluding comments on this were:

"The reported water balance "discrepancy" is not indicative of fundamental flaws in the Hume Coal model, contrary to review comments from DPI Water (2017) and Anderson (2017), and hence their downgrading to a Class 1 model confidence level 1 is invalid. Accordingly, any criticisms based on this invalid premise are not necessarily valid."

Re-running the EIS model with updated solver settings in MODFLOW USG - SURFACT V4 yielded a much lower mass balance error than reported in the EIS groundwater model. Table 9.3 shows a direct comparison between the reported mass balance percentages for the EIS model and the model re-run conducted by HydroSimulations.

Table 9.3 Comparison of cumulative mass balance errors

Model Run	Cumulative Percent Discrepancy	
	EIS model (Coffey 2016b)	EIS model Re-Run (HydroSimulations 2018)
Calibration	-3.8	-0.18
Prediction	-27.6	-0.16

xiii Drain conductance

The drain conductance values used in the EIS model (Coffey 2016b) underwent sensitivity analysis in the original EIS model. The model revision (HydroSimulations 2018) also considered the drain conductance and undertook further sensitivity testing. The results of the sensitivity analysis demonstrate that the model is overall not particularly sensitive to changes in mine drain conductance.

The independent peer reviewer, Hugh Middlemis, provides commentary on the applicability of the 'drain' feature in the Hume Coal model (Hydrogeologic 2017) stating:

"The Hume Coal model applies the "Drain" feature of MODFLOW to simulate groundwater inflows to the mine workings (a standard methodology); see also Figure 3 (later). The drain feature involves a conductance parameter that acts as a resistance to flow (i.e. lower values of conductance require higher groundwater levels to result in the same amount of inflow)."

"The Hume Coal model history match calibration involved adjusting the drain conductance parameter to match the mine inflow and groundwater level data at the Berrima mine for a period of significant climate variability in recent years. The approach required simultaneous matches to stream baseflows, and is a good example of a best practice method that minimises nonuniqueness issues and supports a model Class 2 confidence level. The method justifies the drain feature conductance parameters applied to Berrima conditions. The application of the calibrated conductance parameter to Hume conditions involved appropriate adjustments to account for the different model cell size at Hume compared to Berrima."

"Pells [and Pan] (2017) and Anderson (2017) contend that the drain conductance parameter value is calculated incorrectly and is very low, with the implication that mine inflows may be underestimated. The modelling guidelines (Barnett et al. (2012), section 11.3.5) state the following: "Conductance as a model parameter cannot be measured directly. It is a surrogate for the combination of hydraulic conductivities and geometries that occur in the near field of the water body. A number of analytical solutions give guidance for this kind of conductance, but values are generally either assumed or chosen during model calibration." While this statement is made in the usual context of a model drain feature representing a water body, it is also applicable to a mine inflow feature. The analytical solutions mentioned include the methods applied by Pells to incorrectly infer that the mine workings are "sealed or surrounded by a thick layer of compacted clay" with an equivalent hydraulic conductivity of 2×10^{-5} m/d. Such an analogy may be hypothetically valid if one accepts the riverbed conceptualisation, but this review finds that concept is not applicable in this case, and is inferior to the best practice history match calibration methods applied to the Hume Coal model."

The drain conductance values adopted in the model and the model rework are considered appropriate and 'fit for purpose', providing an accurate representation of the impacts of the project on both water level drawdown in bores, the water table and groundwater inflow to the mine workings.

The presentation of analysed data is undertaken in accordance with requirements of the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), and in accordance with best practice. The NSW Government independent peer reviewer, Hugh Middlemis, concludes that the reporting quality could be improved (Hydrogeologic 2017). These comments have been considered carefully and improvements have been made in the revised model reporting by Hydrosimulations (2018) within the revised water assessment (Appendix 2). The revised model report provides additional detail and explanation on key model inputs, provides additional figures and addresses the independent peer reviewer concerns regarding reporting and presentation of input data.

The raw data files, model files and all information used to develop the conceptual and numerical models has been made available to the NSW Government independent peer reviewer. It is not a requirement that this same information be made available publically, and/or provided to known objectors of projects in NSW.

Concerns from the community that the model “may have deficiencies” are noted. Hume Coal is confident the model is robust and accurately reflects the likely impact of the mine on the groundwater systems across the area. Independent peer review by Hugh Middlemis (Hydrogeologic 2017) concluded:

“.... it is my professional opinion that the Hume Coal model is fundamentally consistent with best practice in design and execution, although the EIS documentation is deficient (not sufficiently clear on some details; see Appendix A). It is fit for mining project impact prediction purposes.”

9.3.5 Accuracy

i Baseflow

Concerns raised by NSW DPI, OEH and WaterNSW on baseflow interception, and that further assessment is required. In particular the use of steady state predictions of baseflow interception will underestimate baseflow losses and water table decline during drought. The baseflow analysis was undertaken at four sites, but only reported at two, and the results or reason why this data is not presented is requested.

The nature of the perennial/ephemeral boundaries and how they might change as a result of the project is questioned.

Concerns regarding reduced baseflow and/or leakage from Medway Dam were raised by WaterNSW.

Community concerns were mostly related to impacts to overlying surface water resources from groundwater drawdown, and the risk it presents.

The baseflow assessment benchmarked rainfall records against baseflow for consistency. The baseflow analysis indicates that annual baseflow to drainage channels is estimated to be 1.5% of annual rainfall for the project area. However, the local geology, topography and hydraulic gradients surrounding the streambed influence baseflow contributions. Most baseflow contribution from the regional Hawkesbury Sandstone occurs in lower catchment areas where permanent streams are incised into the sandstone. Baseflow from the Hawkesbury Sandstone landscape was calculated to be around 3% of annual rainfall. Baseflow from the Wianamatta Group shale landscape is lower and was calculated to be 1-1.5% of annual rainfall. Basalt has significantly enhanced baseflow capacity compared to the sedimentary rocks and but is not quantifiable because of the many small ungauged catchments (Coffey 2016a).

Baseflow analysis was undertaken at five sites in the immediate project area, four additional sites in adjacent catchments, and a comparison basalt site from northern NSW (to provide context for the significantly different results due to the change in geology from sandstone to basalt). Results are provided in Table 9.4. Data from additional sites (Hume Coal monitoring sites) within the immediate project area were considered, but an insufficient period of record and/or data gaps rendered this information unsuitable to use in the baseflow analysis.

Table 9.4 Results of baseflow analysis – Hawkesbury-Nepean catchments and northern NSW (after Coffey 2016a)

Gauge	Catchment Area (km ²)	Time Period		Averages over period (ML/day)		Average annual rainfall over period (mm)	Average Flows as a proportion of rainfall	
		From	To	Baseflow	Total Flow		Baseflow	Total Flow
SW04 (Medway Rivulet at the Hume Highway)	61.7	27-Feb-12	20-Aug-15	3.2	131.3	1178	0.016	0.598
212009 (Wingecarribee River at Greenstead)	599.0	1-Jan-90	31-Dec-02	25.2	139.2	710	0.021	0.113
212031 (Wingecarribee River at Bong Bong Weir)	136.9	1-Jan-90	31-Dec-02	11.5	73.5	874	0.033	0.213
212272 (Wingecarribee River at Berrima)	200.6	1-Jan-90	31-Dec-02	12.4	95.9	831	0.026	0.199
212274 (Caalang Creek)	6.1	1-Jan-88	31-Dec-02	8.1	14.2	1476	0.328	0.571
212238 (Nepean River at Menangle Weir)	1311.5	1-Jan-91	31-Dec-06	30.0	341.0	864	0.010	0.110
213200 (O'Hares Creek at Wedderburn)	73.1	1-Jan-62	31-Dec-01	7.0	81.1	1269	0.028	0.319
212209 (Nepean River at Maguires Crossing)	69.3	1-Jan-72	31-Dec-01	28.5	110.1	1552	0.097	0.374
212053 (Stonequarry Creek at Pictou)	87.9	1-Jan-91	31-Dec-01	1.1	14.9	754	0.006	0.082
203012 (Byron Creek at Binna Burra)	39	1-Jan-53	31-Dec-02	37.6	114.3	1870	0.188	0.572

The water assessment for both groundwater and surface water has specifically considered and focused on understanding groundwater and surface water interconnectivity, and changes to this relationship as a result of the project.

The majority of the streams in the area are (in time and location) gaining systems. That is, the water table is at a higher elevation than the stream stage, and therefore groundwater supplies baseflow to streams. Some are gaining as a result of shallow groundwater which may also be perched and/or disconnected to the underlying regional groundwater system. In systems that are gaining from a perched or disconnected shallow groundwater system, a reduction in the deeper regional groundwater systems will not impact the baseflow contribution to the overlying stream.

Streams gaining from the regional groundwater systems are noted in the western part of the project area, where surface spring flows directly from the sandstone escarpments to the nearby surface water creeks can be observed.

During the project's operation, the gaining streams will mostly remain as gaining streams; so, although there is a reduction in baseflow, the groundwater system still continues to supply baseflow to streams. A small percentage of gaining streams will experience slightly decreased levels of baseflow contribution compared to the pre-mining conditions (this may occur in those streams gaining from the regional groundwater system). Streams gaining from perched or shallow systems are unlikely to be impacted.

Changes to surface water flows are negligible overall. The dominant reason for any change is a slightly reduced volume of baseflow from the groundwater source to streams.

The maximum rates of baseflow reduction as a result of the project for each management zone are shown in Table 9.5. These figures are based on the 67th percentile uncertainty analysis results, so are considered conservative and likely to over-estimate actual baseflow impacts. The 67th percentile is provided to demonstrate the likely worst case. It is important to note that streams are generally gaining streams (ie receiving groundwater baseflow) and although during mining they will experience a reduction in this level of baseflow they will mostly still receive baseflow during this mining period (ie remain as gaining streams).

The maximum rates of baseflow reduction are not consistent throughout the mining period, and the time taken to reach the maximum rate for each management zone is listed in Table 9.5. The timing and duration of baseflow impact for each management zone is presented in Figure 9.10. It can be seen that the rate of baseflow reduction gradually increases at the Medway Rivulet water source to a peak in year 19 (which is illustrated in the Table 9.5 and Figure 9.9). A sharp decline in baseflow reduction occurs after years 20 (ie 20 years from start of mining and following cessation of active mining).

The Lower Wingecarribee River and the Medway Rivulet surface water sources are predicted to have the highest sustained rates of baseflow reduction.

The average Medway Rivulet baseflow rate estimated from baseline monitoring data is 3.3 ML/d at SW04 during average rainfall conditions (Coffey 2016b). This is more than three times larger than the predicted maximum rate of baseflow reduction (0.961 ML/d). The model results suggest the reduction in baseflow in the Medway Rivulet will be a minor proportion of the total baseflow for the whole management zone and is, therefore, unlikely to be measurable, or to influence other users of the surface water source, during a range of climate conditions (Coffey 2016b).

The predicted drawdown in the groundwater regime due to the mine would extend beyond the 19 years of active mining activities but would decrease progressively, mitigated by rainfall and runoff.

Table 9.5 Maximum rate of baseflow reduction from surface water sources

Surface water management zone / sub-catchments	Overlying groundwater source	Maximum rate of baseflow interception (ML/d)		Time to maximum rate (years since start of mining)
		ML/d	ML/year	
Upper Wingecarribee River	NMZ1	0.008	3	42
Lower Wingecarribee River (whole zone)	NMZ1, NMZ2	0.254	93	22.5
Medway Rivulet (whole zone)	NMZ1	0.982	359	19
Lower Wollondilly River	NMZ1	0.008	3	76
Nattai River	NMZ1, NMZ2	0*	0*	-
Bundanoon Creek	SBS	0.007	3	64

Notes: NMZ1 – Sydney Basin Nepean Groundwater Source Nepean Management Zone 1.

NMZ2 – Sydney Basin Nepean Groundwater Source Nepean Management Zone 2.

SBS – Sydney Basin South Groundwater Source.

* – negligible

ii Leakage from surface water

The NSW DPI stated that reporting of predicted losses from Medway Dam is not clear.

As discussed above, the overall changes to surface water flows are negligible. The main cause of surface water flow changes is a slightly reduced volume of baseflow. Streams will continue to be gaining streams and continue to receive baseflow (but at a slightly lower rate). There is a minor component of direct leakage from Medway Dam to the underlying groundwater system during and immediately following mining. These losses are considered in detail via the development of a localised model simulation and data analysis undertaken for Medway Dam. This local model ensured that the connectivity at the local scale was being considered at a local scale, and not totally reliant on the more regional model. In this localised model, based on flux analysis, there is a reversal of status from a gaining (ie baseflow reduction) to a losing system (ie leakage) at about 10 years since start of mining directly underlying Medway Dam.

The reduction in baseflow is considered within the overall reduction numbers for Medway Rivulet, and the additional leakage volume is a small percentage from the dam itself, when the groundwater table is lowered below the base of the dam (ie year 10). This leakage volume is calculated as an average leakage of 12 ML between years 11 and 35, and a peak of approximately 19 ML in year 21 since start of mining. The leakage volume over time is provided below in Figure 9.9.

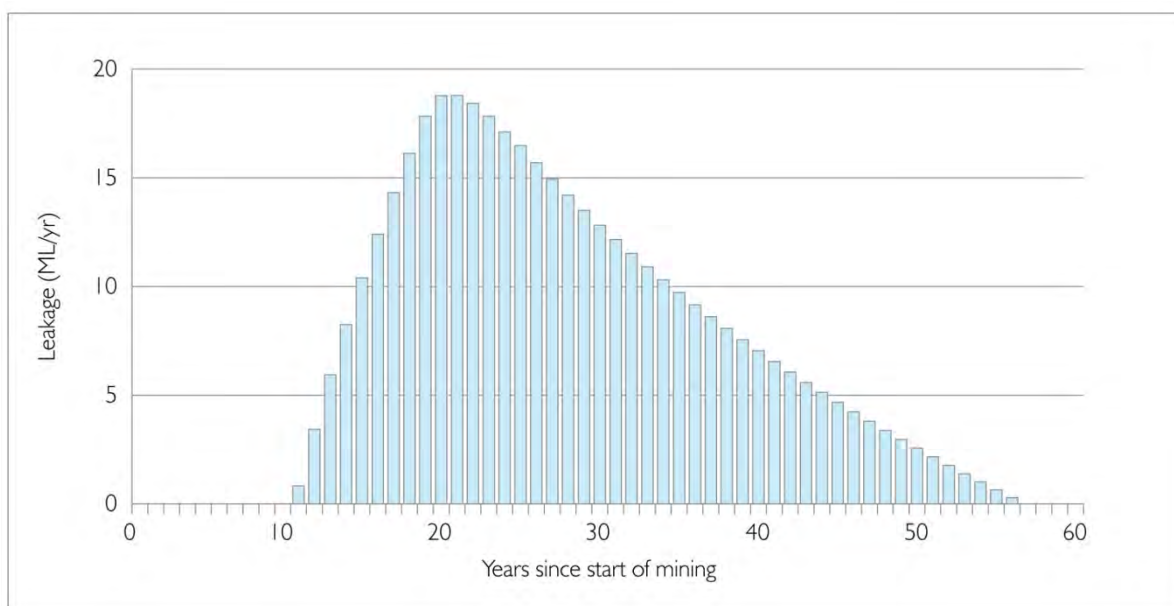


Figure 9.9 Volume of surface water leakage over time

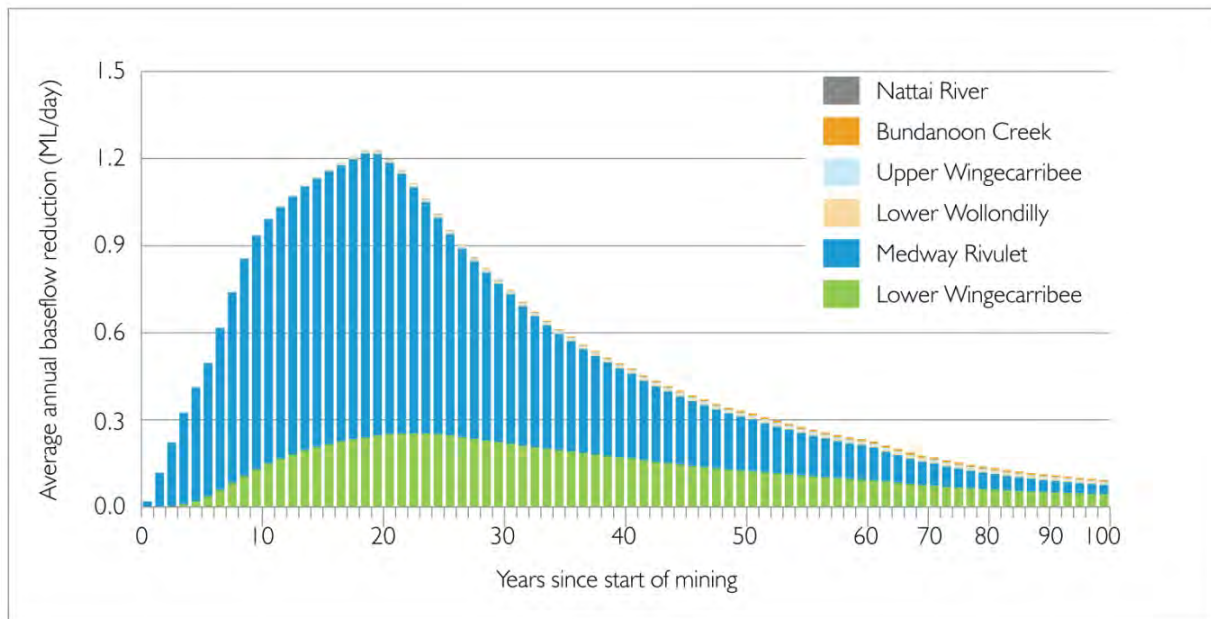


Figure 9.10 Timing and duration of baseflow impact for each management zone

iii Sensitivity

NSW DPI (including DI Water) comments that the sensitivity analysis was not sufficiently comprehensive in that it only tests three model parameters being height of drainage above the mine void's, vertical hydraulic conductivity and the mine void drain conductance. The suggestion is that additional sensitivity be undertaken on horizontal permeability, storativity, boundary conditions, drought periods, initial conditions, stresses and conceptualisation of the sub vertical flow barrier under the basalt.

Further consideration and the sensitivity of the model with respect to landholder pumping was also requested.

Concerns that the model used an approximate mine water balance that then was used to refine the water balance is a potential source for uncertainty and error.

Concerns that the sensitivity analysis in respect of drought (ie worst case) testing of the groundwater model should be undertaken.

Lack of sensitivity analysis is a concern held by most interest groups. Concerns that the parameters used appear 'insufficiently justified and significantly inconsistent' with site field measurements, and are therefore not sufficient to predict impacts. Concern was raised that the parameter sensitivity analysis was not taken far enough in the EIS model.

Interest groups were concerned that the alternate model by Pells and Pan (2017) predicts larger impacts, and predicts that the drain conductance should be the most sensitive parameter in the model and they suggest the need for this to be examined, reported and resolved. Interest groups stated that the hydraulic conductivity values in the EIS model appear to be far too low, and that this needs to be substantiated, and/or supported by detailed field data.

Interest groups maintained that insufficient sensitivity testing on the drain conductance was undertaken in the model. Concerns that no additional maps showing the sensitivity results were provided showing changes to drawdown in landholder bores.

Interest groups also have concerns that in the sensitivity analysis undertaken did not vary the values sufficiently, and that sensitivity should be more robust in those layers with limited data (such as layers 6-10).

The lack of presentation of all additional results and maps from sensitivity runs was also raised, and that the model allegedly does not test sensitivity to the inherent uncertainty from within the overall mine water balance.

Interest groups requested more discussion on the inclusion or not of pseudo soil and how that is considered in the model.

Some businesses were concerned that the sensitivity analysis, although undertaken, was not reported on in the EIS. They also stated that the range of different drawdown/number of bores not reported in EIS for sensitivity analysis.

Community concerns largely aligned with the NSW Government and interest groups. They claimed that insufficient sensitivity analysis in the EIS model and in particular lack of sensitivity on the drain conductance has been undertaken.

Sensitivity analysis involves changing a model parameter by a small amount to establish how model predictions are affected by that change. In the EIS model, sensitivity analysis was applied to relaxation heights, vertical hydraulic conductivity, and drain conductance into the mine. The model audit and peer review by Middlemis (Hydrogeologic 2017) did recommend that additional sensitivity/uncertainty scenarios should be considered and this was part of the revised modelling. In the revised EIS modelling, sensitivity analysis was applied to:

- climate variability;
- specific storage;
- specific yield;
- water level recovery; and
- drain conductance.

The results of the original EIS model three parameter sensitivity analysis reported in the EIS were as follows:

- relaxation height of 2 m and 4 m. These heights were applied over an area representative of the typical extent of an actively draining area at an instant in time (about 11 km²). Results indicated an increase in inflow of 4.3%.
- Kv distributions as follows:
 - The calibrated Kv distribution (listed in table 3).
 - Calibrated Kv of model layers 1 to 5 (see Table 3) multiplied by 3. These layers comprise the Wianamatta Group and Hawkesbury Sandstone between the water table and the mine workings.

The higher Kv case produces an overall 28% increase in mine inflow. Inflows are considered sensitive to the Kv distribution, in comparison to other parameters.

- Hume mine drain conductance of 0.05m²/d (calibrated) and 0.1 m²/d. Only a comparatively small change in inflows occurs between these two cases. (Coffey 2016b).

Following receipt of submissions there were clear concerns regarding some parameters and whether these were sensitive to numerical model predictions. Therefore, Hume Coal committed to do additional sensitivity analysis and this followed the model audit and the independent peer review by Hugh Middlemis (Hydrogeologic 2017). Consultation with the NSW Government (DI Water) occurred in August 2017, and additional sensitivity and uncertainty modelling was discussed and agreed at that meeting.

The sensitivity analysis in the EIS model focused on the key areas of known sensitivity and uncertainty in the data and provided efficiency to the modelling process. As part of the submissions on the Hume Coal Project and subsequent consultation with the NSW DI Water, it was agreed to undertake some additional sensitivity runs for the model. Apart from the investigation of specific storage and specific yield values, additional sensitivity analysis has been conducted by HydroSimulations (2018) on the Modified-EIS model for:

- specific storage;
- specific yield;
- simulations with or without the **pseudo soil function**, which found that the pseudo soil function is required to be enabled in order to allow calibration convergence of the Modified-EIS model;
- simulating Hume Coal Project mining with a **drain conductance** increased by 1 order of magnitude. This indicated that the calibrated drain conductance applied in the EIS Model is considered appropriate and fit for purpose; and
- a simulation testing the efficacy of the Horizontal Flow Barrier by removing the drain cells associated with the simulation of the basalt body south of the Hume Coal project area. The simulation found the representation of horizontal flow barriers within the EIS Model is considered appropriate and fit for purpose.

It is known that hydraulic conductivity is an important parameter in the model, so additional sensitivity on it was not required, instead it was subject to a rigorous uncertainty analysis in accordance with the draft explanatory note published by the IESC on uncertainty analysis (discussed in Section 9.3.5 (iii), and presented in detail in the Revised Water Assessment (Appendix 2), and the revised model report (HydroSimulations 2018).

iv Climate variability

In accordance with standard practice, the EIS model predictions were based on average rainfall due to the impact assessment needing to determine the climate impacts with and without project. The use of average climate conditions for the model is considered appropriate. However, as requested by DI Water, scenario analysis has been conducted on the model using the same 108 climate sequences adopted for surface water modelling.

The results of the sensitivity analysis on climate variability in the number of bores affected by more than 2 m drawdown and mine inflow are very low (<10% change); indicating that the model results are insensitive to climate variability.

Landholder pumping is not metered and, therefore, data on actual usage over time is not available to be included in the model. An empirical approach was used to estimate landholder pumping with very conservative assumptions of usage from water bores, being 3 ML/yr per bore for stock and domestic bores and 97% of licensed entitlement extracted from all Aquifer Access Licences (ie irrigation and industrial licences). The value of 97% was adopted based on the model calibration. This equates to 9 ML/day (3,285 ML/yr) for the mining case and 11 ML/day (4,015 ML/yr) (Coffey 2016b) for the no mining case. These volumes are larger than the potential peak mine inflow (2,066 ML/yr) and intercepted baseflow volume of 461 ML/yr.

In drought years, the volume of groundwater recharge is reduced and water levels decline as discharges to springs, rivers and creeks continue and increased groundwater pumping occurs. In these dry periods, these discharge volumes are in excess of the recharge volumes. However, groundwater is still readily available, as declines are buffered by the large volume of groundwater in storage. The impact of the mine will be much the same in dry and wet periods, and mine inflows will not increase during droughts (in fact they may decrease). The greatest influence on declining water levels will be landholder's pumping more groundwater than during normal to wet seasons. However, the EIS model is very conservative in that it assumes landholder pumping from irrigation bores is 97% of the entitlement, and stock and domestic use is 3 ML/yr per bore in every year. In normal to wet seasons, landholder pumping will be less than this, and therefore water level declines are likely to be less than predicted.

v Specific storage

Specific storage values for the lower model layers (Layers 6 to 13) were increased by a factor of 4 while Hawkesbury Sandstone layers and above (Layers 1 to 5) were increased by a factor of 3.

The values adopted within the revised model are now much closer to the average optimised value provided by the pumping tests. Increasing the specific storage values improved the SRMS percentage error for the revised calibrated model. Due to the updated values being closer to actual field measurements, and the improved SRMS, the increased specific storage values have been formally adopted for use within the revised-EIS model.

vi Specific yield

The specific yield values used in the EIS model (Coffey 2016b) were questioned within submissions for being lower than reported within the data analysis and inconsistent with available pumping test data (Coffey 2016a).

During the process of updating the model, a sensitivity run was conducted on specific yield values that were three times greater than the values for all EIS model layers. These changes resulted in improvements to the percent SRMS error for the calibration model of 0.25%, and the values are now much closer to the field values reported within the data analysis (Coffey 2016a). The increased specific yield values have been formally adopted for use with the revised EIS model.

vii Water level recovery

The EIS Model (Coffey 2016b) was run without pseudo-soil functionality due to the version of MODFLOW used for the EIS model not supporting the pseudo soil function. The use of pseudo soil allows the rewetting of model cells once groundwater levels decline below the base of a model cell and therefore allows for a more realistic simulation of post mining recovery of water levels. The revised model (HydroSimulations 2018) adopts the use of the pseudo-soil function, which allowed for much better model convergence.

viii Drain conductance

The sensitivity analysis for the EIS model concluded that there is only a small change in inflows with realistic variations in mine conductance. This was considered again during the model audit and rework by HydroSimulations who then modelled additional sensitivity on drain conductance by increasing the drain conductance parameter to 0.5 m²/d (a factor of 10).

The 0.05 m²/d drain conductance value used in the EIS model was calibrated against the discharge volumes from the Berrima Mine void, and the relative area of the cell sizes between Berrima Mine and Hume Coal within the model domain (Coffey 2016b). The EIS modelling report also highlights that similar drain conductance values (0.1 m²/d) were used to simulate non-collapsing development headings for proposed mining at Dendrobium Area 3B (Coffey 2012).

The 0.05 m²/d conductance value applied to the drain cells used to simulate mining of the Hume Coal Project was criticised within submissions for being too low and a parameter that was not adequately explored within the sensitivity analysis. However, HydroSimulations defended the adoption of this value at a meeting with DP&E and DI Water in August 2017 based on comparison with other sites after allowing for different cell sizes and different mining geometries.

As part of the groundwater model revision, a parameter sensitivity run that increased the drain conductance to 0.5 m²/d (a factor of 10) was completed.

Increasing the drain conductance by an order of magnitude resulted in a near doubling of the 'to sump' mine inflow, but total inflow did not increase. An approximate 10% increase in the number of bores drawdown by more than 2 m also occurred – which is not significant. This demonstrates that the model is overall not particularly sensitive to small realistic changes in drain conductance. If this increase in conductance was similarly applied to the drains simulating mining at Berrima, the modelled inflow would far exceed the observed discharge from the Berrima mine void.

If this increase in conductance was similarly applied to the drains simulating mining at Berrima, the modelled inflow would far exceed the observed discharge from the Berrima mine void and the conductance values would no longer be calibrated, indicating that this factor of 10 increase in drain conductance is an unrealistic value.

The drain conductance adopted in the EIS model is retained for the revised model following detailed review on drain conductance and sensitivity analysis. Due to the original drain conductance being considered correct and appropriate, and the sensitivity analysis demonstrating that increasing the value by an order of magnitude would result in unrealistic outcomes, alternative results (ie maps and predictions using unrealistic drain conductance values) has not been undertaken. Therefore, alternative drawdown maps (adopting higher drain conductance values) are considered inappropriate and not provided.

However, a maps showing the results of the detailed uncertainty analysis (which considers the main sensitive model parameter, hydraulic conductivity) is provided in Appendix 2 - Figure 11.3.

The similarities in the conductance values for two models within the Southern Coalfield, as well as knowing that the model does not calibrate with an order or magnitude change, serve to show that the conductance values used in the EIS model are suitable and appropriate. The NSW Government independent peer review (Hydrogeologic 2017) concluded that the drain conductance in the original EIS model (and therefore also the subsequent revised model) was appropriate.

ix The presence or influence of the modelled horizontal flow barrier

In the submissions on the EIS, some concerns were raised that the utilisation of the horizontal flow barriers would limit the extent of drawdown within the basalt providing unrealistic 'protection' from drawdown impacts to bores located within the basalt. However, as indicated in the data analysis, large drawdowns to the top of the Hawkesbury Sandstone would only result in small drawdown impacts in the basalt, which would be satisfied in time by decreased baseflow to streams (Coffey 2016a).

HydroSimulations has reviewed this conceptualisation and modelling and finds the method used to simulate the basalt conceptualisation to be effective (Hydrosimulations (2018) in Appendix 2).

Sensitivity runs were undertaken that demonstrate the method used to simulate the interpreted structure and associated unsaturated zone has resulted in a limited ability of drawdown to propagate through the basalt. This is consistent with the EIS (Coffey 2016a, 2016b) conceptualisation that appears to be a strong interpretation of the available evidence. The barriers in the model alone are shown not to provide the protection (ie they are not effective barriers to the overall groundwater flow) that was raised in the submissions as a concern.

Uncertainty with model parameters and therefore predictions was raised by the DI Water, with a request to consider potential worst case scenarios under a larger uncertainty analysis. Requests were made to revisit the model and to consider additional uncertainty to provide more confidence with model predictions.

Concerns that the model predictions are not accurate and that groundwater take and recovery may not be accurate were raised by Wingecarribee Shire Council and NSW DPI, and that this uncertainty may have a 'significant impact' on other authorised users and or the environment. Questions were raised about model calibration, and remodelling was recommended.

A more thorough and detailed approach to uncertainty was requested by the NSW DPI in their submission. In addition, a 'Monte Carlo' approach to uncertainty analysis was requested from DI Water during the consultation meeting on the 25th August 2017.

Interest groups raised the following concerns relating to model uncertainty:

Concerns that a robust and industry standard numerical uncertainty analysis on the groundwater model has not been undertaken and that until additional funds and time need to be spent on this.

- Claims that the Pells and Pan model should be used instead as it underwent some uncertainty analysis.
- Particle tracking to consider groundwater flow time is suggested.
- Concerns that additional modelling in line with IESC requirements, including considering uncertainty, is required.
- Concerns that economic and operational decisions are based on the model inflow and drawdown predictions.
- Concerns that there is insufficient understanding of the hydraulic conductivity values for the site.
- Concerns that uncertainty around faults and fractures between the Hawkesbury Sandstone and the underlying coal measures are significant.
- Concerns that modelling predictions are not accurate, more detailed modelling should be undertaken and drawdown impacts are underestimated.

Some business raised concerns regarding the nature of the geology being heterogeneous and therefore model predictions may be underestimated.

Community members raised the following concerns regarding model uncertainty:

- Concerns that the actual impacts will be much greater than the model predicts, and that this lack of certainty is too much of a risk for the future water supply for Sydney.
- Concerns that a mine in Lithgow modelled predicted impacts that have been since quoted to be much larger than predicted, the submission suggests 7 times greater. The concern is that this will also occur for the Hume Coal project (ie impacts will be much larger than predicted).
- Concerns that model prediction of groundwater inflow to the mine workings and the predicted drawdown impacts are underestimated in the model. Some in the community trust the greater impacts as predicted the Pells and Pan model over the EIS Coffey model.
- Concerns that if inflows are larger predicted the surface water balance modelling will be incorrect, and the surface holding capacity compromised.

There are different ways to categorise uncertainty, but it is often categorised into two main types (Barnett et al. 2012):

- deficiency in our knowledge of the natural world (including the effects of error in measurements); and
- failure to capture the complexity of the natural world (or what we know about it).

Middlemis and Peeters (2018) propose four sources of scientific uncertainty affecting groundwater model simulations:

- structural/conceptual - geological structure and hydrogeological conceptualisation assumptions applied to derive a simplified view of a complex hydrogeological reality;
- parameterisation - hydrogeological property values and assumptions applied to represent complex reality in space and time;
- measurement error – combination of uncertainties associated with the measurement of complex system states (heads, discharges), parameters and variability (3D spatial and temporal) with those induced by upscaling or downscaling (site-specific data, climate data); and
- scenario uncertainties - guessing future stresses, dynamics and boundary condition changes (eg mining, climate variability, land and water use changes).

These are discussed in relation to the Hume Coal Project below.

a. Method for uncertainty analysis

A detailed uncertainty analysis has been completed for the revised EIS model. The EIS model was initially reworked and upgraded to a new more modern software platform and this provided benefits to the mass balance and SRMS calibration statistics. Additional sensitivity was then undertaken, as requested by the NSW Government and as recommended by the independent peer reviewer Hugh Middlemis (see Section 9.3.5 (ii)). Following this model upgrade, a very detailed and considered uncertainty analysis was completed.

This uncertainty analysis was undertaken following consultation with DI Water and the independent peer reviewer Hugh Middlemis, in regard to how the uncertainty analysis should be done, what parameters should be tested and to what level the analysis needs to be undertaken. The uncertainty analysis, combined with the model rework, addresses all the concerns about the EIS model adequacy.

The method of uncertainty analysis undertaken was aligned to the recent draft guidelines on uncertainty analysis released by the IESC in March 2018 (Middlemis and Peeters 2018). The method undertaken for the Hume Project is the most complex and robust approach as suggested in the IESC guidelines. The method adopted by the Hume Coal Project is described in the guidelines as follows:

"An ensemble of model predictions is generated, based on a large number of model evaluations with different parameter values that are all consistent with the observations (Middlemis and Peeters 2018)."

The Hume Coal uncertainty analysis study addresses parameter uncertainty by stochastic modelling using the *Monte Carlo* method. This method operates by generating numerous alternative sets of input parameters to the deterministic groundwater flow model (realisations), executing the model independently for each realisation, and then aggregating the results for statistical analysis. The standalone report by HydroSimulations (2018) in Appendix 2 details this work.

Numerous numerical realisations were undertaken using cloud-based processors due to the significant computer processing power needed to undertake the work. It is a new and evolving area of groundwater modelling and computer science, and the work completed for the Hume Coal project ensures that the modelling and predictions are as accurate and considered as possible to provide confidence and reassurance to the NSW Government, the local community and the people of NSW.

b. Uncertainty analysis results

For each of the 481 accepted model runs the realisation generated by the Monte Carlo process considered every pilot point (256 of them), and assigned a Kx value and a Kx/Kz ratio, for a total of 6,656 parameters (256 points * 13 layers * 2 parameters). Each model cell for each run was then assigned a Kx and a Kz value through interpolation from surrounding pilot point values by *kriging*.

The uncertainty analysis model results are by far the most robust and accurate assessment of the Hume Coal Project completed to date. The model results are considered to be accurate and additional modelling at this time is not warranted. The detailed uncertainty analysis demonstrates the narrow band of uncertainty in the model predictions, and renders the predictions as being sufficiently accurate. A conservative approach to use of the uncertainty analysis results is presented for the impact assessment (ie 67th percentile not 50th percentile) and, therefore, underestimation of impacts is highly unlikely and, if anything, an overestimate of impacts is presented in the Revised Water Assessment (Appendix 2).

Although the Pells and Pan (2017) model did undertake a simple uncertainty analysis, it was not to the same extent as the recent uncertainty analysis for the revised model by HydroSimulations using cloud computing technology. The HydroSimulations uncertainty analysis was completed with the consideration of all data, in consultation with the independent peer reviewer (Hugh Middlemis) and in consultation the NSW DI Water modellers, and it also aligns to the newly developed IESC draft explanatory note on uncertainty analysis (Middlemis and Peeters 2018) and is, therefore, considered to be the most accurate estimate of impacts from the project.

The uncertainty analysis undertaken considers the range of potential hydraulic conductivity parameters (Kz, Kx, and Ky) that may exist and completes model runs with combinations of these different input parameters. The range of hydraulic conductivity values tested in the uncertainty analysis provides a range of values that incorporates the presence or not of localised faults and fractures that could be conduits and/or barriers to groundwater flow.

The results of the uncertainty analysis demonstrate that the uncertainty falls within a relatively narrow range for both groundwater inflow (take over time), and predictions of drawdown and recovery. Therefore, the model predictions of inflow and drawdown in landholder bores can be relied upon. The original EIS model results and the revised results can be considered accurate and fit for purpose with additional confidence now the uncertainty analysis has been completed, and the results demonstrate that there is a large degree of confidence in the model predictions.

The uncertainty analysis with respect to the mine inflow predictions, drawdown in landholder bores and the water table drawdown is taken to be the 67th percentile for consideration of potential inflow (ie not the 50th percentile which is the most likely scenario). This therefore represents a conservative approach for prediction of inflows. In accordance with the draft explanatory note from the IESC on uncertainty modelling (Middlemis and Peeters 2018), the 67th percentile represents the boundary where above which impacts become '*unlikely to occur in normal circumstances*'.

The updated model and uncertainty analysis provides updated predictions which are very similar to the original EIS predictions, with only very minor differences overall in the level of impact:

- mine inflow reduced by 10% (225 ML); and
- number of bores impacted increased by 1% (1 bore).

This provides a significant improvement in the level of confidence in the accuracy of the model predictions. Many of the concerns raised by both NSW Government and the community were around the perceived and demonstrated 'accuracy' of the model predictions and the reliability of these results. The detailed sensitivity analysis, uncertainty analysis and independent peer review as per recommendations from both the NSW requirements and Federal Government IESC guidelines have been adopted, considered, and actioned.

The independent peer review of the EIS model and revised model provides a high level of confidence in the results, and that they are accurate and can be relied upon to predict impacts by the project.

xi Overall mine water balance

The results of the revised groundwater model were provided and adopted in a revised overall site water balance for the project. This revised water balance considers storage volumes and water management generally and is detailed in Chapter 8, and in the Revised Water Assessment (Appendix 2).

xii Model upgrade

One of the key refinements to the groundwater model following the audit was the upgrade to a more recent version of modelling software, MODFLOW-USG. This upgrade alone allowed for more elaborate mathematical solvers to be used and some of the issues raised in terms of SRMS, and mass balance errors were immediately improved by this action alone. The model software upgrade provided new features to improve model performance, and some minor alterations were also made (based on the response to submissions, the audit, and comments from the independent peer reviewer). These are summarised as:

- **upgrade of software interface and software engine** (better convergence, simulation of mining, and mass balance);
- **solver settings** (improved mass balance);
- **removal of inactive model cells** (ie additional deep layers not being used were removed, which improved runtimes);
- **calibration reporting** (removal of misclassified monitoring data, which improved the SRMS significantly);
- **stress period timing** (minor amendments led to improved late time results);
- **increased recovery duration** (possible due to reduced run times);
- **specific storage amendments**, more realistic and in accordance with recommendations from Hugh Middlemis, which then led to improved SRMS and mass balance;
- **specific yield amendments**, more realistic and in accordance with recommendations from Hugh Middlemis, which then led to improved SRMS and mass balance;
- **mine drain duration amendments**, more realistic and lower overall inflow to void;
- **Berrima Mine aureole**, reduced to make it more realistic and aligned to actual monitoring data;
- **amended up-dip mining** to provide realism for likely water flow, led to reduced inflow to voids;
- **time varying materials (Ss, K, Sy and timing)** which provided more realistic void filling times and more realistic drawdown and depressurisation predictions;
- **to void and to sump accounting**, software upgrade allows a more realistic accounting of void inflow;
- **bulkheads**, software upgrade allows for more realistic simulation of timing of bulkhead placements therefore more realistic modelling outputs; and
- **roadways**, software upgrade allows these to be conceptualised more realistically.

Concerns the Hume Coal water take will reduce water available to WaterNSW storages and catchments, and that take must be properly accounted for, and contingency measures implemented if actual take exceeds allocation, particularly in low flow and droughts.

NSW DPI had concerns that the calibration statistics (being over 10) may result in the inflow predictions being in error.

A recommendation that the take volume predictions be reviewed and confirmed that they do not vary from those presented in the EIS.

Concerns that connection with overlying surface water source has not be considered, and the peak rather than average leakage should be reported and licensed.

NSW DPI, Wingecarribee Shire Council and the NSW EPA had concerns that if the inflow volumes are larger than predicted, that there will be water management, and water discharge issues for the project that will need to be addressed.

Business groups raised concerns that impacts to bores will be in excess of what Hume Coal estimate and that the Pells studies should instead be used

Some interest groups raised concerns that the inflow will be larger than predicted and that the mine infrastructure will not be able to cope with a larger volume than predicted. They also had concerns that the Pells and Pan estimate of inflow was much larger than that in the EIS and that therefore it is assumed the EIS has underestimated inflow. Comparison to Berrima Mine inflow is made and scaling that up by 4 times as an approximation is tabled. Concerns about drain conductance values adopted underestimating mine inflow compared to Pells and Pan (2017).

Concerns that the Pells studies are more accurate than the EIS model, and therefore inflows and predictions of the EIS model are not as accurate as the Pells and Pan model. Concerns that the volume of water that inflows cannot therefore be managed.

The Pells and Pan study claims that the use of the pseudo soil function increased the volume of inflow (the EIS model does not use the pseudo-soil function), and therefore the EIS will be under-reporting inflow.

The concerns around modelling and inflow volumes raised by the community were around the unknown quantity of water being taken and used in the mine.

a. Inflows

The EIS model has been revised after a detailed audit, upgraded software platforms and solvers, additional sensitivity analysis, and a detailed uncertainty analysis (HydroSimulations 2018). The model has also been subject to additional NSW Government independent peer review (Hydrogeologic 2017). The additional work and review concluded that the original EIS model prediction of inflow was accurate (in terms of both inflow and drawdown in bores). Although some minor differences have been calculated, total mine inflow has reduced by 10% (from 2,290.5 ML in the EIS to 2,066 ML in the Revised Water Assessment (Appendix 2)).

b. Alternate studies

Alternate studies commissioned by local interest groups have been published in recent years. Both the Pells and Pells (2013) and the revised model presented in Pells and Pan (2017) have been peer reviewed by Senior Principal Hydrogeologist, John Ross (EMM 2018b), Appendix 2. This specialist review was undertaken due to the numerous submissions from interest groups and the general community that relied heavily on predictions made in these two reports to support their arguments in opposition to approval of the project. The review (EMM 2018b) considers both models and their 'fitness of purpose' for making impact predictions for an underground coal mine project. Many of the community and interest group submissions question the differences between the EIS model (Coffey 2016b) results and those presented in the Pells and Pells (2013) and the Pells and Pan (2017) model reports.

The review of the Pells and Pan (2017) model confirmed that the model and reporting did not follow the guiding principles as outlined in the Australian Groundwater Modelling Guidelines (Barnett et al. 2012). The review revealed some major flaws with the model including:

- deficiencies in conceptualisation;
- deficiencies in boundaries assumptions;
- lack of data; and
- unrealistic hydraulic parameters.

The mine method, being non-caving, in panels (not longwall extraction as assumed in Pells and Pells (2013)), means that the roof remains intact with no fracturing of overlying strata. Following mining and filling of voids, recovery of the groundwater level commences immediately after bulkheads are installed, and occurs until pre mining levels are reached. The Pells and Pan (2017) submission suggests that changes to the mining method have little bearing on the inflow volume to the mine. This is different to what would logically be expected and different to what the HydroSimulations (2018) sensitivity analysis revealed. The primary difference is that the Pells and Pan (2017) model has:

- conductance values for mine inflow that are unrealistically high;
- hydraulic conductivity values for overlying strata that are unrealistically high; and
- specific storage/specific yield parameters that are too high.

EMM (2018b) surmises that the key concerns with the Pells and Pan (2017) model is that no conceptualisation is provided, the calibration is poor, there is limited justification for the very high horizontal hydraulic conductivity and conductance values adopted in the model, and the adopted boundary conditions are not suitable. As a result, this Class 1 model is not 'fit for the purpose' of making predictions on drawdown or mine inflow and any predictions made are considered 'unreliable' (EMM 2018b).

The Pells and Pan (2017) model is not as robust or detailed as the EIS model (Coffey 2016b), or the revised model and detailed uncertainty analysis undertaken by HydroSimulations (2018). The revised model (HydroSimulations 2018) provides the most accurate and robust assessment of the potential drawdown in landholder bores for the Hume Coal mine. This statement is agreed to and supported by the NSW Government independent peer reviewer, (Hydrogeologic 2017) in his very detailed review of the data, analysis and models by both Coffey (2016a, 2016b) and HydroSimulations (2018).

c. Comparison to Berrima Mine

The groundwater inflow to the Berrima Mine was used in the calibration of the EIS model. Although the Berrima mine is smaller in size than the proposed Hume Coal mine, the mining impacts in part of the mine are very different and the local geology is different. At Berrima, full pillar extraction occurred, which allowed roof collapse and fracturing of the overlying strata, and this in turn allows for increased groundwater inflow volume to the mine workings. The mine design is a key difference between these two mines, but as seen on Figure 9.11, two other differences that potentially affect the different inflow volume at Berrima are:

- at Berrima, almost the entire mine drains to the main headings and this water then becomes mine discharge, meaning that all of the old workings are constantly being de-watered. At the Hume Coal Project, panels have been designed to be compartmentalised and retain water once mining has been completed.; and
- greater exposed sandstone at the surface at Berrima and therefore higher rainfall recharge rates (ie there is more overlying shale and therefore less groundwater recharge at Hume).

The use of the Berrima mine inflow in calibration of the EIS model, means that this inflow volume and the above differences are incorporated and considered when estimating the potential inflow to the Hume Coal mine in the EIS model. This approach for calibration is endorsed by the NSW Government independent peer reviewer, Hugh Middlemiss who states:

“this is a good example of a best practice method that minimises non uniqueness issues and supports a model Class 2, confidence level” (Hydrogeologic 2017).

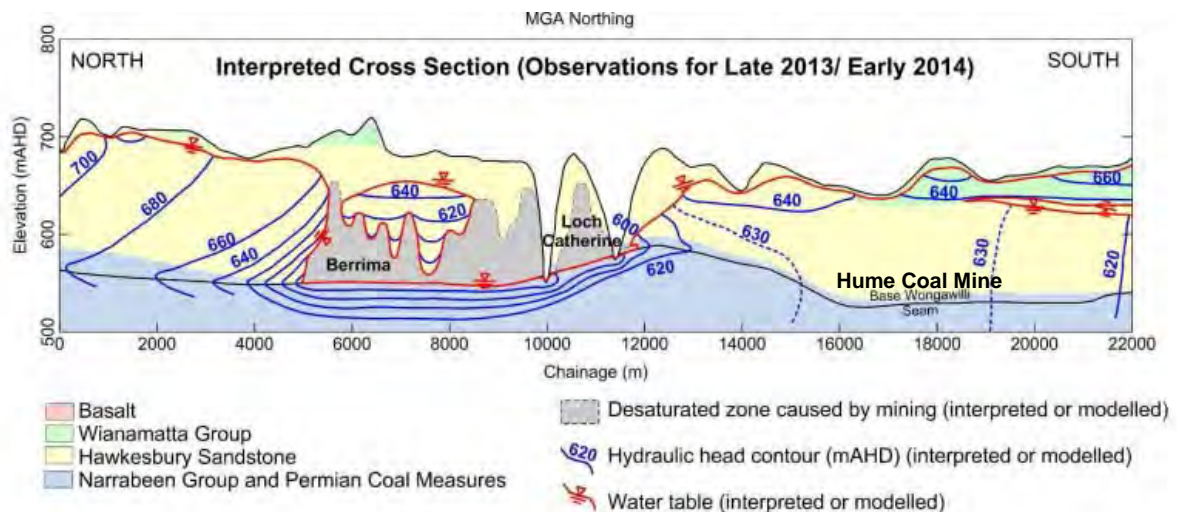


Figure 9.11 Interpreted cross section and piezometric levels 2013/14 (after Coffey 2016b, Figure 4.3)

d. Model audit and peer review – inflows

The model audit and model rework by HydroSimulations (2018) used updated software solvers, and the pseudo-soil function, which proved beneficial for the model calibration, mass balance and convergence. The pseudo-soil function was therefore adopted in the final revised model.

The NSW Government independent peer review by Hydrogeologic (2017) considers the accuracy of the original EIS model and, therefore, also the reliability of the mine water inflow. The review states that the original EIS model was ‘fit for mining purpose impact predictions’ and the revised model and uncertainty analysis undertaken by HydroSimulations (2018) has further confirmed this. There is confidence in the inflow predictions from the revised HydroSimulations (2018) model, which is supported by data, sensitivity runs, and the detailed uncertainty analysis results.

Due to the increased confidence in the model predictions of inflow and the overall water balance, concerns around water management of a greatly increased inflow volume are no longer valid. In addition, the surface water balance has been reworked with the updated results from the revised groundwater model. The surface water balance (discussed in Chapter 8), provides additional detail on water management at the site, including consideration of climate variability.

The water inflow to the mine is required to be licensed from the source in which it is derived from, and the licensing requirements to cover the peak groundwater inflow to the mine workings are clearly discussed in Chapter 11 and the Revised Water Assessment (Appendix 2). The Revised Water Assessment takes a very conservative approach and adopts the licensing of all inflow to the workings irrespective of whether this inflow is removed from the mine sump.

The model audit, revised modelling (HydroSimulations 2018) and independent peer review (Hydrogeologic 2017) confirms that the EIS and revised model predictions of inflow are accurate with remodelling, resulting in a minor lowering of peak inflow volume to the mine (a reduction of 10%). The model, audit, rework and the additional detailed uncertainty analysis provides improved calibration statistics and improved mass balance errors. This further enhances confidence in the predicted model inflows.

e. NSW regulations and the AIP - licensing inflows and intercepted baseflow

The model has been designed in accordance with the NSW Aquifer Interference Policy 2012 (AIP) requirements and predicts the total inflow volume as well as the volumetric contribution and timing of that contribution from adjacent and overlying surface water and groundwater sources. These volumes are presented in the EIS (EMM 2017a) and have been reworked in Chapter 11 based on the revised Water Assessment (Appendix 2) and the revised groundwater model (HydroSimulations 2018). Mine inflows are 10% lower than those predicted in the EIS and intercepted baseflow volumes are similar. Losses from Medway Dam have been analysed using localised modelling and are presented on a yearly time-step (see Figure 9.9 in section 9.3.5 (ii)). The yearly timestep and maximum annual leakage is clearly presented as requested for licensing purposes as required by the AIP.

The revised Water Assessment (Chapter 11 of Appendix 2) provides more information on water take over time (including peak yearly take) from overlying sources and from Medway Dam in particular, as requested by the NSW DPI in their submission.

This volumetric contribution from each respective water source determines the water licence requirement from each source predicted to experience a volumetric impact. Ninety-three percent (93%) of the licence volume required has already been purchased and this is considered in more detail in Chapter 11 and the Revised Water Assessment (Chapter 12 of Appendix 2). The licence volume is required to be held prior to the volume being taken. The model predicts peak take for groundwater to occur in the latter years of mining (Years 17 and 18), and surface water peak take will occur at the conclusion of mining. Therefore there is sufficient time for the limited volume of additional licences to be acquired. In the unlikely event that future remodelling predicts slightly higher volumes that are required, there will be sufficient time and market depth to acquire these licences as well (should they be required).

Water sharing plans set the rules for how water is shared within a water source for a ten year period to provide security to both the environment and water users over that time. Two of the major elements of a water sharing plan are to (DI Water 2018a):

- provide water for the environment by protecting a proportion of the water available for fundamental ecosystem health....
- set annual limits on water extractions to ensure that water extractions do not increase and therefore erode the water for the environmental and also the security of supply to water users....

Specifically, for groundwater sharing plans, the environmental water provisions are aimed at protection of groundwater dependent ecosystems and “important baseflows to rivers and tidal creeks” (DI Water 2018a).

The protection of the environmental values, including baseflows, is achieved by establishing the Long Term Average Annual Extraction Limit (LTAAEL) for each groundwater source at a sustainable volume. This inherently serves to protect the storage within the system, and to reserve water for ecosystem functions, including baseflow. Together with other water sharing plan rules such as distance conditions and trading rules ensure that the water requirements of the environmental users are prioritised over extractive uses.

The *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* has established LTAAELs for each individual water source, and these limits consider environmental water requirements. For the Sydney Basin Nepean Groundwater Source, the water sharing plan has taken an additional step in this regard and has established local Management Zones to allow environmental protection to be applied at a scale smaller than the total water source.

Licences have been acquired on the open market or via an open public tender process, and are therefore within the sustainable limits of each respective water source. The physical impact of the water take for the mine on the water supply sources as a whole remains largely unchanged as the volumes are within the sustainable limits for each water source, and largely from active licences.

The NSW DPI acknowledge in their submission that the market depth for water licence is sufficient for procurement of these licences as the project ramps up and therefore licensing of water does not represent a significant risk for the project. The volume of water that inflows to the mine is all accounted for in licences purchased from existing licensed users as per the AIP. Therefore, there are no additional volumetric ‘impacts’, over and above current levels of ‘impact’, to WaterNSW storages and catchments, particularly those within the Sydney Catchment Authority areas.

The shape of the footprint for the drawdown in the water table is questioned and more detailed discussion was requested by NSW DPI, in particular the similarity of shape between the water table drawdown and the Wongawilli Seam drawdown.

Concerns raised by both DI Water and OEH that greater drawdown than predicted by the model will occur in landholder bores and that further assessment is required.

DI Water considers the impacts have not been assessed in accordance with the AIP. They consider that the project, in accordance with the AIP minimal impact criteria, triggers 'Level 2 impact' for drawdown in landholder bores and a 'Level 1' impact for in groundwater quality.

DI Water commented on the reporting of cumulative impacts in the EIS.

DI Water concerns that landholder bore details in public databases needs to be enhanced with additional information from direct engagement with landholders.

The reliance on the groundwater model for prediction of potential drawdown in landholder bores was raised by WaterNSW.

The large number of bores predicted to experience a greater than 2 m of drawdown was raised by Wingecarribee Shire Council.

Some business groups claimed the model drawdown in landholder bores is unrealistic and/or incorrect compared to a model undertaken in 2014. They also raised concerns that there will be a greater than predicted drawdown in the shallow water table. The shape of the watertable drawdown was also questioned.

Interest groups raised concerns that the Commonwealth EPBC Act prevents the project from being approved based on its potential 'significant impact' and with reference to the NSW minimal harm guidelines. Concerns that the NSW 'minimal harm' criteria is triggered which then prohibits the project from being approved. Concerns that the 'precautionary principle', if applied, would prevent the project from being approved.

They also raised concerns that the impact of private landholder bores is over estimated compared to the groundwater take for the Hume Coal Mine, and that a model is required to predict this.

They also raised concerns that the Pells and Pells (2013) and the Pells and Pan study (2017) predict a much greater extent of drawdown for landholders which may be more correct than the Hume Coal EIS predictions.

There were many submissions on community concerns were aligned and the same as the Interest Groups. Claims are made that the drawdown will be far greater than predicted in the groundwater model.

The mitigation strategies for minimising impacts to landholders includes the mine design and planned sealing of panels following mining, and retaining surplus mine water in these sealed voids as mining progresses. These mitigation strategies will not prevent drawdown in landholder bores. However, compared with other potential mining techniques often used in underground coal mining, these measures are fundamentally mitigation strategies designed to minimise the overall take of groundwater and the drawdown in overlying landholder bores.

a. Water table drawdown contours

The shape of the water table drawdown in the EIS was investigated in detail during the model audit and model rework by HydroSimulations (2018). A comparison between the maximum water table drawdown in the EIS and the revised maximum water table drawdown is presented in Figure 9.12 below (and in Appendix 2, Revised Water Assessment Figure 11.1).

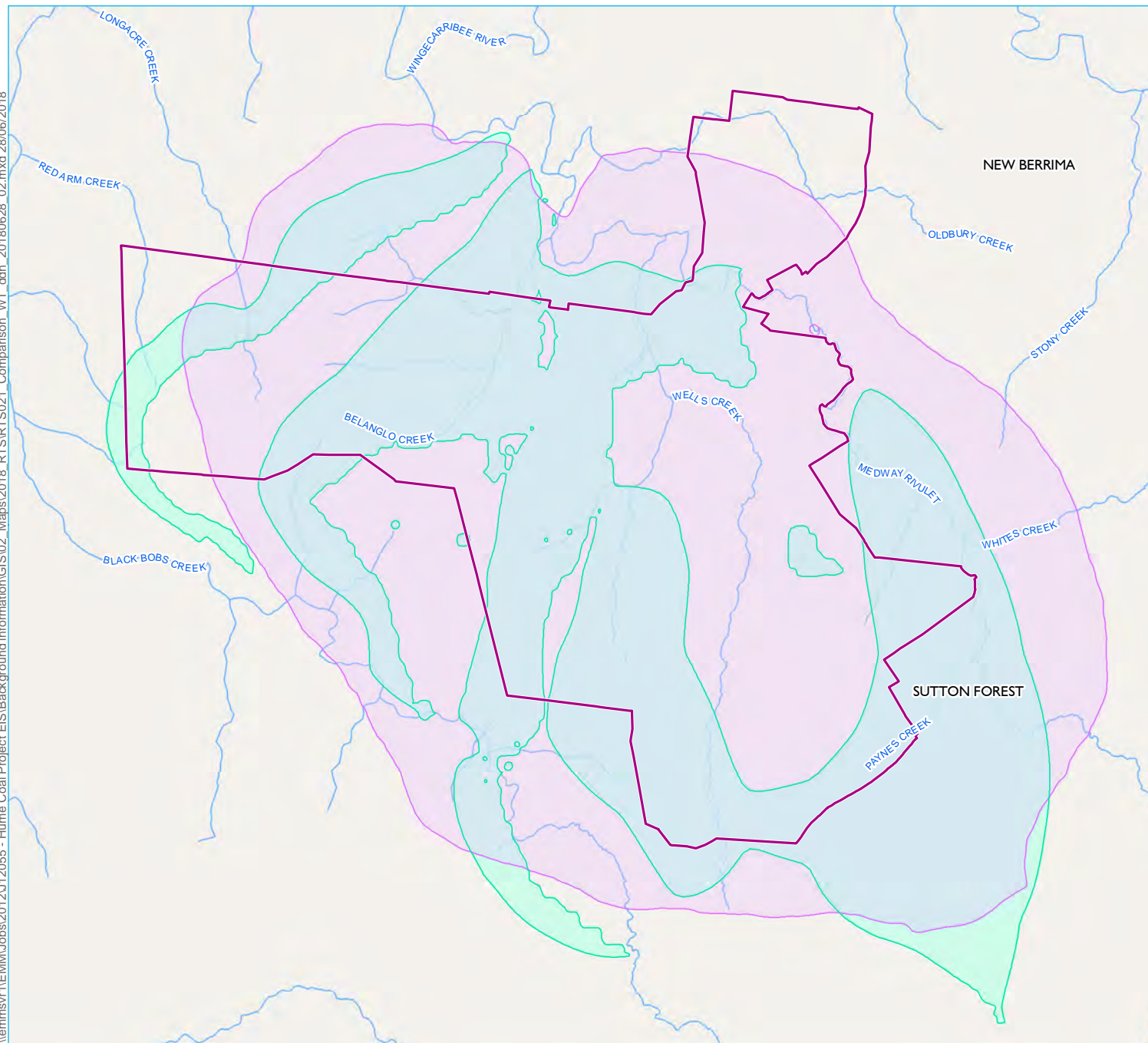
Following the update to MODFLOW-USG, and the implementation of the pseudo soil function, a change in the water table drawdown pattern emerged and it now manifests as a concentric spatial drawdown pattern. The revised maximum drawdown together with the likely to be impacted water bores located above the mine footprint is shown in Figure 9.13.

b. Confidence with landholder bore drawdown predictions

The main concern pertaining to drawdown model predictions in landholder bores is based primarily on the assumption that the EIS model is deficient and only classified as Class 1 confidence level. However, as demonstrated in Section 9.3.3, the original EIS model was indeed a Class 2 model and as clearly stated by Hydrogeologic (2017) in his independent peer review, the EIS model is 'fit for impact prediction purposes', even though the reporting of the model could have been improved. However, since that time, several refinements to the model have been made and has resulted in similar drawdown predictions in landholder bores as the original model.

Although the drawdown impact is over a slightly larger area in the revised model, much of this expanded area constitutes a more minor drawdown in bores. So although over a larger area, the degree of drawdown in many bores is reduced. Figure 9.14 shows the extent of drawdown and the likelihood of registered water bores being impacted by 2 m or greater drawdown.

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KEY

Hume Coal Project area

— Drainage line

2 m water table drawdown contour (maximum extent)

EIS model

Revised model

Comparison between maximum water table drawdown in the EIS and the RTS

Hume Coal and Berrima Rail Project
Response to submissions

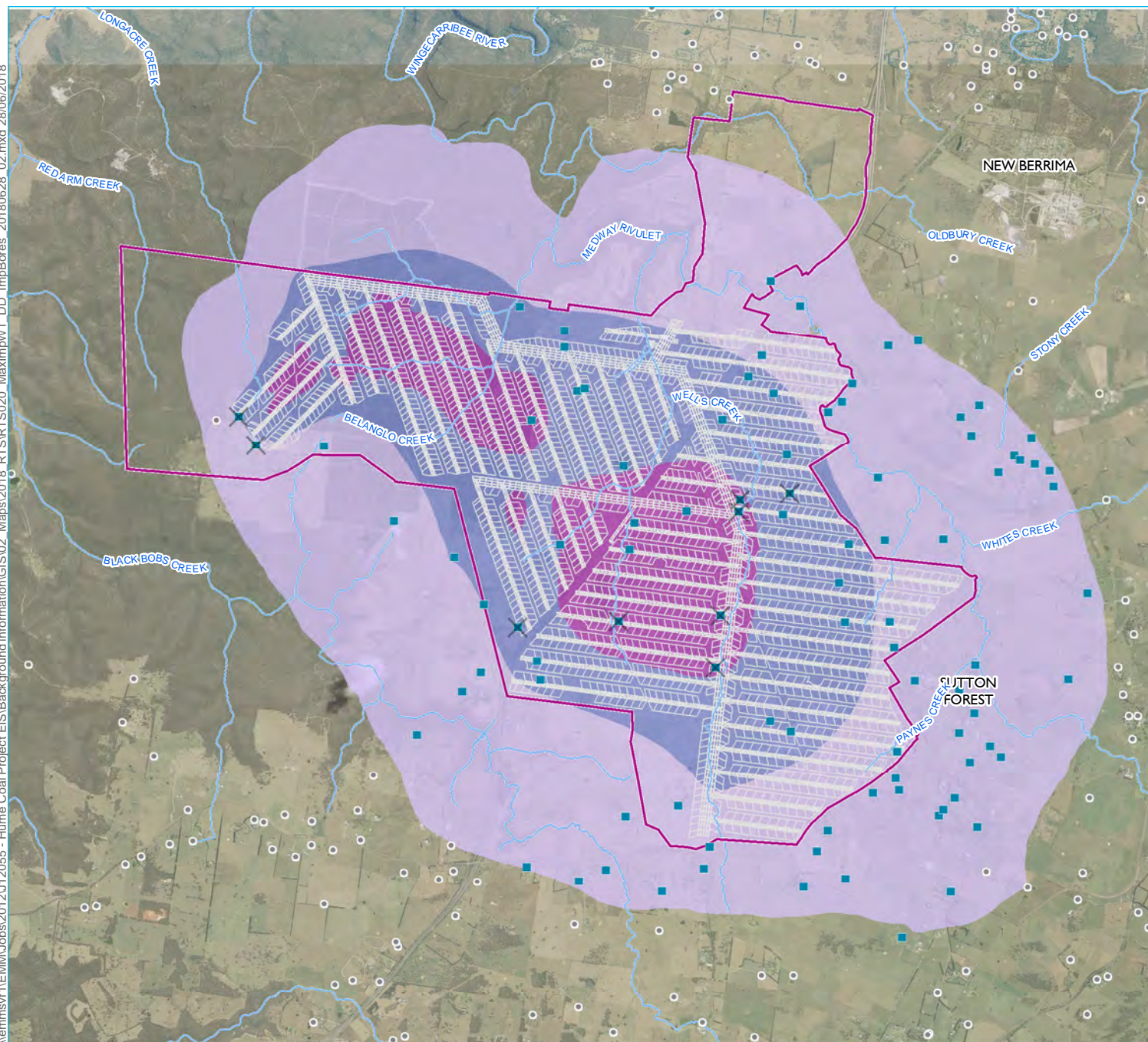
Figure 9.12



Source: EMM (2018); DFSI (2017); Hume Coal (2017); Palaris (2016)

0 1 2 km
GDA 1994 MGA Zone 56 N

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KEY

- Hume Coal Project area
- Underground mine workings
- Drainage line
- Bore intersected by mining
- Bore impacted by 2 m drawdown or more
- Non-affected bores

Maximum water table drawdown (m)

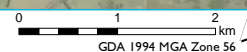
- 2 - 10
- 10 - 20
- 20 - 30

Predicted water table drawdown

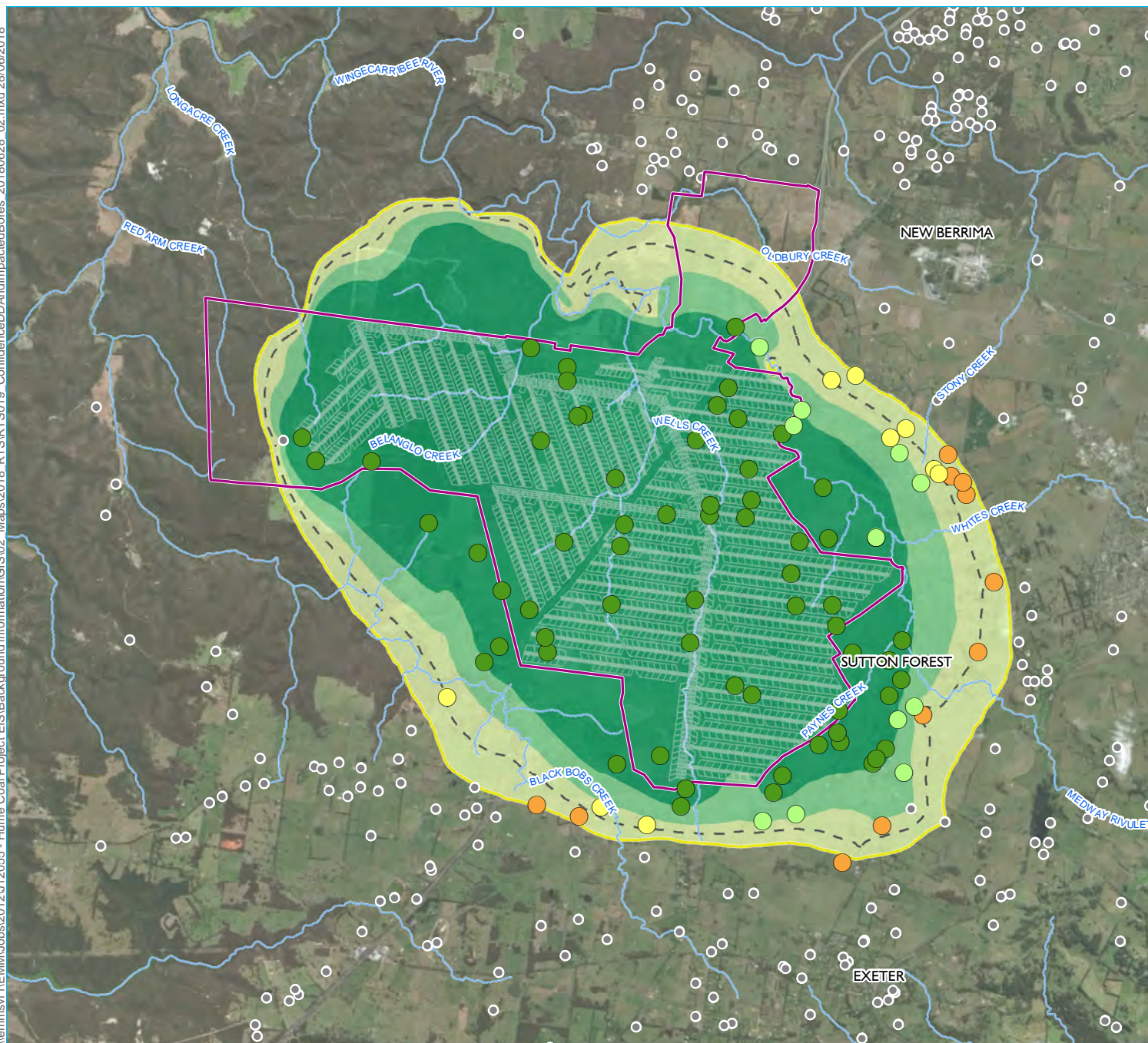
Hume Coal and Berrima Rail Project
Response to submissions
Figure 9.13



Source: EMM (2018); DFSI (2017); Hume Coal (2017); Palaris (2016)



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KEY

Hume Coal Project area

Underground mine workings

Drainage line

Non-affected bores

Confidence of 2m or more drawdown in landholder bore

Very likely

Likely

Median

As likely as not

Confidence of 2m or more water table drawdown

Very likely

Likely

As likely as not

Median (as likely as not)

Watertable drawdown unlikely to occur outside this contour

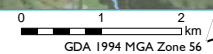
Likelihood of drawdowns of 2m or greater in registered water bores

Hume Coal and Berrima Rail Project
Response to submissions

Figure 9.14



Source: EMM (2018); DFSI (2017); Hume Coal (2017); Palaris (2016)



Many community members and businesses raised concerns that the EIS had inaccurate drawdown predictions when compared to the Pells and Pells (2013) and Pells and Pan (2017). It is noted that both models (Pells and Pells 2013; Pells and Pan 2017) were Class 1 and therefore not suitable to make impact predictions as per the Australian Groundwater Modelling Guidelines (Barnett et al. 2012). The EMM (2018b) review of the Pells and Pells (2013) and Pells and Pan (2017) model reports highlighted other shortcomings, which is discussed in more detail in Appendix 2. The summary conclusion of the review of the Pells and Pells (2013) and Pells and Pan (2017) states that *'the model is not 'fit for the purpose' of making predictions on drawdown or mine inflow and any predictions made are considered 'unreliable'.*

The necessity for the EIS model to predict impacts to water bores and stream baseflows, and to predict inflow to the mine workings is well understood. The model has been peer reviewed throughout the entire modelling process, and the post EIS audit, remodel, and detailed uncertainty analysis, which specifically considered the number of potentially impacted water bores for different uncertainty scenarios.

Hume Coal, the EIS modelling team and the NSW Government independent peer reviewer are confident that the model has been robustly conceptualised and developed, and believes that it demonstrates industry best practice, and that potential impacts are accurately predicted. The model can be relied upon to predict likely impacts in landholder bores, and the model will be verified annually, and then updated, reworked and or recalibrated as required.

The drawdown contours do not extend laterally very far from the mine footprint. This is largely due to the absence of fracturing of overlying strata and the sealing of panels as mining progresses.

c. Individual landholder bore drawdown assessment

The potential for impacts to be greater than those predicted for individual bores is low due to the conservative approach taken to modelling, and the adoption of conservative results (ie 67th percentile results of 94 bores rather than the more likely 50th percentile results of 84 bores). Consequently, the predictions from the model are considered conservative and the actual impacts are more than likely to be less than the predicted impacts.

Mitigation and management strategies for water bores includes: model verification, rework and recalibration as required, and revised make good arrangements for individuals. The model verification is the key management strategy for confirming impacts in landholder bores. The drawdown impact to water bores is predicted to occur over several decades from commencement of mining and the make good assessment will be staged to roll out over time.

Hume Coal commits to annual model verification, and then recalibration and model revisions as required. Model verification provides the most accurate information on timing and level of impact for each individual bore and appropriate mitigation options can therefore be confirmed and implemented in advance of any impacts actually occurring.

d. AIP minimal impact criteria

DI Water consider that the project, in accordance with the AIP minimal impact criteria, triggers 'Level 2 impact' for drawdown in landholder bores and 'less than Level 1' impact for in groundwater quality. The AIP states the following in regard to minimal impact and the level of impacts:

"There are two levels of minimal impact considerations specified in table 1. If the predicted impacts are less than the Level 1 minimal impact consideration then these impacts will be considered as acceptable.

Where an activity's predicted impacts are greater than the Level 1 minimal impact considerations specified in table 1, but these predicted impacts exceed the Level 1 thresholds by no more than the accuracy of an otherwise robust model, then the project will be considered as having impacts that are within the range of acceptability, with extra monitoring and potential mitigation or remediation required during operation, should the project be approved. In such circumstances, the Minister's advice will include a request that appropriate conditions be imposed to ensure the impacts of the activity are acceptable. This may include for example, adaptive management conditions requiring the proponent to monitor the actual impacts of the proposal and take action to mitigate or remediate the impacts that exceed the Level 1 thresholds.

Where the predicted impacts are greater than the Level 1 minimal impact considerations by more than the accuracy of an otherwise robust model, then the assessment will involve additional studies to fully assess these predicted impacts. If this assessment shows that the predicted impacts do not prevent the long term viability of the relevant water-dependent asset, as defined in Table 1, then the impacts will be considered to be acceptable.

The NSW Office of Water's assessment will determine the potential level of impact relative to the considerations in Table 1 and will identify where further mitigation, prevention or avoidance measures would be necessary to meet the Level 1 minimal impact considerations of, under the Level 2 minimal impact considerations, what further studies are necessary to assess whether the project will no prevent the long-term viability of a relevant dependent ecosystem or significant site. The assessment includes determining the rigour of impact predictions and the suitability of proposed mitigation, prevention or avoidance strategies.

As part of the assessment process, there may be no suitable or practical mitigation or prevention options and therefore the proponent may be asked to avoid impacts by modifying the proposed activity." (NOW 2012a).

Based on the AIP definition of minimal impact considerations and the associated 'Levels' of impact, there are two levels of impact, and three categories into which the impacts are then classified. This is summarised in Table 9.6, and provides clarity as to how the project has been assessed under the AIP.

Table 9.6 AIP assessment criteria and levels

Level of impact	Definition	Action required
Less than Level 1 Less than minimal impact criteria	Impacts that are predicted to be less than the 'minimal impact criteria'	Impacts considered acceptable
Level 1 Slightly greater than minimal impact criteria	Impacts are in excess of the Level 1 minimal impact criteria but no more than the accuracy of an otherwise robust model	Impacts within the range of acceptability. Additional monitoring required and potential additional mitigation and remediation during operation
Level 2 Greater than minimal impact criteria	Impacts are in excess of Level 1 by more than the accuracy of an otherwise robust model	Additional studies required. Impacts then considered within the range of acceptability if the additional studies can demonstrate that the long term viability of the resource is not compromised

Hume Coal concurs with the classification of Level 2 impact for drawdown in landholder bores. Hume Coal has taken a conservative approach and included all bores that are impacted by 2 m or greater on the basis of the conservative 67th percentile model predictions – a total of 94 bores. These 94 bores are all included in the detailed make good assessment, even if the drawdown is only marginally over the 2 m threshold and the viability of the bore is unlikely to be impacted. The revised make good Assessment (Appendix 2), addresses the above 'action required' for a Level 2 impact. These additional make good studies, as required by the AIP, demonstrate that the long term viability of the water dependent assets within the Sydney Basin Nepean Groundwater Source are not compromised.

If a project is assessed to cause a Level 2 impact it does not mean the project cannot be approved under NSW legislation. It does mean that additional studies, conditions and mitigation measures are required for the project before it is approved, and Hume Coal has done this and is committed to continue to do required additional studies and assessment around making good predicted impacts to landholder bores.

There is reference in many submissions with regard to triggering the 'precautionary principle' if the project approval poses both a threat of 'irreversible damage to the environment' and 'scientific uncertainty'. This threat is not present for the Hume Coal Project. The revised EIS model predicts full recovery of groundwater pressures over a relatively short period of time (ie compared to many other mines that have recovery times in the hundreds of years), and the very detailed uncertainty analysis provides a high degree of scientific certainty. The uncertainty analysis has reduced the uncertainty of the project's impact significantly. Detailed discussion on this is included in the revised model report (HydroSimulations 2018) in Appendix 2. Further discussion on the precautionary principle is provided in Chapter 6.

e. **Commonwealth Government referral**

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) and its constituent policies require a proposal to be 'referred' to the Commonwealth Government if the project is considered to potentially have a 'more than significant impact'. A significant impact for water resources is one that is defined in the *Significant Impact Guidelines 1.3: Coal Seam Gas and large Coal Mining developments - Impact of Water Resources 2013*. These guidelines require projects to be referred if "a significant impact on a water resource is a real or not remote chance or possibility." Therefore, a conservative approach is taken with most new coal mining projects and modifications in NSW being referred to the Commonwealth Government's Department of Environment and Energy (DEE), and Independent Expert Scientific Committee (IESC) as a matter of precaution.

The Hume Coal project was referred to the Commonwealth Government and formal notice that the project could be assessed under the EPBC Act 1999 as a controlled action was received in December 2015. The referral under the 'water trigger' was undertaken in accordance with the Significant Impact Guidelines and the IESC guidelines for referral.

The Commonwealth Government does not mandate that projects with potential 'significant impacts' cannot be approved. They do, however, require projects to be referred and assessed by the Commonwealth Government for bi-lateral approval with the NSW Government.

The comments from the IESC were received and were considered in the modelling work after the release of the EIS (ie during the model audit, rework and uncertainty analysis). It should be noted that the detailed uncertainty analysis undertaken by Hume Coal was in accordance with the draft guidelines on uncertainty analysis released by the IESC for comment in March 2018 (Middlemis and Peeters 2018). Additional sensitivity was also undertaken in accordance with the comments received from the IESC in this regard.

f. Existing users

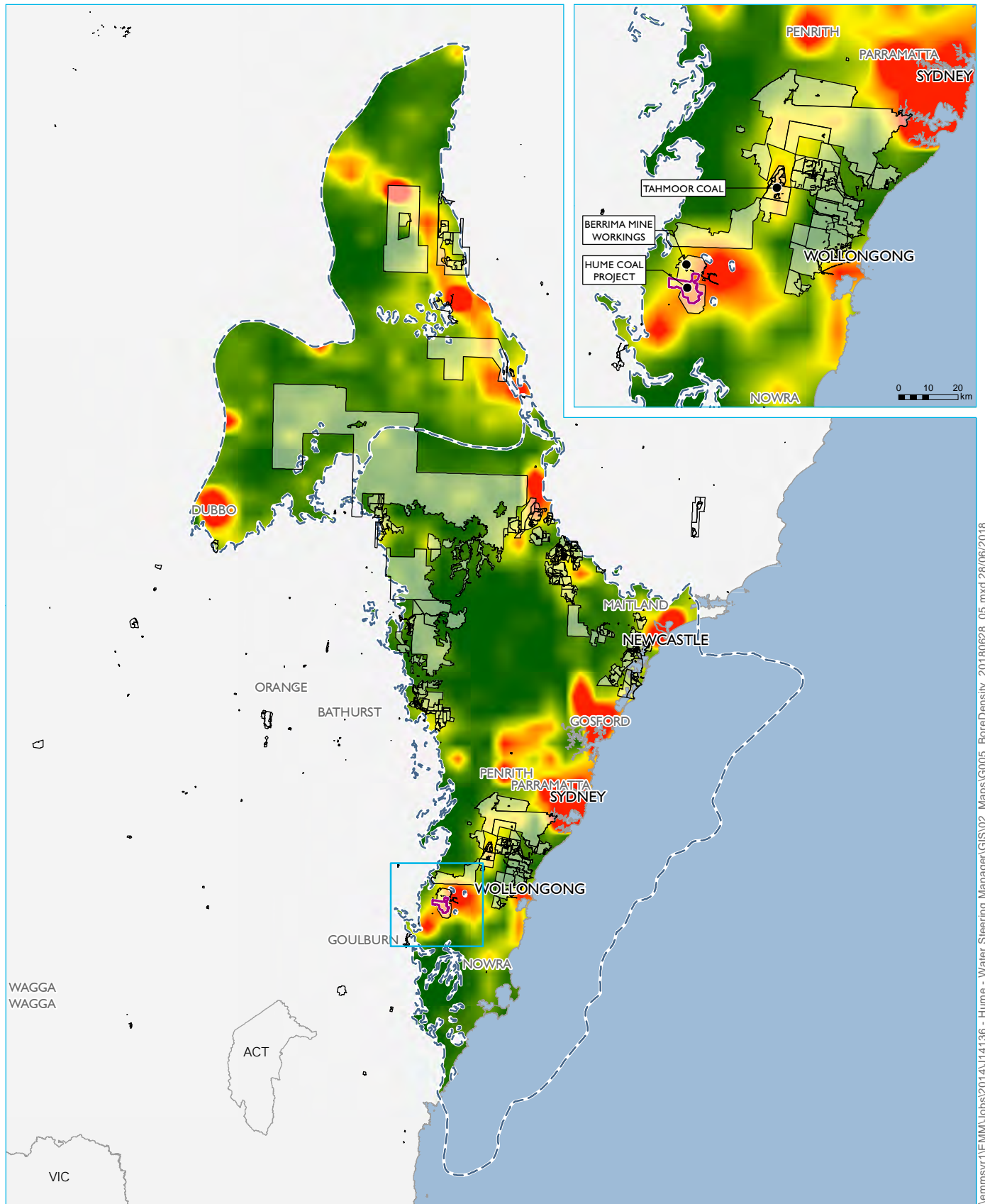
Groundwater extraction from landholder bores is not metered in this groundwater source and, therefore, no long term usage statistics are available for inclusion in the model. This non-metering of bores is common across areas of NSW where there is no obvious stress to groundwater resources (ie such as large sedimentary basins with significant storage and unassigned water). The main groundwater sources where metering occurs is the high value inland alluvial groundwater sources of the Murray Darling Basin, where high yield bores are metered and usage is recorded regularly throughout the year.

Assumptions on groundwater use from landholder bores have therefore been made in the EIS and revised models based on some likely usage rates and model calibration. Stock and domestic bores were assumed to extract 3 ML/yr, and bores with an associated water access licence are assumed to extract 97% of their licence entitlement each year. This is a relatively standard approach taken in modelling groundwater extraction where no usage information is available, and the high percentage of 97% provides contingency for increased usage during drought times, potential over extraction from some bores, and take from unlicensed and unregistered bores.

Bore construction records were obtained from the NSW Government groundwater database for registered water bores, and this information was analysed to determine what formation and what layer/s groundwater was extracted from. This is required to predict regional drawdowns and the expected drawdown at individual bores. Where bore construction records were not available a conservative assumption was made (ie that the Hawkesbury Sandstone is fully open and extraction occurs across all layers). This conservative assumption means that the predicted drawdown at a bore will be the maximum that can be experienced at that location.

A landholder bore survey was proposed and attempted to obtain baseline data. During this process all landholders with bores likely to be impacted were contacted to measure the water level, water quality and to obtain historical records on existing bores (ie construction, pump depths, usage patterns etc). There was minimal participation in this voluntary survey and therefore only a few properties were able to be visited. Subsequent attempts to garner landholder participation throughout the EIS preparation and 'make good' process have been made to engage directly with landholders to obtain information specific to their bores and their water needs, but with limited success. The local anti-mining activist groups have actively encouraged local landholders with bores not to engage directly with Hume Coal, and this has meant that information in the NSW Government database cannot be verified on ground at this stage. Consequently, a highly conservative approach has been adopted regarding groundwater use and the make good assessment.

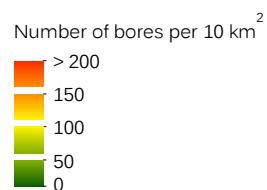
The predicted groundwater drawdowns are mostly concentrated within the area overlying and immediately adjacent to the mine area. There are 94 landholder bores directly overlying and in close proximity to the mine workings predicted to experience greater than 2 m of drawdown. The number of bores may be considered large in comparison to other similar size projects but this should be considered in conjunction with the minimal number of property purchases by Hume Coal, the small landholding sizes overlying the mine area, and the moderate to high density of water bores in the area. The number of landholder bores likely to be affected is not indicative of a widespread environmental impact and or larger than average drawdown from the mine itself, but is instead an indicator of a large number of small properties, all with bores and the resulting moderately high density of water bores (Figure 9.15).



Source: EMM (2018); DFSI (2017); DPE (2017); DPI (2016); GA (2013)

KEY

- Hume Coal Project boundary
- Mining and exploration lease areas
- Sydney and Gunnedah basins



Bore density in the Sydney and Gunnedah basins

Hume Coal and Berrima Rail Project
Response to submissions
Figure 9.15



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g. Cumulative impact

Climatic influences in the area continue to impact upon the local landscape. It is known that in dry periods, the water level in landholder bores can decline considerably. This rapid response is determined as a result of the increased landholder pumping (ie with limited surface water available groundwater is used as the back-up supply), as opposed to a direct effect in that year of reduced rainfall or infiltration. This is common in large groundwater sources such as the Sydney Basin, where the annual impact of reduced rainfall recharge in dry years dampened by the large storage, but groundwater pumping dominates the influence on seasonal groundwater levels.

The Hume Coal EIS states that “There are no potential future projects in the planning process that would influence the assessment of the Hume Coal Project in relation to potential groundwater impacts. Therefore, no cumulative groundwater impacts are predicted.” This statement is questioned in some submissions based on the likelihood that many landholders may have plans for the future. Hume Coal has considered all consumptive groundwater users in the area, and all water access licences have been fully considered in the assessment of cumulative impacts (see Section 9.3.5 (vi)). Even though new projects may emerge in the future, the water licence volume is already capped so new cumulative impacts are most unlikely. Also, it is not an expectation of the NSW Government and the planning and approval processes that future ‘unknown’ projects are considered.

At a recent IESC consultant roundtable discussion in Brisbane on April 11 2018, the IESC confirmed that cumulative impact assessment needed to consider publically available information on proposed developments, and not confidential or non-disclosed future plans. Hume Coal has done this, and does not dispute that some landholders may have future development plans for their properties and their water; however, for the purposes of the cumulative impact assessment as required by the NSW and Federal Government, the original statement in the EIS remains correct.

Cumulative impacts versus Hume Coal only impacts are presented in the EIS model. Cumulative impacts consider all water users (ie landholder pumping and ongoing outflow from the Berrima Mine), and is termed ‘total drawdown’ in the EIS. The project-only drawdown (ie drawdown as a result of the Hume Coal project only), is termed ‘differential drawdown’ in the EIS model reports, and shows the impact of the Hume Coal project irrespective of other current stresses on the system.

Due to the effective embargo on additional licences within Management Zone 1, and the assumed extraction from water access licences of 97% of the licence volume allocated, it is not possible for new or existing users to take additional water from within this zone. New users to the area will need to purchase licences from existing users, so the overall water extraction from the area will remain stable over time and it is unlikely that there will be a greater cumulative impact than what is predicted in the revised model.

The total groundwater within the Sydney Basin Nepean Groundwater Source is illustrated in Figure 9.16. Note that in Management Zone 1, the total of all water access licences (ie not including stock and domestic users) is 12,553 ML/yr. The maximum annual extraction of water from the Hume Coal mine is 1,010 ML/yr, but the maximum volume required to be licensed per year, which includes intercepted baseflow and inflow to the mine void that is not physically removed from the groundwater source, is 2,066 ML/yr. This means that Hume will hold 16% of the available allocated volume, but will only ever remove 8% of the available allocated volume from the groundwater source, in two of the 20 years of mine operation.

Within the Management Zone 1, existing users can extract 84% of the water volume available for use each year. The physical access to this water is guaranteed via make good arrangements for existing users local to the mine area and that are predicted to experience drawdown of 2 m or more in their bore as a result of mining.

This simple analysis of licence volumes within the overall sustainable volume available within Sydney Basin, Nepean Groundwater Source - Management Zone 1 explains why regionally the mine does not represent a threat to the groundwater resource, and why the cumulative impacts of all consumptive users is significant when considering the total drawdown in landholder bores as a result of the project.

If we consider the Hume Coal licence and take in the context of the sustainable limit of the Sydney Basin Nepean Groundwater Source (ie the LTAAEL), the volume Hume Coal will hold in licences is approximately 2% of the sustainable limit, and their physical removal of water from the water source is 1% of the greater water source sustainable yield.

In the revised groundwater modelling work undertaken by HydroSimulations (Appendix 2), the analysis undertaken addresses cumulative impacts of all existing, and future known stressors within the groundwater resources of the area. There are no new volumetric groundwater licensing being granted in Zone 1 of the Sydney Basin Nepean Groundwater Source, and therefore, any new groundwater user will need to purchase from existing users. This means that no additional extraction (ie over and above current extraction levels) will occur in the future, so cumulative impacts are inherently considered. There are no known new developments that are likely to require the movement of significant groundwater licence volume closer to the Hume Coal Mine.

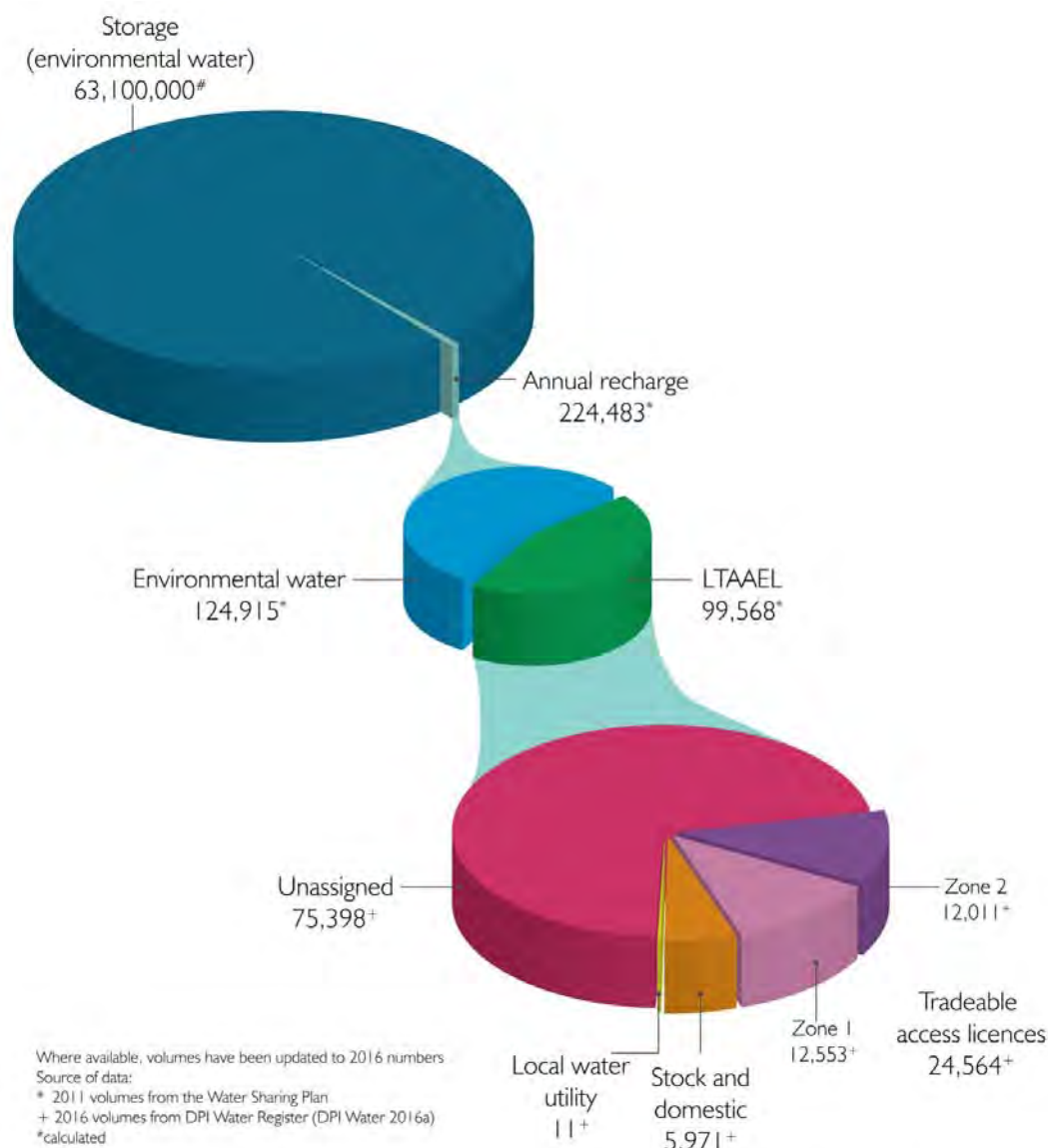


Figure 9.16 Sydney Basin Nepean Groundwater Source available water (ML/yr)

9.3.6 Calibration

NSW DPI (including DI Water) had concerns that the calibration method for the EIS model was trial and error and not aligned with an optimisation program such as PEST.

They also stated there was limited presentation of calibration results in the EIS and requested to include hydrographs illustrating calibrated versus measured piezometric levels.

Mass balance errors were also questioned.

DI Water suggests the model is not adequately calibrated, due to attempts to calibrate it to four different variables.

Rerunning the EIS model with updated solver settings in MODFLOW SURFACT V4 yielded much lower mass balance error than reported in the EIS (Coffey 2016b). Table 9.7 shows a comparison between the reported mass balance percentages from the EIS model and the re-run conducted by HydroSimulations (2018).

Table 9.7 Comparison of cumulative mass balance errors

Model Run	Cumulative Percent Discrepancy	
	EIS model (Coffey 2016b)	EIS model Re-Run (HydroSimulations 2018)
Calibration	-3.8	-0.15
Prediction	-27.6	-0.15

The re-run of the EIS model in the updated software showed some improvements in the key calibration statistics of the Root Mean Square (RMS) magnitude and the Scaled Root Mean Square (SRMS) percentage. The revised calibration statistics have been conducted on all available, time-series calibration data as opposed to the 'last available observed water levels' presented for the EIS model (Coffey 2016b).

Table 9.8 shows a comparison between the reported calibration statistics from the EIS model and the re-run conducted by HydroSimulations (2018).

Table 9.8 Comparison of key calibration statistics

Key statistic	EIS Model (Coffey 2016b)	EIS model Re-Run (HydroSimulations 2018)
Number of Data Points	49	2502
Residual Mean (m)	3.11	3.7
Absolute Residual Mean (m)	12.14	12.19
Root Mean Square (m)	17.06	15.41
Scale Root Mean Square (%)	11.9	10.76
Correlation Coefficient	0.795	0.77

Additional model hydrographs are presented in the revised model report (Appendix 2). DI Water required more demonstrated evidence of calibration, but their submission agreed with the EIS model results as they stated that the calibration parameters, of hydraulic conductivity, stream flows and discharge to voids are all within the plausible range.

The DI Water comment that the calibration to four variables is commendable, but they also state that the calibration is 'inadvertently solved' due to the water balance errors. This is strongly refuted by Hume Coal and the modelling team. The calibration for the EIS was undertaken with great care and in accordance with industry best practice. The updated solver settings in the revised model yield significantly improved mass balance errors, and demonstrate clearly that the EIS model is very well calibrated. The NSW Government independent peer reviewer, Hugh Middlemis, agrees that the calibration is satisfactory (Hydrogeologic 2017):

"Is the model calibration satisfactory? Yes Acceptable model calibration performance and good time series matches at most bores (except 2 of 6 VWP's which is not unreasonable). EIS report states 11.9% SRMS, exceeding 10% criterion, but refinements have reduced the SRMS to <10%, and water balance error terms to <0.5% (see section 2 and Appendix A), which is satisfactory.

Calibration of aquifer property values (Kh, Kv, S, Sy) has been well constrained by pumping test estimates of property values, and by simultaneously honouring observed groundwater levels, along with the measured Berrima mine inflow (deep system) and inferred stream baseflows (shallow system).

This is a best practice approach that reduces model non-uniqueness problems (that many different sets of model inputs can produce nearly identical aquifer head distributions).... "(Hydrogeologic 2017).

9.3.7 Peer review

One interest group stated that independent peer review is required to meet the requirements of the Aquifer Interference Policy.

The community raised concerns that the peer review tables had comments on some model aspects that stated 'insufficient or inadequate', but that the overall model was signed off as 'fit for purpose'. The community claimed that this is not acceptable for some deficiencies to be realised, but the overall model is considered acceptable.

Two detailed peer reviews of the original EIS model were undertaken by pre-eminent hydrogeologists: Dr Noel Merrick and Dr Frans Kalf. The reviews are included in Appendix 2. These reviews were in accordance with industry best practice, which considers both the Murray Darling Basin Commission Groundwater Flow Modelling Guideline (Middlemis et al. 2001) and the Australian Groundwater Modelling Guidelines (Barnett et al. 2012).

The peer review by Dr Noel Merrick declares that the EIS model is 'fully compliant with the guidelines and often goes beyond state of the art techniques', and in respect of the Aquifer Interference Policy, the 'minimal harm consideration is explored fully'. Noel Merrick concludes 'that the model is *fit for purpose*'.

The peer review by Dr Frans Kalf concludes that 'the hydrogeological description conceptualisation model design simulations have been conducted in a professional manner and the exposition of these activities in the two Coffey reports are described in detail. No major flaws in the hydrogeological information or the modelling have been detected in the reports Volumes 1 and 2'.

The final conclusions of the two peer reviewers, Dr Noel Merrick and Dr Frans Kalf, were that the EIS model was fit for purpose.

The model checklist appraisal by Dr Noel Merrick has 37 line items that were assessed for adequacy and 35 of these were considered adequate. Of the two that were not adequate, one relates to the model time horizon (which no mining model for an EIS would ever achieve a satisfactory ranking as it requires a time horizon for baseline to be comparable to the prediction period). The NSW Government only require two years of baseline data but want model predictions to be made for the entire period of mining and recovery and this is considered acceptable. The only other item of the 37 assessed that was not considered adequate was the sensitivity analysis. The final conclusion of Dr Noel Merrick that the model is 'fit for purpose' is considered highly defensible. However, it is noted that since the EIS, additional sensitivity analysis has been undertaken in the revised groundwater model (Appendix 2).

The model appraisal checklist by Dr Frans Kalf also considered 37 line items and of these 34 were considered adequate and three were considered not adequate. Dr Frans Kalf identified the same model time horizon criteria, but also considered that there was a deficiency of climate modelling and testing of different mining method techniques. However, overall these are considered minor points and the overarching conclusion that the model is fit for purpose remains defensible. It should be noted that since the EIS additional climate sensitivities have also been undertaken in the revised groundwater model (Appendix 2).

Subsequent to the EIS and submissions on the groundwater model, and prior to undertaking the revisions to the EIS model, a series of meetings with the NSW Government water regulators occurred. Consultation on the EIS model and required additional model considerations were undertaken and agreed upon. The NSW Government also engaged an independent peer reviewer, Hugh Middlemis to provide a detailed review of the model, and associated input data. The initial output from Hugh Middlemis was the preparation of an issues log, which identified the main points requiring clarification and/or suggested additional work on the EIS model (Hydrogeologic 2017).

The NSW Government independent peer review of the numerical model by Hugh Middlemis (Hydrogeologic 2017) recommended some final changes in the revised groundwater model. These recommendations were adopted and actioned upon prior to finalising the revised EIS and model report.

Based on the: EIS submissions, the further audit by Dr Noel Merrick, and the preparation of the 'issues log' by Hugh Middlemis, a model revision by HydroSimulations was then commissioned by Hume Coal together with the detailed uncertainty analysis.

The model revision and uncertainty analysis was based on the comments and agreed requirements of the NSW Government, selected submissions on the EIS, the independent peer reviewer issues log (Hydrogeologic 2017) and confirmed at the meeting with DI Water in August 2017.

The NSW Government independent peer reviewer has reviewed both the original EIS model and some outputs from the revised model and uncertainty analysis. It is noted that the independent peer reviewer chooses to reference both the Murray Darling Basin Modelling guidelines (Middlemis et al. 2001), and the more recent Australian Groundwater Modelling Guidelines (Barnett et al. 2012) in his review. The NSW Government independent peer reviewer concludes that both the EIS and subsequent approach for the revised EIS model is 'fit for purpose' (Hydrogeologic 2017).

"it is my professional opinion that the Hume Coal model is fundamentally consistent with best practice in design and execution, although the EIS documentation is deficient (not sufficient clear on some details). It is fit for mining project impact prediction purposes."

9.4 Predicted groundwater impacts

9.4.1 Inflow to mine and generalised groundwater impacts

Submissions by interest groups raised the following concerns with relation to inflows to mine and general groundwater impacts:

- Concerns that substantial inflow to the mine will occur and impact the overlying Hawkesbury Sandstone aquifer, and that mining of coal threatens groundwater.
- Water management concerns generally.
- Concerns that cumulative impacts do not consider projects unknown to the proponent (ie landholder development plans for the future).
- Concerns that the Hume Coal PEA did not fully consider mining related drawdown impacts.
- Concerns that impacts are not acceptable.
- Many believe other studies (ie Pells) are more reliable.

Business groups raised concerns over impacts to Sydney's drinking water supply and general concerns about the inconvenience of the mine.

Many community submissions received were aligned to the above concerns of the impacts as predicted are unacceptable, that the impacts as predicted are under estimated and they raise very alarmist sentiments about total destruction and irreparable damage to a 'pristine/world class' system. Community members also raised concerns that exploration holes and monitoring bore drilling will potentially impact the groundwater resource.

Community submissions suggested that a mine should never be considered at this location due to the current overlying landuse, and that the risk of proceeding is just too great. The community submissions likened the mining of coal to pulling a plug in a bath, and included an assumption and fear that the water will drain totally away.

The community submissions raised concerns that promises have been made that groundwater will not be threatened by the project now appear to be incorrect.

i Allowable impacts

Approval by the NSW Government has been granted in this area for exploration activities since the mid 1950's. These approvals have been granted to various companies over the years and exploration drilling activities at the Hume Coal site have occurred via a number of programs up until the exploration area known as A349 was granted to Hume Coal (Table 9.9). The fact there have been a continual granting of the right to explore with the intent to develop a coal mine in the area, as issued and endorsed by the NSW Government the area is deemed suitable for coal mining activities, provided environmental impacts can be managed and mitigated. Hume Coal has a legal right to explore and undertake works to inform the EIS and with a view to obtain approval to mine the resource (provided impacts can be adequately managed).

Table 9.9 History of exploration – prior to Hume Coal in 2011

1956-1957	Illawarra Coke Company
1968 (?)	Southern Portland Cement (Blue Circle Southern Cement)
1968-1971	Bellambi Coal Company
1970-1971	Austen & Butta
1971	Southern Colliery Extended
1986	Austen & Butta/ Bellambi Coal Company

The water resources of the Southern Highlands area are currently used for industry, agriculture and as a drinking water supply. In respect of the local water sources, no additional licences are being granted by the NSW Government in the surface water system or in Management Zone 1 of the Sydney Basin Upper Nepean Groundwater Source. Although the Sydney Basin Nepean Groundwater Source is not fully allocated, with significant volumes of unassigned water available, at this stage additional shares are only being released into Management Zone 2 of the Sydney Basin Upper Nepean Groundwater Source. The Hume Coal water assessment demonstrates that this project can be approved and works within this same paradigm, of maximising development and sustainably using water, while also protecting future use. The Hume Coal project will take and use water resources within these sustainable limits and consequently the project will contribute economically to the local community and the state of NSW.

The NSW planning legislation recognises that impacts from developments will occur, and environmental protection is afforded through the consent conditions, and environment and water licences. Potential impacts are assessed in the EIS (in accordance with policies, regulations and guidelines), and where impacts are predicted, an assessment of the risks and mitigation management of the impacts is required. The Hume Coal water assessment, and in particular groundwater assessment has been completed in accordance with all required guidelines, policies and with ongoing consultation with the NSW Government.

In particular, the AIP defines two levels of impact, and allows for a Level 2 (Greater than minimal impact) to occur, and to be approved. It states that if a more than minimal impact is triggered (ie Level 2 impact), then more studies are required and management and mitigation measures (ie make good arrangements) are required.

The Hume Coal EIS clearly states Level 2 impacts to water levels will occur for local groundwater users close to the mine. The predicted impacts are considered in terms of the legislation and policies (ie the AIP), and the legislation allows for these impacts to occur so long as certain conditions such as mitigation strategies, ongoing monitoring, management plans and make good arrangements are fulfilled. There will nearly always be a groundwater impact associated with any mining project and the assessment and consideration as to how drawdown will be managed is important.

It is noted that the latest groundwater modelling and uncertainty analysis undertaken for Hume Coal is industry best practice. This is recognised by those in the groundwater industry as leading practice and demonstrates that Hume Coal is fully committed to understanding the potential impact of underground mining on the important water resources of the Southern Highlands.

ii Exploration and monitoring bores

Exploration drilling and construction of groundwater monitoring bores is required to assess local aquifer characteristics, baseline conditions, surface water-groundwater interaction, and the overall merits of a project. These activities are strictly controlled, with licence renewals, inspections, and policies and guidelines required every step of the way. Drilling and construction of monitoring bores, and sealing of exploration holes is undertaken in accordance with relevant standards and requirements, such as the *Minimum Construction Guidelines for Water Bores in Australia* (NUDLC 2012). The drilling activities for mining (ie exploration and construction of monitoring bores) is more strictly controlled and regulated than drilling activities for agricultural purposes.

iii General impact considerations

Groundwater inflows to the mine workings will occur and this will be managed by pumping groundwater to surface to augment water demand for mine operations, and by pumping water back into previously mined panel areas sealed with bulkheads. Depressurisation of the overlying sandstone will occur, but full desaturation of the Hawkesbury Sandstone aquifer will not occur.

The risks to the groundwater system have been fully assessed, all work has been peer reviewed and results are openly declared and discussed in the EIS. The EIS numerical model has been revised in accordance with the NSW Government requirements and subject to NSW Government independent peer review (Hydrogeologic 2017) and is found to be 'fit for purpose'.

The surface water management regime is discussed in detail Chapter 8 and the Revised Water Assessment (Appendix 2). No mine water discharges direct to the environment are proposed. The project presents no threat to the water resources of the Southern Highlands or the water supplies for greater Sydney. The results from the yield assessment for greater Sydney indicate that there is a predicted reduction in yield in the Lower Wingecarribee River of 0.02% in wet conditions and 0.05% in dry conditions, and this catchment has the highest percentage impact and is considered insignificant (Appendix 2). The impacts on groundwater resources are clearly assessed, and although localised impacts to groundwater users are greater than the minimal impact considerations proposed in the AIP, there are no regional impacts.

Alternative groundwater studies (Pells and Pells (2013), Pells and Pan (2017)) were commissioned by the community, and suggest greater drawdown and mine inflow impacts than the Hume Coal EIS model. These studies have been reviewed (Appendix 2), and their associated submissions fully considered. Some additional improvements have been incorporated into the revised groundwater model and uncertainty analysis following the receipt of submissions and the Government submissions. The EIS model is calibrated and more robust, and the predictive results of this model are more reliable and more accurate than the Pells' model (EMM 2018b). Ultimately the independent peer reviewer appointed by the NSW Government, Hugh Middlemis, has the final scientific assessment of adequacy and he has concluded that the EIS model (with its associated model and reporting improvements) is suitable for assessing impacts related to the Hume Coal project (Hydrogeologic 2017).

9.4.2 Landholder bores

NSW DPI (including DI Water and) and NSW DPI – Agriculture had concerns that there has been insufficient consultation on make good with potentially affected landholders, in respect of the movement of water access rights from agriculture to mining.

Insufficient detail on ongoing groundwater monitoring and management and planning.

Insufficient detail on the consultation process for make good, and additional information required for details of individual make good agreements.

The NSW DPI commented that the make good strategies were 'reasonable considering the circumstances', but raised points for clarification and consideration such as:

- Increased pumping costs for all bores subject to make good.
- That pump lowering is not always practical (bore age, construction and siltation need to be considered).
- Deepening bores may produce different yields, and different water quality.

Consideration for surface infrastructure locations if replacement bores are relocated to another area of the property.

Questions over how dispute resolution will be managed is raised.

Business groups raised concerns that businesses that use groundwater will be impacted due to changes to groundwater levels and quality. They also stated that the 'aquifer' will be ruined, and irreversible damage will occur and that bores will be ruined and not longer able to be used. They also stated that the site is unsuitable for mining due to current use of overlying land and number of bores.

Some businesses praised the EIS study and stated that they were very happy with the analysis undertaken and that they believed that any impacts to them have been considered and would be actively managed and mitigated.

Interest groups raised concerns that predicted drawdown impacts may threaten local businesses' water availability and therefore indirectly influence the property market. In particular, there were concerns around agriculture industries (ie individual properties with volumetric entitlements), tourism businesses (bookstores and irrigation of gardens, wedding venues), and general tourism and attraction of visitors to the area.

They also submitted concerns that the Hawkesbury Sandstone will be dewatered and impact local businesses that rely and use the underlying groundwater source, including Berrima town people.

Interest groups were also concerned that greater than predicted drawdown in the groundwater system and in bores will occur, and that the Pells models are more correct than the Hume Coal EIS model.

They also held concerns about the logistics of providing water for properties that require make good arrangements (particularly those with irrigation licences) and that the make good arrangements would pose unacceptable burdens on landholders.

Interest groups were also concerned about excessive impacts during El Niño and droughts.

Many community submissions received were aligned to above concerns of the impacts to bores as predicted are unacceptable, that the impacts as predicted are underestimated and they raise very alarmist sentiments about total destruction and irreparable damage to a groundwater resource that can then never be 'made good', and they were concerned that that some bores will go dry permanently.

They raised the risk of impacting landholder bores for this duration and to this extent is just too great. They held concerns that impacts to local gardens, agriculture practices (irrigation and stock), domestic supplies and drinking water are too great, and question the trigger point for make good strategies being applied.

They raised that make good strategies are not sufficient, that they don't want make good, that they want their water access left as it currently is, and that the make good strategies as proposed are not practical, are not wanted and that Hume Coal has not consulted sufficiently. The community is generally very sceptical of the ability to 'make good'. They question the process for conflict resolution in the make good agreements and when they should apply.

Community members also raised concerns that not all bores that could be impacted are being considered, and that those at a distance from the lease are being ignored.

The community made reference to the New Acland Court proceedings and raise concerns that once impacts occur the balance of power resides with the mine and the onus is placed on the landholder to demonstrate they are impacted.

In NSW, a project can have impacts on other users that are deemed 'greater than minimal impact', but these impacts must be managed and mitigated via 'make good provisions'. Hume Coal acknowledge that there will be changes to groundwater levels in excess of the 'minimal impact criteria' proposed by the AIP, and therefore Hume Coal commits to negotiate make good arrangements with these users, in accordance with any relevant conditions of consent. The presence of the mine will not threaten local businesses ability to access water for their operations, and will therefore not influence the property market. Hume Coal is committed to the principle of maintaining existing users' access to water and making good any impacts deemed to be greater than minimal impact.

Partial depressurisation of the Hawkesbury Sandstone aquifer overlying the mine will occur as mining progresses, with some dewatering near the water table. Shallow bores in the sandstone that are not fully penetrating will be the most impacted as drawdown occurs (they may not experience the greatest drawdown but because of their shallow depth they may go dry). Greater water level drawdowns will occur in the deeper sandstone, but groundwater will still occur in these rocks (ie they will remain saturated). The majority of the Hawkesbury Sandstone will remain saturated throughout mining. The Hawkesbury Sandstone aquifer will not be 'drained', 'cracked through' or 'destroyed'. It is depressurised, and as a result the water table will experience some drawdown, but not total dewatering. The integrity of the Hawkesbury Sandstone is not compromised and will not be 'damaged', as the mine is designed to result in minimal levels of overburden deformation. There is no irreversible damage to the Hawkesbury Sandstone, as groundwater levels will fully recover in time.

The make good analysis considers both the depressurisation and drawdown/dewatering impacts of the project on individual landholder bores (ie reduced yields and water levels) and has used the detailed uncertainty analysis to provide greater confidence in the predictions for each individual landholder bore.

The conclusion of the NSW DPI in respect to impacts on landholder bores is that the proposed strategies were "reasonable considering the circumstances". The detailed uncertainty analysis undertaken in the model rework estimates that 94 bores will experience drawdown of 2 m or greater as a result of the Hume Coal Project. This number (94), is based on the conservative 67th percentile which is the boundary between 90-67th percentile (ie unlikely to occur under normal conditions), and the 33-67th percentile (about an equal chance of occurring as not). Hume Coal has taken a conservative approach in adopting the 67th percentile for make good arrangements, rather than the 50th percentile which would have reduced the number of affected bores significantly.

Should the property ownership change prior to the negotiation and implementation of a make good agreement, the requirement for make good, in accordance with the conditions of consent, will remain in place for that individual bore.

The make good strategy contains a number of options for maintaining water supply for landholders. The initial assessment has identified some key overriding principles to categorise bores into groups based on their level of impact and bore construction (ie depth). Field inspection, agreement with landholders and the practicalities of the make good options need to remain flexible to ensure the most appropriate make good arrangements are made for each individual bore and each individual landholder.

Ongoing monitoring of the actual drawdown in landholder bores and across the groundwater monitoring network is required to verify model predictions and the timing of impacts. This information will be critical to ensure the make good arrangements are coordinated efficiently with landholders. It is also recognised that different strategies may need to be adopted for an individual bore over time. The consultation with individual landholders will be ongoing. Make good agreements will be legal commitments to ensure that agreed and acceptable outcomes can be obtained. The method for achieving these outcomes and the timing of implementation of make good arrangements will be supported by verifiable data from affected bores and the monitoring network, and clearly stated in agreements.

The revised make good assessment (Appendix 2) further considers the scale and number of bores potentially requiring make good works, and provides significantly more detail on individual bores and the logistics of implementing such a program. Timing of this is important, as not all bores will experience drawdown at the same time.

The Hume Coal Project drawdown impacts need to be considered in relation to the cumulative impacts generated by other users, and as outlined in Section 9.3.5 (xiv). In areas distant from the mine, perceived impacts to individual bores are more likely to be the result of seasonal conditions, bore or pump problems, and/or usage by others users, and this will be considered when addressing make good strategies for these areas.

The effect of drought has been considered with respect to drought sequences, and climatic patterns such as ENSO (El Niño Southern Oscillation). This climatic variability is included in the groundwater modelling and uncertainty analysis presented in the updated groundwater model report (Appendix 2).

ii Impacts to agriculture and other consumptive users

The groundwater drawdown predictions on landholder bores is subject to the provisions of the AIP, with bores experiencing drawdown of 2 m or greater requiring 'make good' provisions. This assessment has been undertaken in great detail. Consultation with potentially impacted landholders has occurred on several occasions via letters, advertisements in the local paper and phone calls (details on consultation outlined in Appendix 2).

The NSW DI Water provided Hume Coal with a comprehensive listing of all existing water bores late 2015 for use in the EIS (this list was then updated by WaterNSW on 27 April 2018), for an area well in excess of the predicted area of influence of the mine (ie a distance in excess of 5 km from the mine boundary). This list identifies the location of all known bores and their associated licence/approval. Individual bores can then be linked to the groundwater database and their construction details and associated information at the time of construction can be extracted. The location of each bore (and their associated screened interval) was then reviewed against the revised model and the model run to predict drawdown at every location. Hume Coal are therefore confident that all known bores that are in the area have been included in the assessment, and is using the 67th percentile results to conservatively predict potential drawdown impacts for each of these bores.

Movement of water from the agriculture sector to mining has occurred via the purchase of Water Access Licences on the open transfer market. No distinction or priority of access exists in the WMA2000 for uses other than basic rights or town water supply, so both mining and agriculture uses have the same priority for access. The economic assessment of agriculture is outlined in Chapter 17.

The revised water assessment for the project comprises a water monitoring plan, which outlines the ongoing monitoring proposed for the project. This plan outlines how the monitoring network will be sufficient to monitor the project impacts and provide information for model verification over time. This plan will be revised and updated to include requirements from the NSW Government as outlined in the conditions of approval for the project. The onus will be on Hume Coal to monitor the drawdown impacts in their monitoring network, other nominated sites, and work with the community as 'made good' arrangements need to be implemented.

iii Consultation on 'make good'

Consultation on 'make good' commenced in 2016 with several avenues pursued to encourage landholder participation with water bore assessments and 'make good' requirements. The communication strategy included letters, advertising on the local radio and in the newspaper, and phone calls to individuals.

The specific details of likely impacts to individual bores were not known until the EIS model was developed. Prior to this, general information and communication of the project and potential impacts were ongoing. Consultation with individuals on likely impacts to water bores occurred promptly once the model was developed and predictive results were available. This occurred with the exhibition of the EIS. It appears that some in the community are frustrated with insufficient specific consultation occurring on impacts to bores. However, Hume Coal maintains that a considered approach using quality data and peer reviewed results were required before communicating likely impacts to individuals. Only those landholders with bores predicted to experience drawdown of in excess of 2 m were consulted directly with regarding the details of their individual bores. Communication with landholders and the community in areas beyond where 2 m drawdown in bores is predicted has been undertaken but has been more general in nature and not targeted specifically at individual bore owners.

There is an ongoing conversation about the AIP and the requirements for 'make good' arrangements for those bores overlying the mine that are likely to experience drawdown. This conversation to date has been undertaken publically, and also via the Hume Coal Water Advisory Group members.

All landholders with bores that were expected to experience a drawdown in excess of 2 m as predicted by the EIS groundwater model were contacted in January 2017 and in May 2017 via individual letters. Individuals were encouraged to provide information to Hume Coal on their bore, and also have their bore surveyed. This field inspection is important to verify the latest information about the bore against the DI Water groundwater database which only archives the 'as constructed' bore data. Limited responses from landholders have been received, and therefore field verification and detailed one-on-one consultation with landholders has been difficult.

In summary the 'make good' consultation has comprised:

- 148 letters - two rounds of individual letters to all individuals identified as being impacted by more than 2 m (January 2017 and May 2017), and additional ad hoc letters;
- 43 emails for various enquiries;
- 75 phone calls;
- 9 meetings;
- 2 media releases;
- summary project document releases;
- fact sheet releases;
- updates to the Hume Coal website; and
- use of social media (ie Hume Coal Facebook page).

The Water Advisory Group provided a valuable community engagement platform during the development of the EIS. Ongoing consultation with landholders within a formal committee manner will be subject to discussions with both the NSW Government and the local community in the future.

iv 'Make good' detail for individuals

The revised version of the 'make good' assessment (Appendix 2) provides a greater level of detail for each individual bore predicted to experience a drawdown of 2 m or more as a result of the project. Individual bores have been reviewed in great detail, with individual 'make good' options and their applicability over time being explored. Consultation with individual landholders is ongoing, with many landholders preferring not to engage with Hume Coal on this issue at this time due to general concerns about the project and on advice from local interest and activist groups.

The age, construction details and status of individual bores is currently based on the NSW Government bore construction records. Advice from the local community is that regardless of age, bores in the area continue to perform over time, so at this stage no discount for bore age has been applied to the 'make good' assessment. However, field verification of the bore status, condition and current use is required as part of the necessary process for 'make good' arrangements for individual bores. Reluctance for some landholders to engage directly with Hume Coal means that limited direct consultation and field inspection of bores has been undertaken to date.

Field inspection of each location and possible downhole inspection (ie using cameras or logging equipment) is proposed prior to finalising individual 'make good' agreements for bores. Individual bore assessments have not been undertaken due to numerous access restrictions. This has hindered Hume Coal's desire to consult with landholders and to progress individual make good bore arrangements.

Agreements with landholders on the strategy that meets their specific requirements will be negotiated. The most suitable 'make good' arrangement for individual properties may vary and, therefore, flexibility with the exact details as to how water will be supplied is required.

Make good arrangements will remain in place up until groundwater levels have recovered to within 2 m of the original water level prior to mining. Make good arrangements are not required for water quality, as water quality impacts are not predicted to change the beneficial use category of the groundwater source and are therefore within minimal impact criteria.

v Additional strategies for 'make good'

It is acknowledged that the pre-mining pumping rates in bores that will experience significant drawdown may reduce during the period when water levels overlying the mine are lowered. This has been considered in the make good assessment, and should this occur, options such as an increased capacity pump, lowering of pumps, a second bore and/or increased water storage facilities at the surface will be incorporated into the make good agreement so that the water supply can be maintained at the level required and previously delivered. The updated make good assessment report (Appendix 2) contains additional detail on this and details for a staged approach for individual make good assessments.

It is also acknowledged that due to the very high iron levels in the natural groundwater system that iron encrustation of bores may also occur at a higher rate than occurs currently. Provisions for managing iron encrustation in bores that are drawn down significantly can form part of the revised 'make good' arrangements.

The combination of potential temporary yield loss and encrustation of bores and pipes may lead to less efficient water distribution networks for some landholders; this is acknowledged and can be incorporated in the revised make good arrangements.

Provision of water to properties via tankers is not proposed as a key strategy (particularly for large licence holdings); there are alternative options available that are articulated in more detail in the revised make good assessment report.

vi Provision for increased pumping costs

Provision for paying increased pumping costs or other compensatory measures are to apply to all bores that experience a water level decline that is in excess of 2 m from the baseline assessment. The lowering of pumps in the borehole has a capital cost (see below), but the lowered water level (not increased pump depth), determines the increased operating costs. Acknowledgement of these costs is incorporated in both the EIS and Revised Water Assessment versions of the make good assessment reports.

vii Provision for lowering of pumps

The lowering of pumps is proposed to maintain supply to overcome the predicted impact to individual bores. The considerations for lowering pumps include:

- the capital cost (ie pump column and electrics);
- potential additional capital costs (ie should pumps need servicing due to disturbance of the pump during its removal and reinstallation); and
- labour costs (costs associated with the removal and lowering of the pump, and potential additional maintenance costs associated with siltation and sedimentation at the base of the bore should removal be required).

Hume Coal acknowledges that lowering of pumps will not be practical in all bores. Technical limitations for lowering pumps may occur and this has been incorporated into the strategy of the make good assessment. The plan for make good at each individual bore is subject to technical feasibility, and in the process of lowering a pump in a bore it may become apparent that the pump cannot be lowered, or that lowering the pump will not resolve the potential reduction in water supply. Alternative solutions will be negotiated at that time with each landholder. This flexibility of approach is required so that the delivery of make good (ie ongoing water supply for all landholders) can be achieved.

The make good strategies that apply to each bore currently are based on the information, knowledge and understanding of publicly held records. Prior to field assessments to confirm the current status of individual bores, the strategy for an individual bore (ie the logical options based on information at hand) will remain in place.

viii Provisions for deepening of bores

For some shallow bores that are experiencing mine-induced drawdown and are not fully penetrating in the sandstone aquifer, deepening of the bore may be an option. It is acknowledged that in attempting to deepen some bores it may become apparent that it is not physically possible for various reasons such as: the original hole is not straight, partial or full collapse of bore and/or casing at depth, risk of losing drill equipment to rusted casing at the surface etc. Therefore, for bores identified as being suitable for deepening, the best proposition may be the provision of a new, deeper bore immediately adjacent to the existing bore. This is sometimes the simplest, quickest and most cost effective solution to deepening an existing bore.

ix Replacement bores

It is acknowledged and outlined in greater detail in the revised make good assessment report that the decommissioning of old bores may need to occur (ie if the landholder consents to this) in accordance with *Minimum Construction Requirements for Water Bores in Australia* (NUDLC 2012). Individual landholders may also choose to retain the original bore and this will be part of the individual negotiations and agreements for each landholder.

Redrilling of bores will be in accordance with industry best practice and utilise local knowledge of drilling and geological conditions to ensure successful outcomes for replacement bores.

Should a replacement bore need to be moved to a new site distant from an existing site, then consideration of the existing distribution network/power supply and provision for upgrading is included (and this is outlined in the revised make good assessment report). In relocating a bore there may be some changes to individual bore yield and this will be measured and considered upon drilling (strategies may be to construct a larger diameter bore, or to construct two bores in place of one).

Groundwater quality is typically very uniform within the Hawkesbury Sandstone and the Wongawilli Coal seam within the project area, and therefore changes to groundwater quality are not envisaged. Should a bore be constructed into the deeper underlying Illawarra Coal Measures, then the groundwater quality will be tested and if the beneficial use class is no longer maintained then options to rectify this will be investigated (and may include dilution with other water supplies). Water quality differences are considered to be very low risk, but are nonetheless considered.

x Dispute resolution

The AIP provides the framework for how impacts on bores as a result of a project approval are to be managed, and the AIP assumes that an outcome can be reached as it does not discuss dispute resolution mechanisms. The process for resolution of disputes is outlined in the make good assessment Appendix 2. Processes such as mediation, arbitration then legal proceedings may be required in some circumstances. Collectively with the NSW Government, Hume Coal will look to establish a local panel chaired by an independent party provide advice on make good matters.

9.4.3 Water table drawdown and potential impacts to ecosystems

Interest groups raised concerns regarding water table drawdown impacts to EEC, Southern Highland Shale woodland, and mature deep rooted trees. They also raised concerns regarding impacts to nationally important wetlands. Business groups raise concerns over impacts to the water table.

Many community submissions were received which were aligned to above concerns that the impacts as predicted are unacceptable, that the impacts as predicted are under estimated and they raised sentiments about total destruction and irreparable damage to gardens, native trees, an equestrian venue, planted trees at venues and properties, ecosystems and overlying creeks and rivers.

They suggested that a mine should never be considered at this location due to the current overlying ecological value, its 'clean and green image' and that the risk of proceeding is just too great.

The latest water table drawdown results for the 67th percentile model scenario are illustrated in Figure 9.13. Comparison to the water table drawdown in the EIS (Figure 9.12) indicates the area of impact has slightly increased, but remains relatively localised to the mining footprint. The changed shape of drawdown cone is due in part to the improved representation of the water table with the upgraded software solvers and the adoption of the pseudo-soil function.

The revised water table drawdown contours are then compared to areas of known groundwater dependent ecosystems (GDEs) and areas of potential terrestrial ecosystems that may rely on groundwater part of the time.

There are no high priority GDEs identified in the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 for the Sydney Basin Nepean Groundwater Source – Management Zone 1.

Terrestrial vegetation has been classified as having a facultative (opportunistic) dependence on groundwater. Facultative (opportunistic) ecosystems will use groundwater during droughts (ie when surface water is not available), but exist without groundwater most of the time. Long Swamp and Stingray Swamp have been classified as having a facultative (proportional) dependence on groundwater (EMM 2017e). Facultative (proportional) ecosystems take a proportion of their water requirements from groundwater; however, there is no absolute threshold for groundwater availability below which ecosystem structure or function is impaired, and can respond to changes in groundwater.

Long Swamp is assessed to be a valley infill swamp, which is likely to source water from perched groundwater above the regional water table and also potentially from the water table. Although the water table is predicted to be shallow at Long Swamp), it is at least 6 km from the maximum extent of drawdown predicted by the numerical model. Drawdown of the water table upstream of this location is not predicted to impact Long Swamp. Therefore, it follows that Temperate Highland Peat Swamps and the threatened species it supports at Long Swamp would not be impacted by the project.

Stingray Swamp is assessed as a headwater swamp, which is likely to rely on perched groundwater sourced from local rainfall and runoff, and is not connected with the regional water table. As such, no drawdown-related impacts from the Hume Coal Project are predicted to occur at Stingray Swamp.

The *Hume Coal Project Biodiversity Assessment Report* (EMM 2017e) assessed the potential effects of predicted groundwater drawdown on potential terrestrial vegetation GDE locations. The assessment compared areas where the pre-mining water table is 10 mbgl or less (the assumed average eucalypt root depth limit) against the predicted maximum project impact drawdown from the water table. The assessment took into consideration the ecosystem's level of dependence on groundwater. Accordingly, no influence is expected to ecosystems identified if periods of prolonged drought are not experienced during mining. This assessment was revised following the submission of the EIS and updated to include the revised groundwater model results and revised water table drawdown assessment (Chapter 13).

9.4.4 Surface infrastructure

The Heritage Council of NSW and NSW Road and Maritime Services had concerns with potential long term subsidence of the surface and associated impacts to Significant Heritage Sites (SHS) of Oldbury Farm, Golden Vale, and Hillview as well as the Hume Highway.

Some interest groups raised concerns that water table drawdown will impact on the overlying Heritage properties (23 listed).

There is no potential for subsidence related impacts on the nominated heritage sites. These properties will not be undermined.

The potential for surface settlements due to water table drawdown has been quantified in the subsidence assessment in the EIS and will result in imperceptible levels of surface movement.

The long term stability of the non-caving mine plan is reviewed in detail by the NSW Government appointed peer reviewers. One report has been made available (Galvin 2017) and the review concluded that:

"if the pillar systems proved to be unstable, surface subsidence is still likely to be at the lower end of the range and manageable."

Based upon the conclusion the potential subsidence (very low risk of occurring) the impact will be at the lower end of the range and translates to minimal potential impacts to surface infrastructure. The Roads and Maritime Service are satisfied and agree that the groundwater impacts of the mine will not adversely impact on the Hume Highway from a water table drawdown.

9.4.5 Subsidence

NSW DPI had concerns with the long term stability of the mine panels once workings are re-saturated following mining, with a view of potential long term subsidence at the surface or fracturing of Hawkesbury Sandstone strata.

One business group claimed that irreversible damage to the groundwater resource would occur due to subsidence and that the mining methods are not proven that they will prevent collapse.

One interest group raised a concerns that caving of the roof of the mine and fracturing of the overlying Hawkesbury Sandstone will occur, and therefore groundwater inflow and levels impacted more than predicted.

Based on the geotechnical modelling described in Chapter 16, the potential for wide-scale geotechnical instability in the mine resulting in material levels of overburden deformation is extremely low. This effectively translates to the potential for impacts the overlying Hawkesbury Sandstone being very low, and therefore additional drawdown, depressurisation or inflow as a result of this occurring are also very low.

9.4.6 Groundwater quality changes

The NSW EPA had concerns that impacts to groundwater quality will occur as a result of injecting water into underground voids. They also raised concerns on the level of assessment and understanding of potential increased aluminium levels in surface water (as a result of water table decline).

Business groups raised concerns that irreversible impacts to groundwater quality will occur and that ongoing use for stock, domestic and drinking water supplies will not be possible.

One interest group raised a concern that Geosyntec did not consider potential fracturing and higher inflows to mine workings.

Many community submissions were received which aligned to the above concerns that the impacts to bores, as predicted, are unacceptable, that the impacts as predicted are under estimated and they raise very alarmist sentiments and use words such as 'contamination', 'toxic', and 'poison'.

Community concerns assume that the water quality will be changed, resulting in destruction and irreparable damage to a groundwater resource that can then never be 'made good'.

They raise that the risk of changed water quality in landholder bores means they then cannot be used for current purposes of drinking water, stock and domestic supply and irrigation.

They object to tailings being emplaced underground.

They believe that that likelihood of groundwater quality change is too high, and therefore the risk is too high to contemplate.

i Groundwater quality

The groundwater quality assessment in both the EIS and subsequent rework conclude that there are negligible impacts to groundwater quality, and therefore deemed to be less than Level 1 impact as defined in the AIP and outlined in Table 9.6. The risk of any potential impact to groundwater from the quality of collected water (eg at the PWD) or coal reject slurry transferred into underground workings has been assessed as part of the RGS hydrogeochemical modelling program and has been demonstrated to be negligible (RGS 2018).

The underground emplacement of the tailings was a direct request of the NSW government to efficiently and safely deal with this waste stream. There are long term environmental benefits to permanently store tailings in underground workings behind bulkheads as mining progresses. This is examined in great detail in Chapter 10 – the resulting impact to the groundwater quality in the coal seam is negligible. Also, currently, (ie under a non mining scenario) the hydraulic head (pressure) in the coal seam is lower than the immediately overlying Hawkesbury Sandstone. Thus, there is a downward hydraulic gradient (and potential downward flow path), from the overlying sandstone into the coal seam. It is expected that during mining this downward hydraulic gradient (ie from the sandstone into the coal seam) will remain, and, also following full recovery back to current natural condition, this same downwards hydraulic gradient will persist. This effectively means that there is no mechanism for upward flow of water to flow from the coal seam into the overlying Hawkesbury Sandstone currently, during mining, during recovery or post final recovery.

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

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

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

With regard to the requirements of the AIP in relation to groundwater quality, it is not anticipated that the project activities will lower the beneficial use category of the groundwater source beyond 40 m from the mining zone, provided the mitigation measures are implemented. No cumulative changes to groundwater quality are predicted to occur as a result of mining activities.

Landholder bores will not experience change in groundwater quality as a result of the project. Landholder bores within 40 m of the mine workings will be subject to make good measures due to their predicted drawdown being in excess of 2 m. Therefore no groundwater quality impacts to landholder bores are anticipated as a result of the project, and no changes to current uses of irrigation, stock and or domestic groundwater supplies will occur.

ii Surface water quality changes resulting from reduced groundwater baseflow

Comparison of baseline groundwater and surface water results indicate most components (monitored analytes) were generally higher in concentration in groundwater than in surface water; ie a reduction in baseflow would improve surface water quality. However, nitrate, calcium, sodium, sulfate, and aluminium were generally higher in surface water than groundwater; ie a reduction in baseflow would likely increase concentrations of these components. In summary:

- nitrate results were below and calcium, sodium, sulfate results were well below guideline values, and, therefore, changes in these concentrations are will not affect the beneficial use of the surface water; and
- aluminium results exceeded the guideline values for aquatic ecosystems and, in some locations, the ADW guidelines, but not the guidelines for irrigation or livestock.

Increases in concentrations would not necessarily have a detrimental effect on the beneficial use of the surface water. Comparison to the relevant ANZECC (ANZECC and ARMCANZ 2000) and ADWG (NHMRC 2016), guidelines indicates that (WSP 2018):

- nitrate, nitrite, calcium, sodium, and sulfate results were well below guideline values, for both existing and operational scenarios; and
- aluminium results exceeded the ANZECC (2000) guideline value for aquatic ecosystems for both the existing and operational scenarios but was below the ADWG value for health and well below the ANZECC guideline for irrigation and livestock for both existing and operational scenarios.
- These results suggest that changes in surface water concentrations as a result of baseflow reduction will not affect the existing beneficial use of surface water in the project area. The project will have a neutral or, for some components, a beneficial effect on surface water quality within the project area as a result of baseflow reduction due to underground mining.

9.4.7 Salt changes in Hawkesbury Sandstone

The following comments were presented by WaterNSW relating to salt flux:

- There is not enough data to assess/predict impact of salt leaching from the Wianamatta Group shales. Predictions of induced vertical flux of salt from Wianamatta Group shale to underlying Hawkesbury SS is based on water quality data collected at one sampling location that may not be representative for the whole project area. It is commented in the report that groundwater salinity at this Wianamatta Group shale monitoring bore appears to be just moderately higher compared to groundwater in other formations and it can be expected that salinity of groundwater in thicker occurrences of Wianamatta Group shales could be an order of magnitude greater than reported for the project area (at one location).
- It was predicted that the maximum mining induced salt flux will peak by 9 % above baseline approximately 14.5 years from start of mining. This does not appear to account for variability in salt content and thickness of Wianamatta Group shale within the area predicted to be impacted by groundwater drawdown.

In relation to the salt flux, NSW DPI also comment that the geochemical modelling conducted and presented in the Hydrogeochemical Assessment Report indicates that due to mine dewatering altering local flow regime there is potential for a net increase in salt flux from the Wianamatta Group shale to the Hawkesbury Sandstone of 1.3% above baseline conditions. This is not sufficient to significantly alter local quality and will not result in any change to beneficial use of the Hawkesbury Sandstone.

An interest group submission questioned the predicted impact induced inter-aquifer transfer of water and solutes from the Wianamatta Group to the Hawkesbury Sandstone as a result of aquifer depressurisation caused by mining.

Wianamatta Group (WG) shales only outcrop in the eastern half of the project area with Hawkesbury Sandstone exposed in the western half. The shale sequence thickens to the east and north. Where the shale is weathered and thin there is unlikely to be any groundwater present. Where it thickens, a variable depth water table forms depending on recharge rates and the permeability of the shale. There are rarely any water bearing zones of note that are accessed for water supply purposes. There is limited natural vertical connectivity with the underlying Hawkesbury Sandstone aquifer as evidenced by lower water levels in the sandstone. At most sites (such as at the H35A and B site) the groundwater in the shale is perched above the regional water table in the sandstone (ie there is no hydraulic connection as there is an unsaturated zone in between these systems). At other sites where there is hydraulic connection between units, saline groundwater is usually evident at shallow depth in the sandstone.

It is acknowledged that the water quality monitoring data for the Wianamatta Group shales within the project area is limited to one monitoring bore (H35B), due to the difficulty and scarce interception of water bearing zones within the shale geology. However, as a result of this, the potential spatial variability of groundwater salinity in the Wianamatta Group shale is uncertain. The value used (1,700 mg/L) lies within the range recorded for the Wianamatta Group shales elsewhere in the Sydney Basin, and that the groundwater salinity in the Wianamatta Group shales is variable and can be higher. However, given the upland location of the Hume Coal Project, this groundwater salinity is considered acceptable and a likely representation of the groundwater quality of the shales in this area.

i Groundwater Salinity Information

A review of publicly available groundwater quality information for the Wianamatta Group shales in the vicinity of the project area identified that the published proceedings of the 2009 *Groundwater in the Sydney Basin Symposium* includes a paper providing commentary on groundwater salinity in the Wianamatta Group shales of the Southern Highlands (Russell et al. 2009). The following observation was made in the cited paper regarding groundwater salinity in the shale formations:

Notable differences exist between groundwater salinity distributions for the Wianamatta Group strata in the western Sydney area and in the Southern Highlands (Fig. 8). In particular, the salinity of groundwater in the Southern Highlands is generally considerably less (typically <3,000 mg/L) than that in the western Sydney area (mainly >5,000 mg/L). This is presumed to be related to the topographic elevation of the former due to regional and intermediate deformation and uplift leading to the subsequent flushing of accumulated salts from the rock matrix.

This is consistent with the monitoring results from H35B, for which the laboratory-reported total dissolved solids (TDS) ranged from 1,480 mg/L to 1,750 mg/L.

A search of the groundwater databases administered by the DI Water identified very little information regarding groundwater salinity in the shale formations in the vicinity of the project area. The following based salinity information was identified:

- GW057943 (south of Sutton Forest) – a salinity category of 1,001 – 3,000 mg/L recorded for inflows during drilling through shale formations;
- GW102777 (south of Sutton Forest) – a salinity of 380 mg/L recorded for inflows during drilling through shale formations;
- GW104423 (west of Moss Vale) – a groundwater salinity of 540 mg/L was recorded for inflows during drilling through shale formations;
- GW105744 (south of Sutton Forest) – a groundwater salinity of 800 mg/L was recorded for inflows during drilling through shale formations; and
- GW106517 (south of Sutton Forest) – a groundwater salinity of 1,300 to 1,700 mg/L was recorded for inflows during drilling through shale formations.

While the salinity information is limited, it is consistent with the values measured in H35B.

ii Hume Coal Bore Installation Logs

The following groundwater salinity information was recorded for inflows from shale horizons encountered during installation of the Hume Coal monitoring bore network. It is noted that because the bores were installed using an air hammer rig with water introduced as a drilling fluid, the values are considered to be of low reliability for characterisation of formation water quality (i.e. likely to be a mix of drilling and formation water). However, the data are provided for completeness:

- HU0129PZB: 346 to 619 $\mu\text{S/cm}$ (no information on inflow rate recorded);
- HU0136PZA: 506 to 557 $\mu\text{S/cm}$, with inflow rates of 5 to >10 L/s recorded;
- HU0136PZB: 530 to 557 $\mu\text{S/cm}$, with inflow rates of 3.3 to 5 L/s recorded; and
- HU0088PZA: 988 $\mu\text{S/cm}$, with an inflow rate of 0.1 L/s recorded (at base of shale).

In summary, the groundwater salinity values for shale formations in the vicinity of the project area are generally consistent with those reported at H35B, and are characteristic of the lower salinity groundwater of the WG Wianamatta Group Shale in the Southern Highlands, rather than the higher salinities reported in the Cumberland Basin of Western Sydney to the north.

iii Potential Increase in Downward Groundwater Flux from the Shale

At most sites where the groundwater in the shale is perched above the regional water table in the sandstone, groundwater migration cannot occur unless the unsaturated zone between the units becomes saturated or there is a conduit (such as water bore) that connects the two formations.

At other sites where there is full saturation, there is a natural downward hydraulic gradient between the shale and the underlying Hawkesbury Sandstone. At these sites the magnitude of groundwater flux between the shale formation and the underlying sandstone is a function of:

- the hydraulic conductivity of the shale (which can reasonably be assumed to remain constant over time), and;
- the height of the saturated water column in the shale in excess of the “pressure head” at the top of the sandstone formation.

The greater the pressure head in the upper Hawkesbury Sandstone formations, the smaller the downward flux of groundwater from the shale formations and vice versa.

The temporary loss of this pressure head due to depressurisation may result in a marginal increase in the downward gradient in the affected area (where connection occurs). However the absolute change in the downward groundwater flux would be relatively small and the maximum mining-induced depressurisation at the top of the sandstone can only ever result in a small incremental increase in the downward flux of groundwater from the Wianamatta Group shales, as indicated by the modelled flux results during the life of mining.

In summary, the groundwater connectivity and salinity migration between Wianamatta Group shales and the underlying Hawkesbury Sandstone will be one of three scenarios:

- (Most likely) where the shale water table is perched above the sandstone water table there is negligible migration of saline water into the sandstone and this will remain unchanged with mining that induces a fall in sandstone water levels.
- (Likely) where the shale water table is higher than the sandstone water table which is within or at the base of the shale then there is limited migration of saline water into the sandstone and fluxes are likely to remain unchanged or reduce with mining that induces a fall in sandstone water levels.
- (Unlikely) where the sandstone water table is higher than the shale water table and currently there is no migration of saline water into the sandstone, a reversal in the hydraulic gradient caused by mining that induces a fall in sandstone water levels may induce a small flux of saline water into the sandstone.

Therefore, the influence of the groundwater salinity in the shale on the groundwater salinity in the upper Hawkesbury Sandstone is at its maximum during the current pre-mining conditions. Irrespective of any spatial variability of salinity in the shale, a potential increase in groundwater flux between the geological units attributable to mining-induced depressurisation is considered negligible.

9.4.8 Mitigation and monitoring strategies

i Mitigation

WaterNSW raised concerns that reinjection of water into the Hawkesbury Sandstone has not been tested as a mitigation strategy, and mitigation of impacts during mining cannot be completely achieved via reinjection.

One interest group raised a concern that reinjection of groundwater in shallow Hawkesbury Sandstone is a short term strategy.

Reinjection into the Hawkesbury Sandstone is not being considered at this stage for the Hume Coal Project. Initial studies into this technique were very positive, but physical testing of this technique is no longer licensable in NSW and therefore reinjection field testing and analysis is no longer proposed. It has been removed from the project as a mitigation strategy and is not being considered further. It is therefore not being relied upon for any degree of mitigation of project impacts.

The pumping of surplus water into voids remaining after panel mining and then sealed is proposed, and will be undertaken as the project progresses. This is a mitigation strategy that minimises drainage to the active mine workings and enhances recovery of groundwater levels in the overlying Hawkesbury Sandstone.

ii Monitoring and management

NSW DPI raised concerns regarding monitoring following drought and over the long term (it is suggested that 5 years of monitoring post mining is insufficient).

Additional details on the monitoring network and monitoring plan is requested, including monitoring of landholder bores were requested by the NSW EPA, NSW DPI and WaterNSW.

Business groups stated that if increased drawdown occurs in landholder bores how will this be managed and concerns that make good commitments cannot be met if drawdown is larger than predicted.

Interest groups stated that details of trigger levels for monitoring of levels and quality not yet defined and quality control procedures not defined.

Many community concerns were raised regarding mitigation, monitoring and management aligned to the logistics of how you can mitigate reduced groundwater levels and how to manage. They also questioned how will water take be measured and recorded and verified.

Community members also raised concerns that current usage is not metered (ie for irrigation or stock and domestic users) so how can we get a good understanding of current versus future use from the groundwater source for long term management.

In accordance with the Groundwater Monitoring and Modelling Plan (GMMP) a detailed water monitoring program is currently being undertaken. The GMMP is periodically reviewed by DI Water and any required changes are incorporated. This process will be ongoing for the life of the mine and the details of the GMMP are incorporated into the overall water management and monitoring strategy for the project.

In summary, all existing monitoring bores will continue to be monitored (with automatic data loggers installed in all bores and dedicated low flow pumps installed) to provide for regular water quality sampling to be undertaken.

The monitoring network will be expanded with extra monitoring bores strategically placed (subject to land access) to ensure that model verification can occur (ie allow comparison of model results to actual water levels as mining progresses), and to provide early indications of any likely impacts to landholder bores. Consultation with DI Water on placement of additional monitoring bores will be undertaken, with a view to providing more at a distance from the mine to confirm the lateral extent of drawdown. Monitoring of shallow groundwater near terrestrial ecosystems that may be partially groundwater dependent is also being considered. Monitoring (both level and quality) of selected landholder bores in and around the project area (particularly those predicted to experience drawdown in excess of 2 m).

The post mining monitoring will be in excess of 5 years post mining, and Hume Coal will monitor post closure in accordance with the relevant approval and licence conditions. Monitoring of groundwater will occur post mining, regardless of whether there is a drought or not. Consultation with DI Water will occur during the post mining monitoring period and an agreement on the timeframe of recovery monitoring will be determined collectively. The timeframe required is likely to be subject to the level and speed of groundwater recovery, and will be reviewed and revised annually. It is likely during this period that a gradual scaling back of the monitoring network will occur (both in terms of number of bores and frequency of measurements/sampling).

The trigger levels for responses based on monitoring of water levels and quality during mining are yet to be developed and will be completed as part of the secondary approval process that involves monitoring plans and environmental protection licences. The principles for beneficial use will be considered for groundwater monitoring, and alignment with predicted water level drawdown from the revised EIS model.

Model verification (ie using actual data collected as mining progresses) and reporting is proposed at 12 monthly intervals for the first 10 years of operation, with model recalibration as/when required. Following the first 10 years of operation, model verification is proposed to occur at 2 yearly intervals until mining ceases, with recalibration as/when required. Model verification is the process by which the model predictions are measured against observed monitoring data. Recalibration is only required if the predictions of impact in the model vary significantly from the observed water level drawdowns and mine water inflow volumes, or stream flow is responding to baseflow losses. If model recalibration is required, then updated predictions of drawdown in landholder bores will also be reforecast at that time. Ongoing monitoring will inform the drawdown predictions (and any revised prediction in terms of degree of impact and the timing of the impact). It is envisaged that where an accurate understanding of groundwater take volume is required for landholder bores, that meters will be installed. It is a mandatory condition for bores that are linked to a Water Access Licence to have a metre installed, but not for stock and domestic bores – however, they can be applied to stock and domestic bores as required.

A subsidence monitoring plan will be prepared by Hume Coal and DI Water will have an opportunity to review and provide comments on this plan once it is available. Any recommendations for additional groundwater monitoring as a result of this plan will be incorporated into the groundwater monitoring program.

Hume Coal's analysis of drawdown in landholder bores via the uncertainty analysis and detailed work provides confidence in the accuracy of the predictions. The uncertainty analysis undertaken provides confidence that the range of potential changes (ie moving towards to boundaries of the uncertainty analysis results), that impacts (ie drawdown and inflow) at these more conservative ranges can be managed. It is not anticipated that drawdown in landholder bores will be greater than predicted. However, if it is, then it will be managed using the same make good strategies that are being applied all impacted bores, ie funding for increased pumping costs, lowering pumps, providing a new bore and associated headworks etc.

9.5 AIP assessment

NSW DPI (including DI Water) raised concerns regarding the AIP assessment. They stated the need to ensure all AIP criteria adequately addressed, various aspects not adequately addressed in the EIS, in particular the validity of numerical modelling to define impacts and the flow on mitigation and management of those impacts.

Requirement to address AIP checklist independently of the EIS – not refer to sections of the EIS.

The make good strategies are confirmed to be reasonable, but more information is required in the timing of implementation of these strategies for individual bores. The NSW Government also supports the Hume Coal proposal approach of entering into individual make good agreements with each landholder.

The dispute resolution approach requires additional information to address the potential that landholders will not willingly agree to enter into make good agreements with Hume Coal.

Concerns that the required licenced entitlement in the Sydney Basin Nepean Management Zone 1 Groundwater Source may not be able to be obtained.

Interest groups stated that the AIP requirement to hold an Aquifer Interference Approval (S97 (f) Water Management Act 2000), is tabled as a reason why Hume Coal cannot be approved.

Clause 14 of the Mining SEPP is referenced in regard to mining project impacts needing to be 'minimised or avoided', and that unless this can be done the project should not be approved. The definition of avoid and minimise as being a concept of zero impact is suggested. They stated that the drawdown is predicted to be in excess of the 'minimal impact criteria' of the AIP and therefore the project should be refused.

Interest groups raised that the NSW Government should refuse to issue additional water access licences to Hume Coal.

The AIP assessment has been undertaken in detail in the Revised Water Assessment (Appendix 2). This revised assessment addresses each of the requirements in detail in the checklist table and does not refer back to sections of the EIS.

The revised groundwater modelling work and detailed uncertainty analysis (Appendix 2) provides more confidence in the modelling results and hence the attributed mitigation and management strategies. A detailed discussion on the 'make good' arrangements is provided in Section 9.4.2.

The WMA2000 (under Section 91) defines an 'aquifer interference activity' as an activity involving any of the following:

- a) penetration of an aquifer;
- b) interference with water in an aquifer;
- c) obstruction of the flow of water in an aquifer;
- d) taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations; and
- e) disposal of water taken from an aquifer as referred to in paragraph (d).

The WMA2000 Section 91 provisions require a separate 'Aquifer Interference Approval', but the Section 91 provisions are not currently active. They will come into force when the Aquifer Interference Regulation is made under the WMA2000. In the meantime the NSW Aquifer Interference Policy 2012 (the AIP) sets out the policy around subclause (d) with respect to interference to water levels, water pressures and water quality.

Although an Aquifer Interference Approval is not required, the volumetric take of water does require licensing. Water access licences are able to be traded on the open market, and additional groundwater entitlement is not 'issued' by the NSW Government in this area. Hume Coal currently holds 79% of the required licensed entitlement from the Sydney Basin Nepean Management Zone 1 Groundwater Source.

Hume Coal concurs with the classification of Level 2 impact for drawdown in landholder bores, and a less than Level 1 minimal impact for groundwater quality (Section 9.3.5 (vii)).

The AIP requires Level 2 impacts to be further investigated, and then mitigated or avoided, and/or to enter into make good arrangements. The policy therefore provides a mechanism for 'greater than minimal impact' to be approved, but requires that any impacts that are considered 'greater than minimal impact' are adequately studied, and then either avoided, mitigated or that impacts are subject to made good.

10 Rejects management

10.1 Coal reject emplacement assessment

10.1.1 Method and validity

i KLC tests and additional hydrogeochemical modelling

Submissions queried the validity of the limited data presented and used in the decision process to emplace rejects underground. Specifically, several submissions questioned the validity of the kinetic leach column (KLC) methods used to assess/predict the dynamic geochemical nature of coal reject materials and represent potential operational impacts under proposed surface stockpile and underground storage conditions.

The NSW EPA indicates that they were not satisfied that the use of the KLC test is justified as the primary means to determine or validate the disposal decision. They claim that the EIS did not identify the limestone dosage rate applied to the KLC tests. The comments state that within the discussion of results from the final KLC test (KLC 24), the potential variability in its methodology was not outlined. It was recommended that the Hume Coal Project undertake additional investigations to provide more certainty in the rejects emplacement predictions presented.

Some submissions refer to the United States Environment Protection Authority (USEPA) studies on KLC tests, citing that commonly used leaching tests do not reliably estimate the leaching characteristics of many wastes in the long-term because the tests are unable to predict leaching behaviour over the wide range of potential disposal scenarios that are subject to diverse chemical and hydraulic conditions, which may change over time. A submission refers to the USEPA's "Leaching Test Relationships, Laboratory-to-Field Comparisons and Recommendations for leaching evaluation using the Leaching Environmental Assessment Framework (LEAF)", which recommends that the LEAF testing procedure is more reliable at assessing leaching characteristics of waste materials in the long-term.

Additionally, some submissions recommended that additional investigations be completed to provide more certainty regarding the predictions associated with reject emplacement.

a. Use of KLC tests and data in the mining industry

KLC tests have been used as a tool in the mining industry to predict the likely geochemistry of mine materials for over 30 years and are recommended for use in Australian Government (COA 2016) guidelines and Australian and international mining industry guidelines (AMIRA 2002; INAP 2009).

The KLC tests were not used to represent potential operational impacts under the proposed surface stockpile and underground storage conditions, but rather, the data were used to provide geochemical information and loading rates (solute release rates) for the subsequent hydrogeochemical modelling performed.

A total of 25 KLC tests were completed on coal, spoil and coal reject materials. The geochemical characterisation of these materials is described in the EIS (RGS 2016). The tests were adjusted to represent a variety of conditions for six months. The initial nine tests (KLC1 to KLC9) followed the Australia mining industry guidelines for such tests (AMIRA 2002). All leachates collected were tested at a NATA certified laboratory (ALS Environmental in Brisbane) using standard laboratory quality control/quality assurance procedures.

Subsequent KLC tests (KLC10 to KLC19) were designed to establish the effect of alkaline amendment of coal reject on contact water quality and solute release rates under fully saturated (reducing) and intermittent wetting and drying (oxidising) conditions.

The final six KLC tests (KLC20 to KLC25) were also designed to investigate the effect of milled limestone amendment of coal reject on contact water quality and solute release rates under reducing and oxidising conditions using specific groundwater samples from the site to leach the columns.

The limestone dosing rates are stated in Table 4-2 (Page 15) of the geochemistry report prepared for the EIS (RGS 2016), and are far in excess of acidity that could be generated from coal rejects. These dosing rates are in line with the rates nominally specified for amending the reject materials in the EIS. The series of KLC tests provided a better understanding of the dynamic geochemical nature of amended coal reject materials under both surface stockpile and underground storage conditions at the site, and subsequently used in hydrogeochemical modelling.

b. Particle size distribution and age of coal rejects

KLC tests (KLC10 to KLC25) were performed on coal reject material passing through a 0.6 mm sieve size, whereas the actual coal reject material resulting from the washing process at the Hume Coal Project is expected to include particle size fractions ranging from silt/clay ultrafines to coarse aggregate (8-16 mm topsize) (Page 54, Geosyntec 2016). Therefore the KLC tests on coal rejects (KLC10 to KLC25) represent a worst-case scenario in terms of the potential surface area of the coal rejects available to react.

The coal reject materials used for the KLC10 to KLC25 column tests had been stored (and thus exposed to oxygen to some extent) for a period of least 12 months before testing. The coal rejects in the surface stockpile as well as those emplaced underground are to be amended with limestone within days of mining rather than after 12 months of exposure to atmosphere, which will provide acid buffering that was not available for the KLC test materials until immediately before the tests. The samples comprised of drill core that had been through a multiple stage process involving drilling, transportation, crushing, separating and storage before being run through the KLC tests.

c. KLC data confidence, predictions and hydrogeochemical modelling

Some of the submissions suggested completion of additional investigations to provide an increased level of confidence in the geochemical information and loading rates derived from KLC tests. The main areas where additional investigations were advocated are associated with an alternative leach test methodology (LEAF test (USEPA 2017)) typically used for hazardous wastes in the USA, predicting the geochemical behaviour of coal rejects beyond six months using KLC data, and completing additional hydrogeochemical modelling work.

Alternative coal reject leach test methodologies

The LEAF comprises four laboratory methods for characterising the leaching behaviour of inorganic constituents from solid materials under specified environmental conditions. Three of the laboratory methods are batch tests and one is a dynamic test. The LEAF methods address factors which may affect leaching behaviours such as leachate pH, liquid-to-solid ratio and the physical form of the material.

The LEAF was developed primarily for municipal waste landfills to address concern in the USA that existing methods for determining whether a material was hazardous based on its toxicity characteristics (Toxic Characteristic Leaching Procedure (TCLP)) and leaching behaviour (Synthetic Precipitation Leaching Procedure (SPLP)) were being utilised outside of the intended use by users unfamiliar with the limitations of the data (USEPA 1992; 1994). The LEAF framework regards laboratory leaching tests as a basis for estimating which constituents will leach from a material, the rate at which they will leach, and the factors that control leaching. In addition, dynamic leach data can be used to develop a quantitative description of the leaching behaviour of a material (leaching source terms) under defined management scenario conditions. Source terms can then be used for subsequent fate and transport modelling (e.g. hydrogeochemical modelling) (USEPA 2017).

A recent review of the LEAF (Lee et al. 2016) found that while the four laboratory methods are more detailed and robust than commonly used methods designed for hazardous wastes (eg TCLP and SPLP), they are more time consuming and labour intensive. In addition, the LEAF has not yet been used for testing coal reject materials in Australia (and most likely not yet in the USA) as Australian Standard (AS) and international standard (American Society for Testing and Materials - ASTM) methods, methods for batch leaching, and KLC methods for dynamic leaching of mining waste materials are appropriate and are used in Australia.

The USEPA's guide to LEAF testing states: "While not a regulatory test, LEAF testing may nonetheless be useful in support of evaluations for which TCLP is not technically appropriate."

The Australian Standard Leaching Procedure (ASLP) method AS4439.3 bottle leaching procedure (Standards Australia 1997) is Standards Australia's version of the TCLP and is commonly used in most Australian states and territories. ASLP testing is highly appropriate for the testing of coal rejects as explained below, especially when coupled to an additional rigorous KLC testing regime. LEAF testing is therefore unnecessary on the basis that ASLP (equivalent to TCLP) is technically appropriate in this case.

The New South Wales EPA endorses the ASLP method in Appendix 1 of the Waste Classification Guidelines, Part 1: Classifying Waste (NSW EPA 2014), which in some instances allows the use of alternative leaching solutions depending on the application including local water when exposure to local surface and/or ground is expected. The leaching solution options available essentially allow 'waste type' and 'disposal situation' to be included in the decision process.

The leach test method used by RGS for the testing of coal reject materials included initial screening batch leach tests on various coal reject source types including coal; coal seam roof, parting and floor; coarse reject; and fine reject materials. These tests were conducted at the ALS laboratory using a modified (ie deionised water leach) shake flask extraction (SFE) method (*ASTM D3987-85*) and five of the six tests were completed at pH value slightly lower (and therefore slightly more aggressive) than the pH 5.0 recommended in the TCLP procedure (pH 4.4 to 4.9).

The SFE is a benchmark screening test used to compare mine waste samples in Australia and is not overly conservative due to pH buffering and using non-representative extraction fluids. RGS personnel have used the SFE method for over 100 coal mines in various jurisdictions in Australia (including NSW) and overseas over the past 25 years. Samples of interest are then subjected to a program of more detailed KLC testing.

KLC tests (KLC10 to KLC25) for the Hume Coal Project were completed on a bulk coal reject sample prepared from a composite of samples from multiple drill holes. The core samples were processed to best represent coal reject material likely to be generated from coal processing at the proposed coal processing plant. The geochemical characteristics of all 25 coal and coal reject samples tested by ALS Laboratory are provided in the EIS (RGS 2016).

The KLC tests on coal reject materials were completed under a variety of conditions using a methodology aligned to the Australia mining industry guidelines for such tests (AMIRA 2002). Some samples were run at natural pH (ie using deionised water) and a number of additional variables were included in the KLC test program to test the effect of alkaline amendment of coal reject on contact water quality and solute release rates under fully saturated (reducing) and intermittent wetting and drying (oxidising) conditions. In some KLC tests, specific groundwater samples from the site were used to leach the columns.

The KLC tests completed under reducing conditions using site groundwater simulate, as far as practicable, conditions experienced by coal reject materials after underground placement and groundwater recovery and results indicate low metal/ metalloid release rates under these conditions.

The series of batch tests and KLC tests therefore address the leaching goals advocated in the LEAF and provide a better understanding of the dynamic geochemical nature of limestone amended coal reject materials under both surface stockpile and underground storage conditions. These tests have generated high quality information as one of several inputs into subsequent hydrogeochemical modelling (RGS 2018).

Predicting the geochemical behaviour of coal rejects beyond six months using KLC test data

The KLC test program generated dynamic leaching data on coal reject materials under a variety of conditions to test the effect of alkaline amendment of coal reject on contact water quality and solute release rates under reducing and oxidising conditions over a six month period. In some KLC tests, specific groundwater samples from the site were used to leach the columns. These data were used to determine loading rates for subsequent hydrogeochemical modelling (Geosyntec 2016).

Some of the submissions suggest that there may be value in predicting the geochemical behaviour of coal rejects beyond six months using KLC test data and geochemical modelling software. Additional work was completed in this area subsequent to the EIS, as part of a hydrogeochemical modelling program (RGS 2017) and is summarised below.

To predict solute release rates and contact water quality beyond six months, time and mass-dependent loading rates were calculated by multiplying the KLC leachate concentration and volume and dividing by the sample mass and time interval (to produce an element release rate in mg/kg/month). Three loading rates were calculated for the coal reject material for the Base Case, Upper Bound and Flush Load. The data points from the first six months of leach cycles (ie seven leach events) were plotted and fitted to a mathematical power equation that allowed concentrations (or loading rates) to be numerically modelled and forecast into the future (RGS 2018).

Whilst there is always some uncertainty with respect to scaling up laboratory scale leaching tests to the field situation it is generally accepted that KLC tests provide a conservative outcome in terms of sulfide oxidation and solute release because under oxidising (wetting and drying) conditions contact with oxygen is not limited. In addition, under field conditions, processes such as sulfide oxidation can be slower than under laboratory-controlled conditions. One of the mechanisms for slower sulfide oxidation under longer-term field conditions is “passivation” of reactive surfaces in the reject material due to oxidation/mineral precipitation and the effect of surface passivation over time is to lower reactivity of emplaced reject with infiltrating groundwater (Miller et al. 2009; Li et al. 2011; Smart et al. 2010).

Physical conditions in the field (e.g. the underground environment) that would also reduce any sulfide oxidation compared to the laboratory KLC test environment include lower groundwater temperature, lack of ultra-violet light, lower reject surface area, and oxygen adsorption to coal limiting access to oxygen in sealed goaves.

Hydrogeochemical modelling (PHREEQC) (Parkhurst 1995) was used in RGS (2018) to assess the KLC water quality and to provide an indication of which minerals may geochemically control the observed water quality. Measured water quality data from the KLC tests were compared with theoretical solubility limits for several minerals and mineral saturation states calculated from saturation indices determined using PHREEQC. The concentrations (or loading rates) were then determined, which allowed the geochemical behaviour of coal rejects to be modelled beyond six months and forecast into the future, albeit much of this behaviour is likely covered in the inherent layered conservatism in the original assessment.

Additional hydrogeochemical modelling

Some of the submissions suggested that there may be some value in completing additional hydrogeochemical modelling for coal reject materials under variable conditions, to increase confidence in the conclusions of the hydrogeochemical modelling program completed for the EIS (Geosyntec 2016). In order to address these submissions, RGS (2018) has completed additional hydrogeochemical modelling under variable conditions (including temporal variations in water quality in the Primary Water Dam (PWD) water potentially due to water recycling, water balance, climate and mine water demand, for example) and including relevant sensitivities to a number of variables, the details of which are provided in Section 8.7.2 and Section 11.2.2 of the Revised Water Assessment (Appendix 2).

The results of the subsequent geochemical modelling indicate that the use of 2% limestone amendment of fresh coal reject at the surface reject stockpile over the first 12 to 18 months of the project will limit the potential for acid generation and therefore the potential for mobilisation of any acidity and metals/metalloids will be limited. The temporary reject stockpile(s) will be progressively covered with topsoil and re-vegetated to limit infiltration, stabilise and mitigate dust until placement underground at the end of mine life.

Whilst formation of colloidal iron precipitates (ferrihydrite) at the PWD may occur due to ROM and Product Stockpile inputs and equilibration of groundwater with atmospheric conditions, this occurrence is likely to enhance precipitation of any dissolved metals/metalloids and improve the quality of PWD water. The mobility of adsorbed metals/metalloids will remain low and will therefore not be affected by any dam stratification. The use of a standard flocculent at the PWD and removal of precipitates would address this issue, in the unlikely event that it was to occur. Other than removing iron precipitates from the PWD from time to time and planned water quality monitoring, no other special management activities would be required at the PWD. The additional RGS modelling (RGS 2018) has assumed that there will be no co-precipitation of dissolved metals/metalloids by ferrihydrite at the PWD and that they would remain in solution, thus being conservative.

ii Groundwater model accuracy

A number of submissions, including some by WaterNSW, query whether groundwater will be impacted by the quality of collected water or by the water pumped into underground workings as part of the co-disposed coal reject. Modelling of the groundwater flow pattern for the Wongawilli Seam and more detailed discussion for setting the western groundwater model boundary is advocated. Information on how perennial/ephemeral boundaries are likely to change as a result of groundwater drawdown is also requested.

There is a perceived paucity of water quality data to assess/predict the impact of salt leaching from the Wianamatta Group (WG) shale to the Hawkesbury Sandstone and current predictions may not be representative for the whole project area.

The submissions also requested clarification in the terms of efficient recharge, citing that many groundwater samples collected outside the project area would be classified as sulfate-type waters, with low pH and low (on non-detected) concentrations of chloride and bicarbonates. It was claimed that this sulfate dominance (unusual in Hawkesbury Sandstone pore water) may be associated with areas subject to particularly efficient rainfall recharge.

The information presented in Section 10.2.1 above discusses that the risk of contamination of groundwater at the mine is low and, therefore by extension, is also low downgradient of the mine. The risk of any potential impact to groundwater from the quality of collected water (eg at the PWD) or from reject slurry transferred into underground workings has been assessed as part of the RGS hydrogeochemical modelling program, which was demonstrated to be negligible (RGS 2018).

The modelled concentrations resulting from the emplacement of reject slurry in a mined-out void, and subsequent groundwater interaction are generally lower than or equal to baseline groundwater conditions for the Wongawilli Coal Seam. The only exception is for some nickel scenarios/sensitivities, which are still within the range of the baseline concentrations reported for the Wongawilli Seam.

It is important to highlight the modelling inputs are typically conservative, with inputs utilising the 95th percentile values of each the annual rainfall and the groundwater quality dataset (refer to RGS (2018) for more details on the input data). Similarly, some minerals were suppressed (prevented from precipitating) during the modelling, which can result in higher predicted concentrations of dissolved metal(loid)s than would occur under field conditions.

a. Potential salt leaching from the Wianamatta Group shales

It is acknowledged that the water quality monitoring data for the Wianamatta Group (WG) shale in the project area is limited to one monitoring well (H35B), and therefore the potential spatial variability of groundwater salinity in the WG shale within the project area is uncertain. An additional literature search for relevant groundwater salinity information was performed, the results of which are discussed below.

The salinity of the groundwater in the Wianamatta Group is almost irrelevant to the assessment, however, since the downward groundwater flux at the base of this unit is already close to its full potential in its pre-mining state, as discussed in further detail below.

Groundwater salinity information

A review of publicly available groundwater quality information for the Wianamatta Group shale formations in the vicinity of the project area identified that the published proceedings of the 2009 Groundwater in the Sydney Basin Symposium include a paper providing commentary on groundwater salinity in the Wianamatta Group Shales of the Southern Highlands (Russell et al. 2009). The following observation was made in the cited paper regarding groundwater salinity in the shale formations:

Notable differences exist between groundwater salinity distributions for the Wianamatta Group strata in the western Sydney area and in the Southern Highlands (Fig. 8). In particular, the salinity of groundwater in the Southern Highlands is generally considerably less (typically <3,000 mg/L) than that in the western Sydney area (mainly >5,000 mg/L). This is presumed to be related to the topographic elevation of the former due to regional and intermediate deformation and uplift leading to the subsequent flushing of accumulated salts from the rock matrix.

This is consistent with the monitoring results from H35B, for which the laboratory-reported total dissolved solids (TDS) ranged from 1,480 mg/L to 1,750 mg/L.

A search of the registered bore databases administered by the NSW Department of Industry, Crown Lands and Water Division identified very little information regarding groundwater salinity in the shale formations in the vicinity of the project area. The following salinity information was identified:

- GW057943 (south of Sutton Forest) – a salinity of 1,001 – 3,000 mg/L recorded for inflows during drilling through shale formations;
- GW102777 (south of Sutton Forest) – a salinity of 380 mg/L recorded for inflows during drilling through shale formations;
- GW104423 (west of Moss Vale) – a groundwater salinity of 540 mg/L was recorded for inflows during drilling through shale formations;
- GW105744 (south of Sutton Forest) – a groundwater salinity of 800 mg/L was recorded for inflows during drilling through shale formations; and
- GW106517 (south of Sutton Forest) – a groundwater salinity of 1,300 to 1,700 mg/L was recorded for inflows during drilling through shale formations.

While the information is limited, it is consistent with the values measured in H35B.

Salinity information was also recorded for inflows from shale horizons encountered during installation of the Hume Coal monitoring bore network. It is noted that because the bores were installed using an air hammer rig with water introduced as a drilling fluid, the values are considered to be of low reliability for characterisation of formation water quality (ie likely to be a mix of drilling and formation water). However, the data are provided for completeness:

- HU0129PZB: 346 to 619 $\mu\text{S/cm}$ (no information on inflow rate recorded);
- HU0136PZA: 506 to 557 $\mu\text{S/cm}$, with inflow rates of 5 to >10 L/s recorded;
- HU0136PZB: 530 to 557 $\mu\text{S/cm}$, with inflow rates of 3.3 to 5 L/s recorded; and
- HU0088PZA: 988 $\mu\text{S/cm}$, with inflow rate of 0.1 L/s recorded (at base of shale).

In summary, the groundwater salinity values for shale formations in the vicinity of the project area identified from a literature review were generally consistent with those reported at H35B and appear to be characteristic of the lower salinity conditions of the shale formations of the Southern Highlands, relative to the higher salinities reported in the Cumberland Plain of Western Sydney to the north.

b. Potential Incremental Increase in Downward Groundwater Flux from the Shale Formations

According to the baseline hydrogeological interpretation of the project area, the saturated thickness of the shale formations imparts a natural downward hydraulic gradient between the shale and the underlying Hawkesbury Sandstone. This is because the height of the saturated water column in the shale significantly exceeds the hydraulic pressure, or “pressure head”, in the sandstone formations immediately below the shale.

The magnitude of groundwater flux between the shale formations and the underlying sandstone is a function of the hydraulic conductivity of the shale (which can reasonably be assumed to remain constant over time), and the height of the saturated water column in the shale in excess of the “pressure head” at the top of the sandstone formation. The greater the pressure head in the upper Hawkesbury Sandstone formations, the smaller the downward flux of groundwater from the shale formations and vice versa.

According to the current hydrogeological interpretation of the mine lease area, a relatively small pressure head exists at the top of the Hawkesbury Sandstone formation (~10 m or less), such that the downward hydraulic gradient (and groundwater flux) between the WG shales and the sandstone is close to its full potential under pre-mining conditions. The temporary loss of this pressure head due to depressurisation would result in a marginal increase in the downward gradient in the affected area; however, the absolute change in the downward groundwater flux would be relatively small (since the magnitude of the vertical gradient change would be relatively small). Hence, the maximum mining-induced depressurisation at the top of the sandstone can only ever result in a small incremental increase in the downward flux of groundwater from the WG shale formation, as indicated by the modelled flux results during the life of mining.

Accordingly, the influence of the groundwater salinity in the shale formations on the salinity of the upper Hawkesbury Sandstone is close to its full potential in pre-mining conditions, due to the downward gradient within the shale, and the small pressure head at the top of the sandstone. Irrespective of the potential spatial variability of salinity in the shale, the potential incremental difference in groundwater flux attributable to mining-induced depressurisation is small.

10.2 Reject groundwater quality

10.2.1 Interaction with groundwater

Many submissions, including some made by WaterNSW, focus on the potential impact of the placement of limestone amended coal rejects to the quality of groundwater. Generally, the submissions suggest that they do not agree with the results of the assessment presented in the EIS, that groundwater quality will not be affected. The submissions maintain that the water in mine panels will not be of the same quality as the natural groundwater and instead, the quality may be much lower or different. Some submissions raise a concern that the EIS insufficiently supports the claim that the mine waste will be, and will remain, 'inert', and that this conclusion is not supported by rigorous analysis and appropriate testing over extended time frames.

The submissions maintain that the hydrochemical modelling presented in the EIS was insufficient in replicating the potential interactions underground and that there are numerous uncertainties with regard to the degree of potential contamination to nearby (down-gradient) groundwater and surface water resources. The submissions request that a more detailed discussion of the potential impacts of the placement of crushed limestone adjusted coal rejects on groundwater quality (and consequently Sydney's potential water supply) is provided.

A number of submissions raised concerns relating to potential to pollute neighbouring groundwater systems (including the Hawkesbury Sandstone) and water quality impacts to existing or future bores from the placement of coal reject material into the mine voids. Two particular concerns were:

- Impact to overlying groundwater systems as a result of oxidation of sulfide minerals in the emplaced reject material, potentially causing acidification of the pore water and consequently acid leaching of heavy metals would occur. The submission was concerned with the potential for groundwater in contact with the emplaced reject material (and presumably with elevated levels of heavy metals and sulfate) to move upwards and contaminate the overlying groundwater systems.
- Possibility for re-saturation of the void (including emplaced rejects) to occur via means other than lateral flow through the Wongawilli Coal Seam. The submission asserts that the EIS only considered one mechanism of re-saturation of the void (being lateral flow through the Wongawilli Coal Seam) and suggested other mechanisms may also be important, including: partially saturated vertical flow from the overlying Hawkesbury Sandstone; a rising water table from below; or inflow controlled by fracturing associated with regional structures, including faults, and these other mechanisms may results in different water quality effects than the ones presented in the assessment.

i Effect of coal reject emplacement on groundwater quality

As described in Section 10.2.1, the (conservative) modelling results indicate that the leachate quality would be nearly indistinguishable from ambient groundwater within the reject emplacement zone. As such, there is not considered to be a risk to groundwater or surface water quality down hydraulic gradient, regardless of the direction of re-saturation.

The EIS clearly demonstrates (RGS 2016) that the addition of limestone (1%) to coal rejects produces a neutral pH leachate with excess alkalinity. Emplacing the reject material underground in sealed voids filled with water will remove the potential for oxidation of sulfide minerals due to removal of oxygen, even without the addition of limestone.

Once the mining and backfilling operation is completed in each underground panel, it will be sealed from the rest of the mine using mass concrete plugs (bulkheads) installed in each of the three gateroad headings. These bulkhead seals will hydraulically compartmentalise the mine. The parts of the mine behind the bulkhead seals will be allowed to fill with water, allowing the groundwater recovery process to commence. Once this takes place, in the unlikely case any CO₂ degassing from coal is present in the mine, it will be restricted to the operational parts of the mine.

For an underground coal mining situation, such as is proposed for the Hume Coal Project, the atmosphere in coal mine panels, once sealed, will become oxygen deficient because remnant coal adsorbs oxygen (Yuan and Smith 2009). Figure 10.1 illustrates the simulated oxygen deficient atmosphere in a mined-out area at a typical longwall underground coal mine (NSW DII 2011). As the active longwall panel retreats, oxidation takes place in the area behind the face until the goaf atmosphere becomes inert by containment, seam gases and goaf consolidation. In the oxidation area CO and CO₂ are produced, a process that can be accelerated by introduction of inert gas into the goaf.

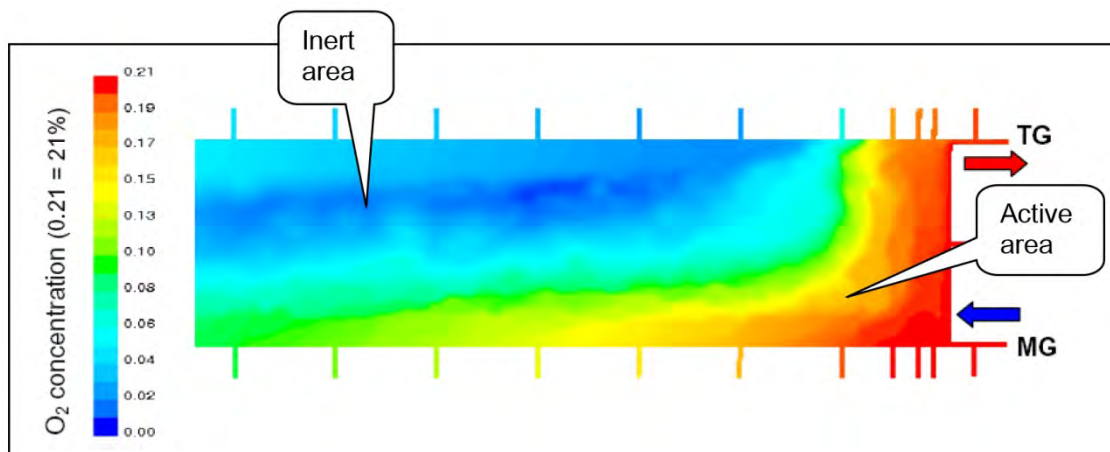


Figure 10.1 3D Computational fluid dynamic model of goaf atmosphere

Section 10.1.1ic further discusses the conservative results provided by KLC tests in terms of sulfide oxidation. Hydrogeochemical modelling (PHREEQC) (Parkhurst 1995) has been used (RGS 2018) to assess the KLC water qualities to provide an indication of which minerals may be geochemical controls on the observed water quality. Measured water quality data from the KLC tests have been compared with theoretical solubility limits for several minerals and mineral saturation states calculated from saturation indices determined using PHREEQC. The concentrations (or loading rates) have been determined, which allows the geochemical behaviour of coal rejects to be modelled beyond six months and forecast into the future, albeit much of this behaviour is covered in the inherent layered conservatism in the original assessment. The results reiterate the findings of the original assessment (RGS 2016), that the leachate quality would be nearly indistinguishable from ambient groundwater within the reject emplacement zone.

The EIS detailed the results of laboratory scale KLC tests (RGS 2016) completed on physically representative samples of coal reject material and groundwater to derive loading rates for subsequent hydrogeochemical modelling (Geosyntec 2016). This information was used to assess the potential change to groundwater quality resulting from groundwater interaction with coal reject material emplaced in sealed underground mine voids.

The loading rates were selected from the specific KLC tests which best represent the expected sub-surface conditions at the mine; simulated mine reject material generated from cores recovered from the project area, leached with groundwater from the Wongawilli Seam, as would occur within the backfilled mine void.

The KLC loading rates were used from two KLC tests: one representing coal reject material only and one representing coal reject material amended with 1% limestone. The coal reject sample material used in both of these tests had been stored (and therefore exposed to oxygen to some extent) for at least 12 months – adding conservatism to the results.

The KLC and hydrogeochemical modelling results demonstrated that limestone addition to coal rejects was beneficial and resulted in the reject slurry water quality being almost indistinguishable from natural groundwater quality and therefore will not change the beneficial use status of the groundwater resource. In addition, lining the underground mine with limestone dust, as is common practice for underground coal mines in Australia, will also have an overall beneficial effect on the quality of recovering groundwater.

The hydrogeochemical modelling has demonstrated that the quality of leachate from limestone-amended reject slurry (reject material mixed with PWD water) stored underground is similar to existing groundwater quality at the site (RGS 2018). Therefore, the potential for coal rejects to cause any contamination issues and potentially impact on users accessing groundwater down gradient of the proposed mine is negligible.

Further responses to queries regarding monitoring and risk management in relation to potential impacts to bores are presented in Chapter 9.

ii Risk to groundwater and surface water downgradient of the mine

As discussed above, the risk of contamination of groundwater and surface water at the mine and, therefore by extension, downgradient of the mine due to the presence of milled limestone-amended coal reject materials stored in sealed and flooded underground mine workings is negligible.

Additional geochemical modelling was completed to assess the quality of leachate produced through the interaction of groundwater with emplaced limestone-amended reject material. The modelling results, which incorporated significant conservatism, indicated that the leachate quality would be nearly indistinguishable from ambient groundwater, and would maintain the same beneficial use status. Accordingly, given that this was the leachate quality immediately within the reject emplacement zone, there is not considered to be a risk to groundwater or surface water quality down hydraulic gradient from the emplaced reject material.

10.2.2 PWD water quality

i Pollution risk from water management and rejects

The NSW EPA requested a discussion of the data sources used to determine the quality of contained and potential underground discharge of water from the PWD, noting that one of the agencies comments request consideration as to whether discharges from the PWD will constitute pollution of waters under Section 120 of the POEO Act.

One special interest group was concerned with the water quality management for the temporary reject stockpile and potential impacts. Another special interest group was concerned with the potential for underground storage of rejects to impact on groundwater and surface water resources.

The sources and quality of water entering the PWD, the quality of water contained in the PWD and by extension, the quality of potential water discharges from the PWD were investigated further as part of the RGS hydrogeochemical modelling program (RGS 2018). The sources and quality of water entering the PWD included the temporary surface stockpile for the Coal Processing Plant (CPP) reject, which will operate over the first 12 to 18 months of the project. The fresh coal reject will be amended with 2 % limestone to limit any potential for acid generation and therefore the potential for mobilisation of any acidity and metals/metalloids will be limited. The temporary reject stockpile(s) will be progressively covered with topsoil and re-vegetated to limit infiltration, stabilise and mitigate dust until placement underground at the end of mine life.

It should be noted that the KLC tests (KLC10 to KLC25) were performed on coal reject material passing a 0.6 mm sieve size, whereas the actual coal reject material resulting from the washing process at the Hume Coal Project will have a top size of around 4-6 mm or higher. Therefore, the KLC tests on coal rejects (KLC10 to KLC25) are highly conservative in terms of the potential surface area (and rate of any oxidation) of the coal rejects available to react.

The coal reject materials used for the KLC10 to KLC25 column tests had been stored (and therefore exposed to oxygen to some extent) for at least 12 months before being amended with limestone and run through the KLC tests. The coal reject materials tested, therefore, had been exposed to oxygen to a similar length of time as would be expected at the proposed surface coal reject stockpile at the project (albeit that the coal rejects reporting to this stockpile will be amended with 2% limestone typically within days of mining rather than after 12 months of exposure to atmosphere, which will provide acid buffering that was not available for the KLC test materials until immediately before the tests).

There appears to be a misconception that the KLC tests were used to somehow represent potential operational impacts under proposed surface stockpile and underground storage conditions. This is not correct as the data from some of the KLC tests were simply used to provide geochemical information and in particular loading rates (solute release rates) for subsequent hydrogeochemical modelling.

The modelled scenarios indicated that the PWD water qualities are circumneutral (pH 6.03 to 8.25) and are likely to remain neutral over the mine life. There are several dissolved metals/metalloids which are greater than either the Australian Drinking Water Guidelines (ADWG) (NHMRC 2016) and/or ANZECC (ANZECC and ARMCANZ 2000) water quality criteria for modelled scenarios and sensitivities (ie Al, Cu, Cr, Cd, Co, Ni, Pb, Se and Zn). However, whilst some of the modelled metal/metalloid concentrations are greater than guideline values, nearly all values (excluding Cr and some Ni) are within the range of baseline groundwater conditions for the Wongawilli Coal Seam.

The modelled Cr concentration exceedance criteria for ANZECC guidelines is associated with the Cr^{6+} species, which was applied to the modelled total Cr concentrations. The presence of Cr^{3+} is more common under the modelled conditions and considered non-toxic. Therefore, applying ANZECC guidelines to the modelled total Cr concentrations is highly conservative.

Similarly, the modelled Ni concentrations only marginally exceeded the range of baseline groundwater conditions for the Wongawilli Coal Seam in two of the twenty-six simulations (ie 0.108 mg/L was the measured maximum Ni concentration for the Wongawilli Coal Seam groundwater compared to the modelled maximum Ni concentration of 0.124 mg/L). However, these results are conservative as the inputs to the model included 95th percentile baseline water quality and co-precipitation or surface absorption were not included in the model simulations.

As discussed in Section 10.1.1, the risk of contamination of groundwater and surface water at the mine and, therefore by extension, downgradient of the mine due to the presence of limestone-amended coal reject materials stored in sealed and flooded underground mine workings is negligible.

Additional geochemical modelling was completed to assess the quality of leachate produced through the interaction of groundwater with emplaced limestone-amended reject material. The modelling results, which incorporated significant conservatism, indicated that the leachate quality would be nearly indistinguishable from ambient groundwater, and would maintain the same beneficial use status. Accordingly, given that this was the leachate quality immediately within the reject emplacement zone, there is not considered to be a risk of pollution to groundwater or surface water quality down hydraulic gradient from the emplaced reject material. As such, in this aspect, the project will be in accordance with Section 120 of the POEO Act.

ii Salt content of the PWD

WaterNSW commented that it appears possible that water will be recirculated several times through the various storages, and may become progressively saltier as it does.

The perception that water could become progressively saltier as it is recirculated several times through the various storages at the mine has been addressed in the RGS hydrogeochemical modelling work (RGS 2018). As part of the hydrogeochemical modelling, numerous scenarios were modelled which included different annual rainfall and evaporation regimes identified in the water balance modelling (WSP 2016a). The collective storage surface water quality contribution to the PWD is dominated by groundwater (47.54 – 78.46%) and non-contact rainfall/runoff (15.22 - 48.5%) over the mine life resulting in significant dilution. The plan of operations is to maintain low volumes of water in the SBs and MWDs at all times; therefore, reducing the potential for evapo-concentration in these storages. The result of the modelling shows that the PWD water quality is predicted to remain relatively neutral pH and relatively consistent low salinity over the life of the mine (RGS 2018).

iii CO₂ degassing

WaterNSW raised a concern related to the geochemical modelling results regarding the water quality evolution of groundwater transferred to the PWD. This submission focused on carbon dioxide (CO₂) degassing affecting carbonate equilibria that are associated with changes in pH (an increase) when groundwater from the mine sump is transferred to the PWD. The submission requested further explanation of the reactions likely to cause a predicted decrease in redox potential during CO₂ degassing.

In terms of further explanation of the reactions likely to cause a predicted decrease in redox potential during CO₂ degassing when groundwater is transferred to the PWD and exposed to atmosphere, a two-step approach to the equilibrium modelling was used:

1. CO₂ degassing from the water until it reached atmospheric equilibrium, followed by; and
2. addition of oxygen until it reached atmospheric equilibrium.

The redox chemistry of the coal seam and sandstone groundwater is controlled by the equilibrium between solution-phase ferrous iron (Fe²⁺) and a solid-phase Fe(OH)₃ precipitate, ferrihydrite, as shown in Figure 10.2.

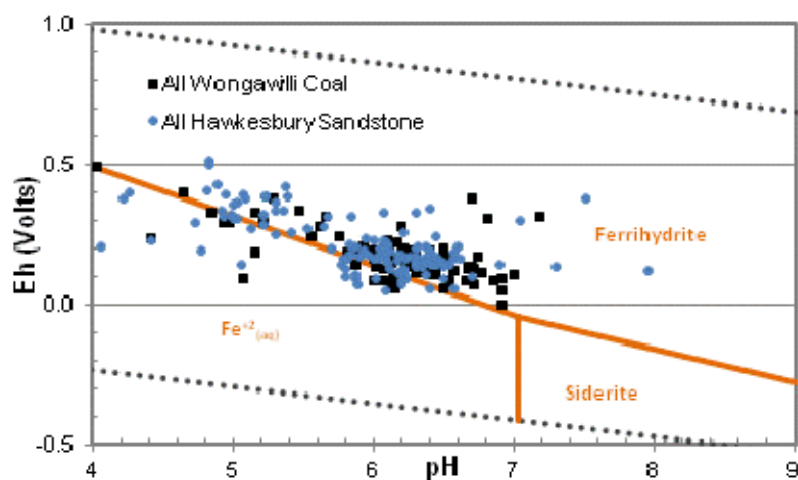


Figure 10.2 Redox distribution against pH of the groundwater in the coal seam and sandstone

In step 1, the degassing of CO_2 caused the pH to rise. Because the redox chemistry was defined by the equilibrium between ferrihydrite and Fe^{2+} , the increase in pH followed the contact line between these two phases (defined by the Nernst equation), which resulted in a decrease of the reduction potential (Eh) with increasing pH.

The second step, addition of oxygen as the groundwater is exposed to the atmosphere, caused the Eh to jump up into the ferrihydrite range (ie Fe^{2+} is no longer stable in the presence of the additional O_2 , and is converted to ferrihydrite). This modelled reaction is presented in Figure 10.3 and Figure 10.4 and is also shown for reference on a Pourbaix diagram for iron in Figure 10.5.

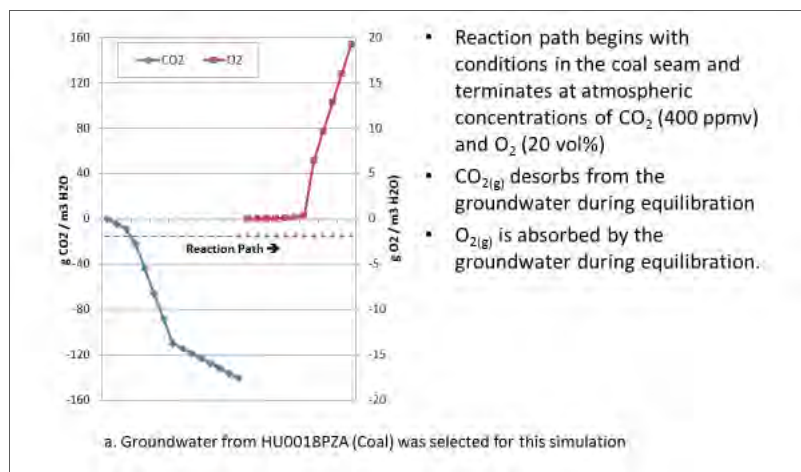


Figure 10.3 Gas exchange between extracted mine water³ and the atmosphere

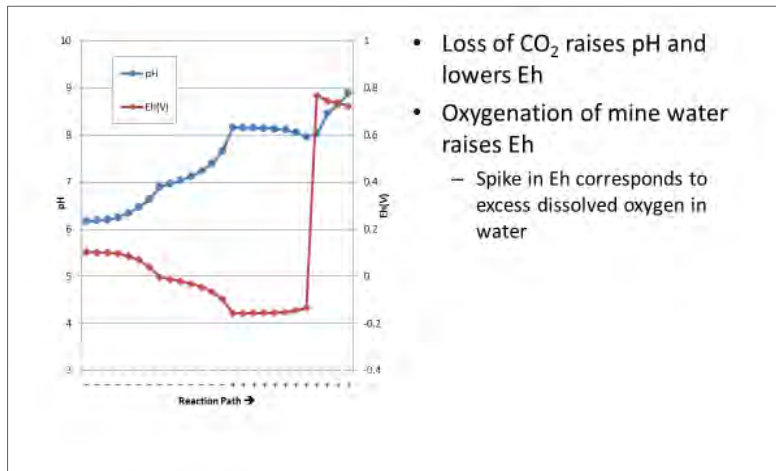


Figure 10.4 Effect of gas exchange on pH and Eh

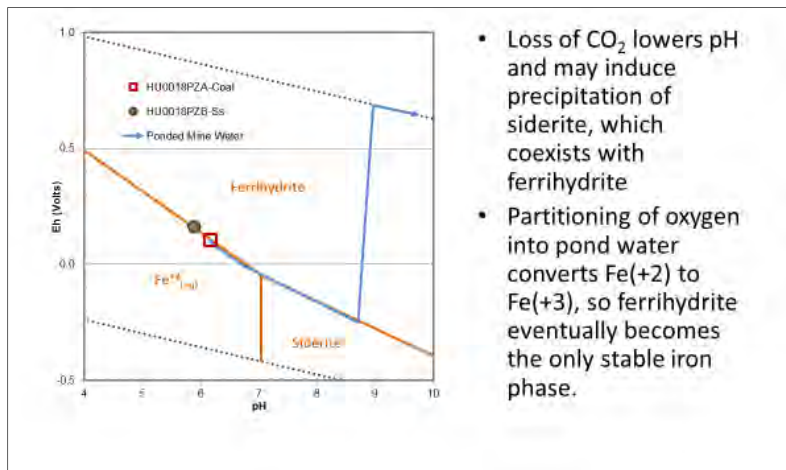


Figure 10.5 Model result on Pourbaix diagram of iron

Hence, the decrease in Eh in modelling step 1 was simply a function of maintaining equilibrium between ferrihydrite and Fe^{2+} during the first step of the modelling, which was corrected during the second step of the modelling by addition of oxygen. The net result was a rise in pH and Eh, which is the expected groundwater quality evolution in this situation.

It should be noted that the initial groundwater/atmosphere equilibrium modelling documented in the EIS has now been superseded by the more detailed modelling performed by RGS for PWD water quality simulation (RGS 2018) (refer to Section 8.7 of Appendix 2).

10.2.3 Underground emplacement process

Some submissions relate to concerns with the condition of the mining voids prior to placement of the co-disposed reject and integrity of the bulkheads and cement plugs in the long term to prevent adverse impacts to groundwater quality and local water bodies in the long-term.

The submissions request a more detailed description of the process and a discussion of potential impacts and risk given that the sealing of mine voids is considered to be an unproven technique.

One submission was concerned with the operational logistics of emplacement of the co-disposed rejects with respect to mine-safety and ensuring the safety of workers and operations are safe if the bulkhead seal(s) were to fail.

As stated in Section 2.8 ii of the EIS, once the mining and backfilling operation is completed in each underground panel, it will be sealed from the rest of the mine using mass concrete plugs (bulkheads) installed in each of the three panel headings. These bulkhead seals will hydraulically compartmentalise the mine. The parts of the mine behind the bulkhead seals will be allowed to fill with water, allowing the groundwater recovery process to commence. And as previously stated in this Chapter, the modelling completed has shown that the quality of leachate produced through the interaction of groundwater with the emplaced limestone-amended rejects in the voids would be nearly indistinguishable from ambient groundwater.

Underground mine backfill is a technology commonly used in metalliferous and coal mines. Managing these activities in proximity to the other mine activities is routinely done. The review by Galvin and Associates (2017) undertaken on behalf of DP&E (Galvin and Associates, 2017) notes that: “the disposal of coal washery rejects in underground mine workings is also an established mining practice internationally and in NSW that dates back decades”. Section 8.2 ii of the EIS (EMM 2017a) states that the co-disposed reject pipe range will be constructed from the surface to the working parts of the mine and will incorporate one or more redundant lines to allow for continuous operation in the case of blockages, and allow for variable coal reject yields while maintaining pipe velocities within. If the co-disposed reject operations are interrupted, reject will be temporarily diverted to an emergency surface stockpile for later processing.

Chapter 16 of this report discusses the bulkhead design in detail.

10.3 Reject management and monitoring

10.3.1 Acidification of sealed voids

WaterNSW raised a concern related to potential risks associated with presumed acidification of sealed underground voids.

The EIS demonstrates (RGS 2016) that the addition of limestone (1%) to coal rejects produces a neutral pH leachate with excess alkalinity. As discussed in Section 10.1.1, emplacing the reject material underground in sealed voids filled with water would remove the potential for oxidation of sulfide minerals due to the removal of oxygen, even without the addition of milled limestone. The potential for acidification of sealed underground voids is therefore negligible.

10.3.2 PWD sludge

The NSW EPA requested clarification as to the fate of sludge from the bottom of the PWD. The EPA also notes that ongoing PWD management costs including sludge, tailings management is not considered.

Final rehabilitation and project closure requirements will be devised and documented as part of a detailed mine closure plan, which will be produced within five years of when closure begins and will take into account input from government agencies and relevant stakeholders at the time. It is anticipated that the following steps would be taken in order to rehabilitate the PWD.

Any remaining liquids (ie water) in the dam will be tested to determine if water quality criteria are met, and if not, then water will be treated to remove contaminants before discharging, or pumped into the underground voids. Water will be treated to a standard that meets the assessment criteria established as part of the water assessment so that NorBE is met. Solids remaining in the dam will be managed in a similar manner as soils under the stockpile area and will be selectively assessed against background criteria. If contamination is found, then the area will be appropriately remediated prior to the dam walls being pushed down and the area re-shaped and seeded so that it is suitable for the agreed future use of land grazing.

Other than removing iron precipitates from the PWD from time to time and planned water quality monitoring, no other special management activities would be required at the PWD.

Costs associated with operation and management of the PWD are included as part of the overall annual site operating cost estimate and are immaterial to the overall operating costs of the site. Costs associated with closure and rehabilitation of the PWD have been accounted for as part of the economic assessment and financial model for project, as have all costs associated with rehabilitation (refer to Section 2.3.1 of the Economic Impact Assessment of the Hume Coal Project (BAEconomics 2017)). The mine will not produce a separate tailings stream, therefore costs associated with tailings management are irrelevant to the project.

10.3.3 Temporary reject stockpile management

i Justification and purpose of the stockpile

While NSW DPI state that an underground disposal option would be beneficial for maintaining the aesthetic appearance of the surface infrastructure for the mine, the NSW EPA and interest group submissions requested a justification as to the need for maintaining a temporary stockpile on site given presumed associated pollution risks.

The temporary coal reject surface stockpile will consist of reject accrued during the first 12 to 18 months of project development and will be amended through the addition of 2% limestone. The stockpile will be progressively reshaped, capped and re-vegetated. Once complete, the stockpile will remain in place and unaltered until the final stages of mining, at which point, it will be placed into the last remaining void spaces underground. Surface runoff from the temporary stockpile will be captured in SB01.

Coal reject generated after the first 12 to 18 months will be amended with 1% crushed limestone and go directly from the plant, to the batch mixer, then immediately placed underground – it will not be stockpiled at surface. The 12 to 18 month time period is primarily dependent on void space availability underground and timing of the processing plant's commissioning. The exception is under special circumstances (eg unplanned breakdown or panel relocations) where reject would be placed on the surface temporarily and pumped underground once the plant is operational again (this type of stockpile would be used for a period of days, not months or years). In any case, all material stockpiled at surface – even for emergency storage – will be amended with 2% limestone to ameliorate the potential for acid generation.

ii Monitoring and management of risks associated with the stockpile

Submissions suggest that Hume Coal does not adequately consider the potential contamination risk to the environment (primarily seepage) from the temporary reject stockpile, and request that practical measures to manage any risks to receiving waters be outlined in the EIS, such as bunding, drainage and stormwater management.

The NSW EPA suggested some practical design measures including, but not be limited to:

- location the stockpile on a low permeability base;
- capping the stockpile; or
- leachate collection/monitoring.

They also suggested that leachate from the temporary reject stockpile should be monitored and that the project should demonstrate that the proposed barriers from the stockpile are sufficient to prevent pollution of the surrounding environment.

The EIS states that stormwater controls for surface operations of the mine, including the temporary reject stockpile location. The stockpile will be 'top-dressed' and revegetated to limit infiltration and promote efficient surface runoff of rainfall and reduce infiltration. Surface runoff from the temporary reject stockpile will be captured in SB01 and then transferred to the PWD as part of the mine water management system.

The area where the temporary reject stockpile will be located will have approximately 150 mm of topsoil stripped, and stockpiled for post-mining rehabilitation, and a suitable pad will then be prepared prior to placement of any rejects. Management of the temporary reject stockpile will be in line with site procedures for waste management and water management.

As also stated in the EIS, a monitoring and management plan will be developed to document the methodology applied to the temporary reject stockpile. The Hume Coal Project is committed to the development of targeted monitoring and management plans for the project. A specific monitoring and management plan will be developed to document the methodology applied to the temporary surface stockpile and permanent underground storage of coal reject materials detailed in the EIS.

10.3.4 Processing reagents

In relation to pollution risks from water management and rejects, the NSW EPA commented that the EIS does not provide enough information and discussion on the environmental and human health risks related to water management, coal washery and reject management.

WaterNSW, special interest groups and community submissions requested information as to the chemicals used, which are associated with the coal processing and mine operation, and whether such reagents may cause contamination and potentially impact users accessing coal seam groundwater downgradient of the proposed mine. One submission was concerned if methyl isobutyl carbinol (MIBC) and 4-methylcyclohexane methanol (MCHM) would be used as part of the project.

The Hume Coal Project will use reagents commonly used in the coal mining industry in Australia for coal processing.

Other materials used in general mine operations in Australia will also be used. These materials have already been clearly identified in Section 2 of the Hazard and Risk Assessment Report (Appendix P of the EIS (EMM 2017a)) and include:

- Diesel – there will be approximately 50,000L of diesel storage capacity on site during construction and operations. It will be stored in bunded tanks at the surface infrastructure area in accordance with *Australian Standard 1940:2004 The Storage and Handling of Flammable and Combustible Liquids*.
- Petrol – Small quantities of petrol will be in the fuel tanks of light vehicles and some other small equipment and will be stored and handled on-site in accordance with AS 1940:2004.
- Other Hydrocarbons (oil, grease and degreaser) – approximately 6.4 t of these materials will be stored in the workshop and storage warehouse in accordance with AS 1940:2004. Small quantities of oils will also be stored in the oil tanks of plant and equipment, vehicles and some other small equipment. Equipment such as large, fixed surface transformers will be housed in bunded areas to contain any potential leaks. Used hydrocarbon materials will be collected by licenced waste contractors for off-site recycling or disposal contractor.
- Paints, cleaning and coal processing substances – these substances will be stored in the workshop and storage warehouse, or CPP, near the centre of the surface infrastructure area in accordance with AS 1940:2004 where appropriate, and in bunded storage areas to prevent the uncontrolled release of any spillage. It is unlikely that any non-trivial quantities of paint will be stored on-site since equipment will be typically overhauled and painted off-site. Coal processing substances will be used at the CPP for coal washing and processing and their hazard potential (based on their Material Safety Data Sheets) are noted as:
 - NALCOAG 3268 – Not classified as hazardous according to Safe Work Australia and not classified as a dangerous good according to national and international regulations.
 - ULTRION 8187 – Classified as hazardous according to Safe Work Australia as it is irritating to eyes in concentrated form. Hazard relevant to the workplace but not relevant to public safety as it will be used in a closed area distant from the boundary of Hume Coal owned land. Not classified as a dangerous good according to national and international regulations.
 - NALFLOTE 9840 PLUS – Not classified as hazardous according to Safe Work Australia and not classified as a dangerous good according to national and international regulations.
 - HITEX 82230 – Not classified as hazardous according to Safe Work Australia and not classified as a dangerous good according to national and international regulations.
 - CoalEX 88007 – Classified as hazardous according to Safe Work Australia as it is irritating to eyes in concentrated form. Hazard relevant to the workplace but not relevant to public safety as it will be used in a closed area distant from the boundary of Hume Coal owned land. Not classified as a dangerous good according to national and international regulations.

Storage and use of paints, cleaning and coal processing substances at the project will therefore not qualify the project as a potentially hazardous or offensive development under the former NSW Department of Planning's *Applying SEPP 33* (DoP 2011a).

All potentially hazardous materials at the proposed project will be stored and used in accordance with a hazardous materials plan as detailed in the EIS (Appendix P) (EMM 2017i). In addition, a contingency plan for environmental incidents will detail the response actions during any potential environmental spill incident. The hazardous materials plan will include details such as the standards for bunding and storage, transportation and receipt of goods to site and spill response measures.

In addition to the information provided above, the mine water management system to be used at the project detailed in Section 2.3.2 of the EIS Water Assessment Report (EMM 2017c) and will include:

- runoff from undisturbed areas will be diverted around or away from the infrastructure and remain within the natural catchment;
- surface water runoff from disturbed areas will be collected in stormwater basins (SBs) and mine water dams (MWDs) and reused as much as possible as part of the operational demands;
- runoff from disturbed areas not in direct contact with coal (SB03 and SB04 catchments) will potentially be discharged to Oldbury Creek after first flush and water quality criteria have been met; and
- water in excess of operational needs will be pumped underground into the sealed void areas.

The information provided above, the coal reject materials stored on surface and underground will be sealed in underground workings. Whilst some groundwater interaction with the stored coal reject materials may occur over time, the results of hydrogeochemical modelling indicate that the leachate quality generated through the interaction of coal seam groundwater with the limestone-amended reject material (in the subsurface geochemical environment) was within the same beneficial use classification as ambient coal seam groundwater, despite several layers of conservatism being adopted in the modelling.

The types of coal processing reagents that will be used at the CPP for coal washing and processing (listed above) are widely used across industries including the treatment of drinking water and stormwater to remove suspended particles. For the purpose of coagulation or flocculation of ultrafine coal particles, the polymers in Hi-Tex 82230 and NalCoag 3286 and the only ingredient of Ultrion 8187 (aluminium chloride hydroxide) are all approved for use in treating drinking water (NHMRC 2016). Any residual product will be readily biodegraded within the reject material.

Naflo 9840 and CoalEx 88007 form the froth that collects ultrafine coal particles and primarily sticks to the coal particles in preference to the coal reject material. The ingredients in these products biodegrade readily within a few weeks.

Given that the ultrafine material makes up only 10% of the overall solid material excavated from the proposed mine and only 17% of the reject material to be replaced in the mine is ultrafine material, only a small proportion of the material replaced into the mine has any potential to contain trace amounts of these commonly used reagents. The potential for any perceivable impact to groundwater quality from these reagents is therefore negligible.

It is noted that there is no intention to use methyl isobutyl carbinol (MIBC) and 4-methylcyclohexane methanol (MCHM) as part of the project, as better alternatives are available.

10.3.5 Ongoing monitoring

The NSW EPA provided recommendations that targeted monitoring and management plans (including TARPs) be developed for the project.

The agency further recommended that justification as to why monitoring is important is provided within the plan, and adequate shallow groundwater monitoring program should be implemented to monitor potential pollution.

With respect to coal reject materials, a detailed monitoring and management plan will be developed to specifically document the methodology applied to the temporary surface and permanent underground storage of coal reject materials. The plan will identify the specific monitoring requirements that will be implemented. The coal reject management and monitoring plan will also include a section detailing the TARP associated with coal reject management.

Section 7.7.3 of the EIS (EMM 2017a) outlines the potential expansion areas of the groundwater monitoring network, which may include monitoring of groundwater seepage adjacent to the PWD, monitoring adjacent to existing bores, shallow monitoring at Medway Dam, or shallow monitoring in areas identified as having shallow groundwater and known ecosystems with threatened species.

Further details regarding the Monitoring and Management Plans are provided in Chapter 13 of the Revised Water Assessment (Appendix 2).

10.3.6 Mitigation

Some special interest groups and community submission comments questioned the reject management approach and effective mitigation options proposed. Specifically, the concerns were:

- how effectively mixed the proposed limestone is likely to be, or what degree of mixing is practicably achievable.
- whether alternative options for reject management have been considered, for example, stockpiled at surface and used for fill in roadbase or civil construction.

Section 6.4 of the EIS (EMM 2017a) states that reject emplacement underground was selected after consideration of alternative methods, given that it removed the need for permanent surface emplacement. This selection was made following consideration of environmental, social and financial aspects. The environmental and social benefits of underground emplacement compared with surface emplacement include elimination of permanent tailings ponds at surface; reduced surface disturbance footprint; removal of air quality, noise and visual impacts associated with traditional surface emplacement. Options for beneficial use of the material may arise in the future. If this did occur, it would need to be the subject of an appropriate environmental and economic feasibility assessment at that time.

The limestone will be added to the reject in powdered form via a dosing system prior to being pumped underground and will be very well mixed. Many of the processes involved in the preparation of the reject material are turbulent and/or mechanically violent, and will result in extremely effective mixing of the limestone, which can be added prior to any of the following processing steps:

- log washing;
- crushing;
- screening;
- adding water in a mixing tank;
- pumping; and
- emplacing the material.

11 Water licensing

11.1 Overview

Some interest groups had concerns that the mine design is tailored to minimise groundwater take, and that this aspect is overshadowing the modelling process.

Some community members raised concerns that Hume Coal will seek handouts or exemptions from government to cover their water licence needs.

11.1.1 Modelling process

In no way have the mine design aspects overshadowed the numerical modelling process. The modelling process determines the model results with the mine design being amended over time to minimise impacts. The numerical groundwater modelling work undertaken for the project is robust and holds solid scientific integrity. The NSW Government independent peer reviewer concludes that both the EIS and subsequent approach for the revised EIS model is 'fit for purpose' (Hydrogeologic 2017).

The Hume Coal mine layout and proposed mining methods are deliberately designed to protect the overlying regional Hawkesbury Sandstone aquifer and to minimise groundwater inflows into the mine workings. However as with any underground mine, there will be groundwater inflows that can only be predicted at this pre-development stage by the EIS numerical model constructed to replicate the regional hydrogeology and the local influence of the mine. The incidental water that flows into the mine and the take of water from the mine for reuse must be licensed under NSW water legislation and associated policies.

11.1.2 Water licensing requirements

The licensing aspects of the project were undertaken in accordance with the legislative requirements and the NSW DI Water in their submission stated that the '*Water Impact Assessment Report has adequately outlined groundwater licensing requirements, although this will need to be reassessed following review of the groundwater model*'. Therefore, this chapter provides additional information on water licensing and also clarifies changes to licensing requirements as a result of remodelling and the revised water impact assessment (see Chapter 9).

Hume Coal is required to licence surface water and groundwater in accordance with the Aquifer Interference Policy (AIP), the Water Management Act (WMA) 2000, and the relevant statutory water sharing plans. The most relevant Water Sharing Plan (WSP) is the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The surface water WSP relevant to the project area is the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011. Licensed volumes must include water taken from natural sources for use as well as intercepted baseflow and incidental water captured as a result of mining activities. Intercepted baseflow is a loss from the contributing groundwater source rather than a loss from the receiving surface water source. Sufficient water access licences (WALs) must be held to account for any extra water intercepted from these water sources (directly or indirectly).

The AIP specifies the project licence requirement to consider adjacent and overlying water sources (both groundwater and surface water). Should the project cause water to inflow from an adjacent or overlying water source, a licence for that volume is required from that adjacent water source. The numerical groundwater model predicts the total volume of water intercepted during mining and the ultimate sources of that water.

The mine design is a considered non-caving design tailored to ensure long-term stability of the columns and therefore protect the overlying formations from fracturing, avoid surface subsidence and minimise short-term impacts to the groundwater system, and ensure that in the long-term, the groundwater water levels fully recover. The mine design has been incorporated into the numerical groundwater model as have other aspects of the conceptual model, equally, such as hydrogeological properties and conceptualisation. In no way have the mine design aspects overshadowed the numerical modelling process. The modelling process determines the model results with the mine design being amended over time to minimise impacts. The numerical groundwater modelling work undertaken for the project is robust and holds solid scientific integrity. The NSW Government independent peer reviewer concludes that both the EIS and subsequent approach for the revised EIS model is 'fit for purpose' (Hydrogeologic 2017).

Hume Coal has already acquired the vast majority of their groundwater licence requirements on the transfer market, and has 93% of the licence requirements for the Sydney Basin Nepean Groundwater Source – Management Zone 1 (the outstanding 7% volume equates to approximately 150 ML). Hume Coal also currently hold 93% of their peak take from all water sources. The 93% of licence requirements from Zone 1 has been purchased from willing sellers, and expects to purchase the remaining volume of the market. For the other groundwater sources (Nepean Groundwater – Management Zone 2 and Sydney Basin South), Hume Coal holds the necessary licences, with the exception of 3 ML from the Sydney Basin Nepean Groundwater Source – Management Zone 2 (which has unassigned water that is available to be purchased via the next NSW Government controlled allocation release), or is available via permanent or temporary transfers from existing users. Hume Coal is not and will not be seeking exemptions or handouts from the government to cover the water licence needs for the project

The relevant surface water source that covers the project area is the Upper Nepean and Upstream Warragamba Water Source, and within that source, the Lower Wingecarribee Management Zone, Lower Wollondilly Management Zone and the Management Medway Rivulet Zone are the most relevant to the project. Hume Coal holds more than 100% of the required surface water licence requirements.

11.2 Water sources and legislation overview

Concerns were raised by interest groups that Sections 63 and 97 of the Water Management Act (WMA2000) states that the Minister will not grant a licence or approval unless the "no more than minimal harm" requirement will be met. Given there is no definition in the Water Management Act as to what 'no more than minimal harm' is, the submission interprets the definition as per an English language dictionary as being 'smallest, very small, negligible, extremely small, minor or minimal amount'. The submission states that based on that definition, the Minister should not be able to grant Hume Coal further licences.

Interest groups also had concerns that all water sources for which Hume Coal require licences are fully allocated and that no water licences can be obtained.

Some interest groups were also concerns that Hume Coal will not licence all water in strict accordance with the aquifer interference policy, and that only physical take is being licensed, and not the inflow and movement of water within the workings as a result of mining. Concerns were raised by members of the community in regard to the interpretation and implementation of the AIP were raised, with respect to licensing water that is 'removed' or 'moved' within the groundwater source as a result of the activity. The concerns suggest that the AIP managed both removal and injection of water into a groundwater source, and that a volumetric licence is required for both removal and pumping of water (ie pumping into the void), and that these two volumes should be added together to arrive at the total volume of water licensing requirements.

11.2.1 Definition of water 'take' and aquifer interference in the context of licence requirements

The AIP (as defined in section 1.3 of the AIP) states that an aquifer interference activity includes:

- penetration of an aquifer;
- interference of water within an aquifer;
- obstruction of the flow of water in an aquifer;
- taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations, and
- disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulators.

The AIP overall therefore does consider reinjection of water and it goes on to clarify this, stating

"Examples of aquifer interference activities include mining, coal seam gas extraction, injection of water and commercial, industrial, agricultural and residential activities that intercept the water table or interfere with aquifers"

"Section 1.4 of the AIP then goes on to state that:

"Aquifer interference activities may or may not take water from the water source...." and

"Water is taken when it is specifically required to be used as part of an activity, for example the washing or processing of ore. Water is also taken incidentally where the take is required to allow the effective and safe operation of the activity, for example dewatering to allow mining..... In all cases the activity is taking water from a water source."

The AIP then goes on to state that:

"To comply with extraction limits set by water sharing plans it is important that the volumetric take of water by aquifer interference activities is appropriately licensed and accounted for. "

The Section 2 of the AIP discusses the licensing requirements of the AIP, and clearly states that it applies to water 'taken' from water sources to ensure that the groundwater sourced can be sustainably managed – ie to allow the water budgets of these water sources to be considered each year. Specifically, Section 2 of the AIP states:

"...Water Sharing Plan set extraction limits and rules for water access.... in order to protect water sources and their dependent ecosystems, whilst recognising the social and economic benefits of the sustainable and efficient use of water".

The AIP then clearly states that these licensing provisions apply to take of water (ie specific take and incidental take), and not to reinjection, and this is stated in Section 2.

"all water taken by aquifer interference activities, regardless of its quality, needs to be accounted for within these extraction limits"

and

"a water licence gives its holder a share of the pool of water available for extraction".

Hume Coal will (in strict accordance with the AIP and the WMA 2000) obtain water licences to account for water that;

- flows into the mine sump and is pumped to surface for use in the mine water demand;
- flows into down dip void following mining that remains underground and is not handled during mining
- flows into sealed voids following mining (ie Hume Coal hold licenced under this aspect of the definition until all voids are full;
- movement of water from adjacent groundwater sources (Sydney Basin South Groundwater Source, and Sydney Basin Nepean Groundwater Source – Management Zone 2; and
- movement of water (ie induced leakage) from overlying surface water sources.

It is important to note that the AIP states that not all aquifer interference activities require a licence. Therefore, even though pumping water back into the underground void following mining by Hume Coal is technically an 'aquifer interference activity' it **does not** require volumetric licensing to account for this water put back in, because this is not **take** and is not causing water to 'move' out of a groundwater source. In addition, the volume of water pumped into the void is already licenced and taken into account when determining water licence requirements for the project and is therefore the original 'take' of this water is already included in the licensing calculations.

The Hume Coal Project is located within Management Zone 1 of the Sydney Basin Nepean Groundwater Source. In accordance with the AIP, water either used or intercepted by mining activities needs to be licensed within the source from which it derives. For the Hume Coal project the majority of the licence volume is sourced from Nepean Management Zone 1, with some minor contribution over time from adjacent groundwater water sources (Nepean Management Zone 2 and Sydney Basin South).

Additional licence share components are no longer being issued in Nepean Management Zone 1 of the Sydney Basin Nepean Groundwater Source (even though there is available unassigned water) as per the rules in the Water Sharing Plan (ie it is effectively embargoed).

Hume Coal has acquired most (93%) of the required licences for the mine development to satisfy their requirements in Nepean Management Zone 1 of the Sydney Basin Nepean Groundwater Source from existing water licence holders on the open market. The transfer of existing licences to Hume Coal means, from a regional water source perspective, additional stress (ie above what is considered sustainable) will not occur in this water source. The current water rights within this water source and management zone are well within the defined sustainable limits (Long Term Average Annual Extraction Limit - LTAAEL).

11.2.2 Section 63 of the WMA2000

Section 63 of the WMA2000 is titled 'determination of applications' and largely applies to the Ministers Authority in determining the granting or refusing of an access licence. Clause (2) (b) of Section 63 states:

"an access licence is not to be granted unless the Minister is satisfied that....adequate arrangements are in force to ensure that no more than minimal harm will be done to any water source as a consequence of water being taken from the water source under the licence".

The AIP states

"The Water Management Act 2000 includes the concept of ensuring 'no more than minimal harm' for both the granting of water access licences and the granting of approvals (see Section 3 of the AIP). Water Access licences are not to be granted unless the Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to any water source as a consequence of water being taken under the licence.

Where a water access licence has been applied for by a method consistent with a controlled allocation process then adequate arrangements are in force to ensure that no more than minimal harm will occur. This is because the controlled allocation process allows for the allocation of a proportion of the unassigned water within the relevant water source using a conservative approach. Furthermore, unassigned water can only occur where total water requirements within a water source are less than the long-term average annual extraction limit specified in the relevant water sharing plan".

Hume Coal has already been granted 30 ML of licence under controlled allocation releases. This combined volume was applied for within the Sydney Basin South (25 shares) and Sydney Basin Nepean Groundwater Source Management Zone 2 (5 shares). These water sources have significant volumes of unassigned water available within their sustainable limits (65,004 ML and 75,398 ML per year respectively). Share components for both these sources were made available under a controlled allocation release (Section 65 of the WMA2000) in May 2015. Hume Coal applied and was granted 25 shares (currently equivalent to 25 ML) for Sydney Basin South and 5 shares (currently equivalent to 5 ML) for Sydney Basin Nepean Groundwater Source Management Zone 2. These licence shares constitute a very minor volume which is within the sustainable limits defined in the WSP, and as stated above in the AIP and that adequate arrangements are in force to ensure that 'no more than minimal harm will occur'.

In the Sydney Basin, Nepean Groundwater Source – Management Zone 1, Hume Coal is not requesting nor does Hume Coal require the Minister to grant a licence under Section 63 for the take or interception of water. Hume Coal has purchased over 90% of their required WAL volume (share components) from within the Sydney Basin, Nepean Groundwater Source – Management Zone 1, from existing active licence holders. As such, Section 63 does not apply, as it pertains to the granting of new licences. Even if it did apply, the WAL shares purchased by Hume Coal are within the predefined sustainable limits for the Management Zone (as defined in clause 49 (3)(c) of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011). Therefore the definition of 'minimal harm' with regard to this particular matter is either irrelevant, or can be demonstrated that it is met (i.e. Hume Coal Licences are within defined Long Term Average Annual Extraction Limits and local sustainable limits applied at the Management Zone level within the water source).

This is confirmed in the AIP, which states at section 2 that the issue of a licence with a zero share will not cause more than minimal harm because the water access entitlements will be purchased from existing licence users within the sustainable limits of the system.

Hume Coal will purchase a further 150 ML of water entitlements from within the Sydney Basin Nepean Groundwater Source, Management Zone 1 from existing users, and an additional 3 ML from within Sydney Basin Nepean Groundwater Source, Management Zone 2, or via then next controlled allocation release.

11.2.3 Sections 91 and 97 of the WMA2000

Sections 91 and 97 of the WMA2000 discuss the definition, granting and refusal of aquifer interference approvals.

Section 91 (3) defines an aquifer interference approval and states that an example of where an aquifer interference approval may be needed includes mining operations. Section 91F establishes the penalties for those carrying out aquifer interference activities without the necessary approval. Section 97 (6) of the WMA2000 deals with the grounds for refusal of an aquifer interference approval, which it states is not be granted '*unless the Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to the aquifer....*'.

Although the aquifer interference approval clauses in the WMA2000 have received 'assent', they are yet to commence and therefore do not apply to any water sources in NSW. Aquifer interference approvals will not exist until they are commenced by 'proclamation' in the NSW Government Gazette to apply to selected, or all groundwater sources in NSW. This effectively means that the aquifer interference approvals, as an approval required by mining companies under Sections 91 and 97 of the WMA2000, do not exist. Hume Coal therefore does not need an aquifer interference approval under s97 or s91F of the WMA2000 to take water associated with undertaking mining activities.

Even if Hume Coal were to seek s91F approval, the 'minimal harm' requirement in s97(1) and s97(6) of the WMA2000 is met, for the same reasons the 'minimal harm' requirement in s63 is satisfied.

11.2.4 Aquifer Interference Policy

Section 3 of the Aquifer Interference Policy deals with the assessment process for aquifer interference activities *under both the EP&A Act and the WMA2000, for approval under the EP&A Act*. Section 3.2 provides a framework for assessing the impacts of aquifer interference activities on water resources and states that:

"The assessment of aquifer interference activities seeking approval under the EP&A Act will be made on a case by case basis for each particular project in accordance with this Policy.

... the assessment and subsequent advice on a project will be based on the proponents:...

ability to demonstrate that adequate arrangements will be in place to ensure that the minimal impact considerations specified in Table 1 and section 3.2.2 can be met; and

proposed remedial actions for impacts greater than those that were predicted as part of the relevant approval. "

The Aquifer Interference Policy defines and develops 'minimal impact' (not 'minimal harm') considerations that apply to groundwater sources at a local scale. The minimal impact considerations deal with measurable and defined local scale drawdown and water quality criteria around water dependent assets such as: high priority ecosystems; culturally significant sites; and water supply works.

The 'minimal impact' of the AIP in the proper context of the EP&A Act is discussed in other parts of this section 6 of this RTS.

It is noted that the **Aquifer Interference Policy 'minimal impact considerations'** as defined in Section 3 and Table 1 of the AIP deals with measurable and defined local impacts at defined water dependent assets.

Minimal impact as defined in the AIP does not suggest that a project not be approved if it is predicted to have 'greater than minimal impact'. Instead, impacts predicted to be 'greater than minimal impact' require additional management and mitigation measures, such as additional monitoring and make good arrangements. **This is a very different concept and different definition to the Water Management Act 2000 references to 'minimal harm'**, which apply as a regional water source scale and are managed via the Long Term Average Annual Extraction Limit as stated in Section 2 of the AIP.

11.2.5 Summary of difference between 'minimal impact' and 'minimal harm'

Hume Coal does not need approvals under Section 63 or Section 97 of the WMA2000. Even if it did, the 'minimal harm' requirement, at the regional water source scale, would be met, pursuant to the AIP.

The term 'minimal impact' for purposes of the implementation of the Aquifer Interference Policy is a localised consideration that applies to measurable impacts at a local scale. Projects are assessed against minimal impact criteria as set out in the AIP, which then informs potential additional mitigation and management measures that need to be adopted if the impacts are assessed as greater than minimal impact. The project can still be approved (and are routinely approved) if impacts that are greater than minimal are predicted.

Therefore the terms 'minimal harm' as used in the WMA2000 at the water source scale is very different to the term 'minimal impact' as used in the AIP at a local scale. They are different terms, under different Acts, used for different purposes.

11.2.6 Current licence status

Groundwater sources adjacent to Zone 1 (ie Sydney Basin Nepean Zone 2 and Sydney Basin South) are not yet fully committed, with unassigned water available to be granted by the NSW Government. This is undertaken periodically via a controlled allocation release and in accordance with Section 65 (1) of the WMA2000.

Hume Coal previously applied for licences within the Sydney Basin South and Sydney Basin Nepean Groundwater Source Management Zone 2, via the controlled allocation process. These water sources have significant volumes of unassigned water available within their sustainable limits (65,004 ML and 75,398 ML per year respectively). Share components for both these sources were made available under a controlled allocation release (Section 65 of the WMA) in May 2015. Hume Coal applied and was granted 25 shares (currently equivalent to 25 ML) for Sydney Basin South and 5 shares (currently equivalent to 5 ML) for Sydney Basin Nepean Groundwater Source Management Zone 2. These licence shares constitute a very minor volume which is within the sustainable limits defined in the WSP.

Currently Hume Coal holds the following water licences in the each of the relevant water sources:

- 1,909 shares in Management Zone 1 of the Sydney Basin Nepean Groundwater Source;
- 5 shares in Management Zone 2 of the Sydney Basin Nepean Groundwater Source;
- 25 shares in Sydney Basin South Groundwater Source; and
- 31 shares in the Upper Nepean and Upstream Warragamba Surface Water Source – Medway Rivulet Zone.

The total groundwater resource volumes within the Sydney Basin Nepean and South Groundwater Sources are shown in Table 11.1 and are illustrated in Figures 11.1 and 11.2.

Table 11.1 Southern Sydney Basin Groundwater Sources – water availability

	Sydney Basin Nepean Groundwater Source	Sydney Basin South Groundwater Source
Storage (ML)	63,100,000	22,300,000
Annual recharge (ML per year) *	224,483	225,326
Environmental recharge component	124,915	155,434
Extractive recharge component	99,568	69,892
Breakdown of the extractive recharge component (ML per year) **		
Basic Rights	5,971	2,098
Local Water utilities	11	0
Access Licences (tradeable)	24,564	3,102
Unassigned water	75,398	65,004

Notes * - Volumes taken from Greater Metropolitan Region Groundwater Sources WSP 2011.

** - Volumes taken from DPI Water Register 2016.

The WSP does not provide a breakdown for the two management zones within the Nepean Groundwater Source in terms of the water availability. The WSP does not specifically preclude an increase in entitlement in Zone 1, but implies such by prohibiting trading into Zone 1 that would result in an increase in the total zone entitlement that existed at the commencement of the Plan.

Therefore, the available water on the trading market is constrained to the tradeable licences in Zone 1 at the time the plan commenced. This volume is not provided in the WSP so a review of the Water Register was undertaken and there are 12,553 shares (currently equivalent to 12,553 ML) assigned to Aquifer Access Licences in Zone 1, and all of these shares (except the 11 ML of local water utility licence) can be traded. The 12,553 ML does not include basic landholder rights.

Hume Coal has already secured 93% of the total licence requirement for the project with the majority obtained from existing licence holders and a small percentage via the NSW Government controlled allocation release. Hume Coal with a clear pathway for how the remaining licence volume will be secured to meet extraction requirements. Trading of water from the Nepean Management Zone 1 is proposed to secure the remaining 150 ML (remaining 7%) of the licence requirement from that zone. For the additional 3 ML of share component required from the Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source, either an application through the next controlled allocation order or trading from within that zone is proposed.

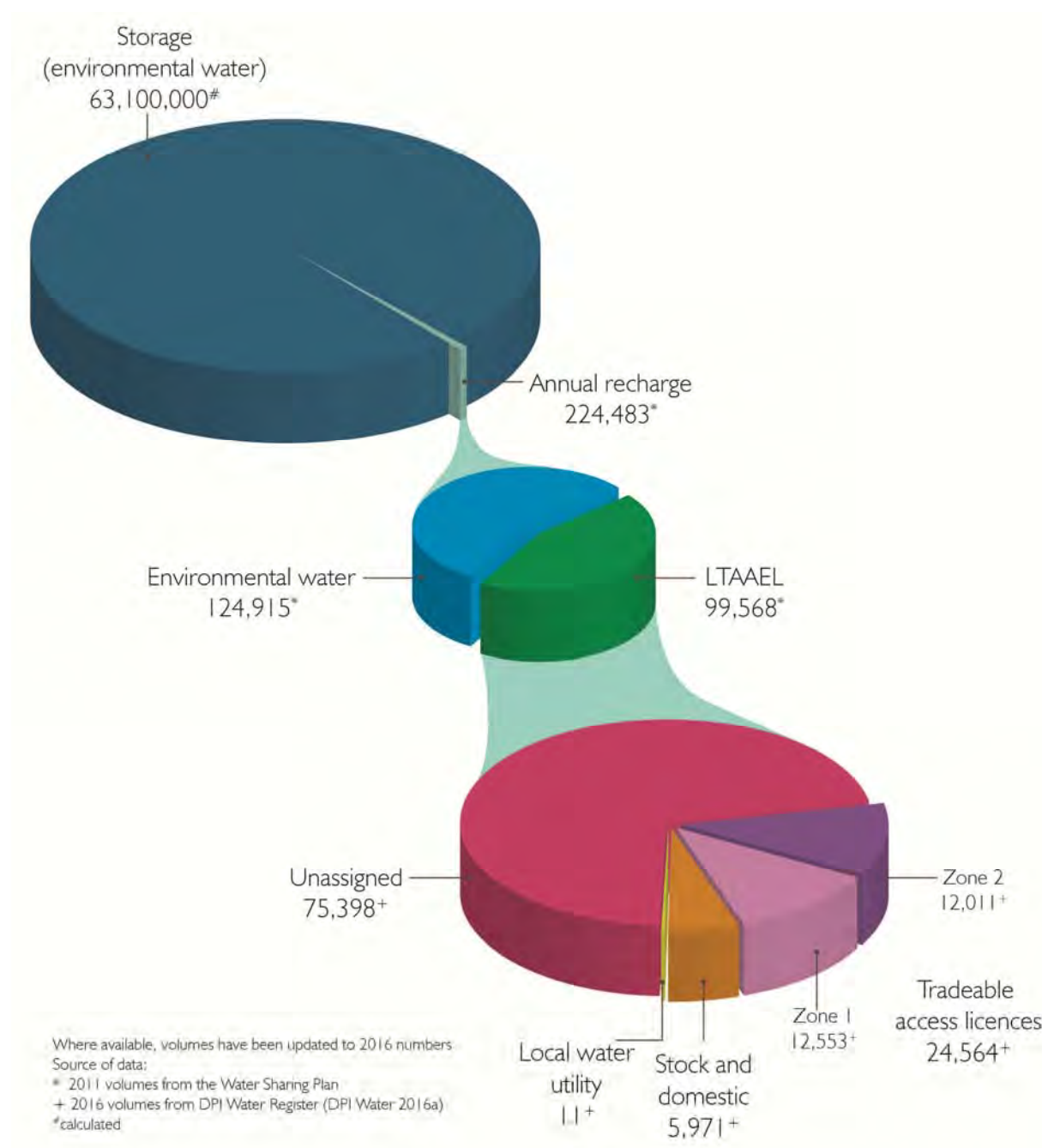


Figure 11.1 Sydney Basin Nepean Groundwater Source available water (ML/yr)

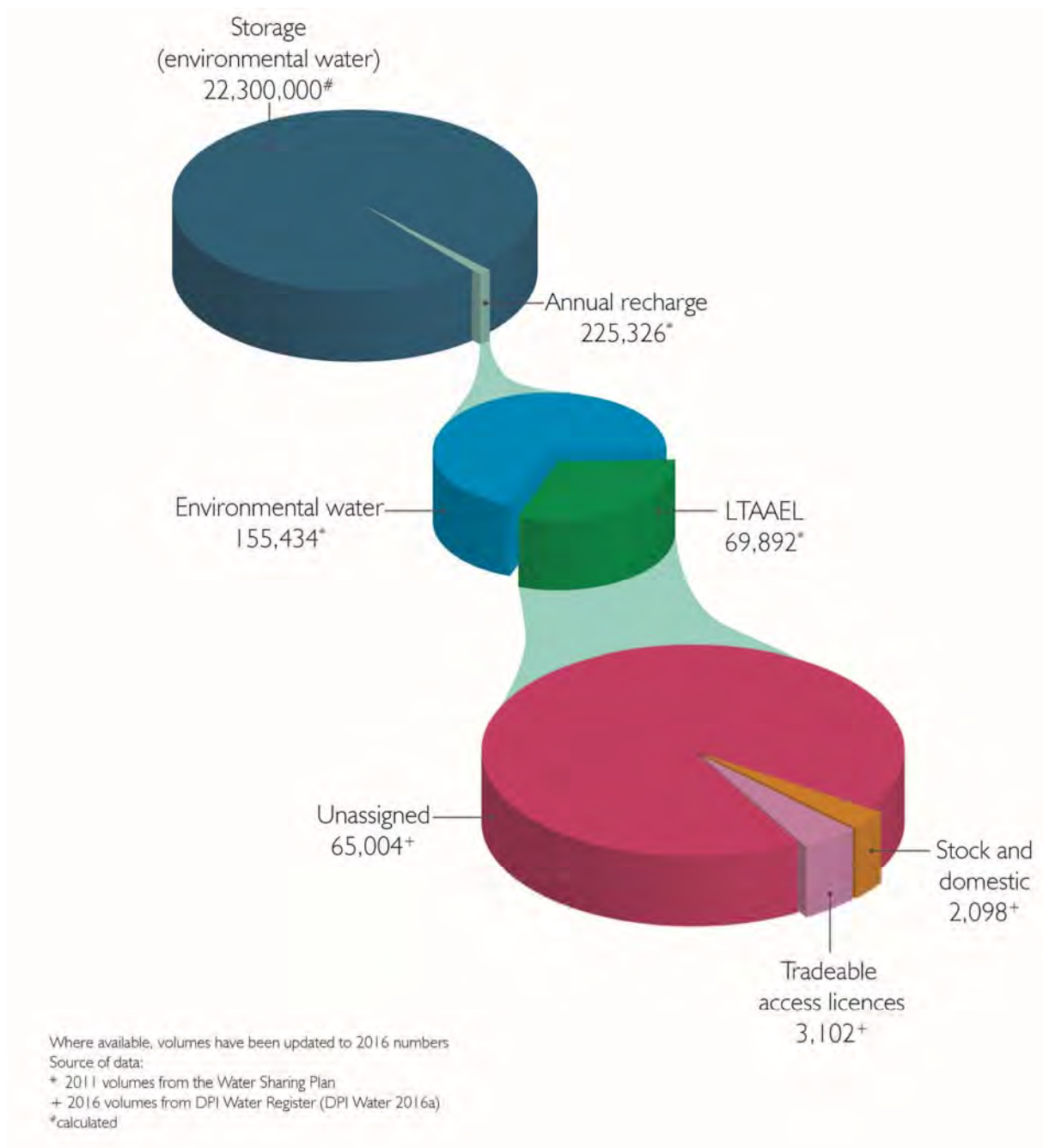


Figure 11.2 Sydney Basin South Groundwater Source available water (ML/yr)

11.3 Harvestable rights and exemptions

Some community members were concerned that Hume Coal are seeking licence exemptions from Government.

NSW DPI requested confirmation that the Primary Water Dam is a turkey's nest dam and whether all dams meet the exclusion requirements of the Harvestable Rights Dam Order.

It was requested that the final Harvestable Right calculation for the Hume Coal owned properties be undertaken.

Water NSW request that the volumes of surface water that Hume Coal estimate to be entitled to take under 'Harvestable Rights' provisions and the methods of estimation require further information to be provided within the EIS.

Hume Coal are not seeking licence exemptions or water licences from the NSW Government over and above standard exemptions that apply for all major projects in NSW. Hume Coal have applied the current regulation and policies as they stand to ensure that they are compliant and they hold water licences (purchased from the open market) for water inflows and take in accordance with the WM Act, Aquifer Interference Policy and relevant Water Sharing Plans.

The Primary Water Dam (PWD) is constructed as a turkey nest dam, and does not receive any runoff from the surrounding catchment. It only receives water via direct rainfall on the surface of the dam, and water that is pumped from stormwater basins and mine water dams during high rainfall events. The main function of the primary water dam is flood mitigation and water management in wet periods to avoid discharges to local creeks (hence its large size). Its secondary purpose is a water supply holding dam for the project water requirements. Turkey's nest dams are exempt pursuant to item 5 of Schedule 2 of the Harvestable Rights WMA s 54 order made in Gazette Number 40 on 31 March 2006 at page 1,628.

Stormwater basins SB01 and SB02, mine water dams MWD05, MWD06, MWD07 and the PWD are all classified as "special dams which are not included in harvestable right calculations" as they either do not have a catchment (ie PWD) or they are dams for the purpose of preventing contamination of a water source (ie PWD, SB01, SB02, MWD05-07) (NOW 2015). As such, the catchments of these dams (where applicable) are not included in the harvestable rights calculations as provided in item 3 of Schedule 2 of the Harvestable Rights WMA s 54 order made in Gazette Number 40 on 31 March 2006 at page 1,628. Catchments of SB03 and SB04 are included in harvestable rights calculations, however, the dams themselves are not (as the water captured will be released following collection of first flush and capturing and retaining first flush is classified as preventing contamination to a water source).

Considering the above, the maximum harvestable rights dam capacity (MHRDC) for Hume Coal owned properties is 111 ML per year (calculated using NSW Government's maximum harvestable rights calculator (DI Water 2018b)). Existing farm dams located on these properties will not be utilised for the project. To ensure MHRDC requirements are adhered to, existing dams can be converted to turkey's nest dams (ie dams with no catchments) if required, with the exception of the instream storages located on Oldbury Creek. The capacity of the instream storages on Oldbury Creek is approximately 40 ML (based on an average depth of 2 m), which is significantly less than the MHRDC for the properties.

11.4 Licensing requirements

DI Water requested the re-evaluation of the volumes required to be licensed based on maximum/worst case conditions (not average conditions) direct and induced take from water sources impacted by the development, and evidence that sufficient entitlement can be obtained. Modelling only considers average conditions, what happens during drought to required licences.

DI Water state that maximum annual volumes of surface water and groundwater predicted to be taken by the proposed mine during operation and in the recovery phase (in case of ongoing residual take) is required to be licensed from the commencement of the mine. Further detail is also requested of the pathway to obtain any additional entitlement.

Concerns were also raised that the volume required may change due to the modelling being potentially inadequate and that remodelling should occur to demonstrate the volume requirements for licences are accurate.

NSW DPI suggested that the works associated with the dam wall on Oldbury Creek will lead to additional water being harvested and that additional licence volume may be required.

11.4.1 Worst case' taken into consideration

The effect of climatic variability (i.e. wet and dry periods) was considered in the revised groundwater modelling and analysed in detail within the sensitivity analysis and compared to the results of using the average climate. The modelling showed that climate variability had limited effect on required water licence volumes (for both groundwater and surface water). There was minimal change in licence requirement between the average climate, the wet climate, and the dry climate cases. The technical aspect of this climate scenario modelling is discussed in detail in chapters 8 and 9, and Appendix 2.

11.4.2 Groundwater model accuracy

The groundwater model for the project has been through rigorous review, audit, upgrade and revision and detailed uncertainty analysis. The NSW Government appointed independent peer reviewer, Hugh Middlemis has also undertaken a thorough review of the model. The model is deemed 'fit for the purpose of predicting inflows from mining' and as such stakeholders can have confidence that the numbers presented for water licensing are accurate, and are unlikely to change significantly as mining progresses.

The effect of climatic variability was considered in the revised groundwater modelling, the sensitivity analysis and the detailed uncertainty analysis. The climate variability had limited effect on required water licence volumes (for both groundwater and surface water). The technical aspect of this climate scenario modelling is discussed in detail in chapters 8 and 9, and associated appendix reports. The conservative approach of the 67th percentile is adopted for the predicted licensable volume which is conservative in that the most likely scenario is 50th percentile and Hume Coal are therefore licensing more than the most likely scenario to provide existing water users and the NSW Government with enhanced confidence that the likely water requirements for the project are more than fully covered.

The detailed uncertainty analysis has provided robust and defensible results in terms of water requirements. Hume Coal has taken a conservative approach to licensing requirements, and is using the 67th percentile (and not the average 50th percentile which is the most likely scenario). The revised modelling and uncertainty analysis provides revised forecasts of required licence volume, which are very similar to the original Coffey EIS results – but are considered more robust due to the very detailed uncertainty analysis upon which they are based (this is in accordance with the new draft IESC guidelines for modelling uncertainty).

The project's mining method progressively seals off the mine void from the active mine workings with bulkheads, so that most groundwater that would have otherwise flowed into the mine is not extracted and pumped to the surface, but physically remains in the groundwater source. The volume of water proposed to be licensed by Hume Coal is in strict accordance with a literal reading of the Aquifer Interference Policy. It is taken to be intercepted baseflow, plus the groundwater inflow to the sump that is physically handled (taken) by the mine's water management system, plus the groundwater inflow to the void (both behind bulkheads and into down dip areas), even though this water in the void is not physically removed, and remains within the groundwater source.

Based on the results of the 67th percentile uncertainty analysis revised numerical groundwater model (HydroSimulations 2018) and the revised water balance model (WSP 2018), the maximum physical extraction of water from within the mine workings in one year is 1,010 ML/yr in Year 17 (Figure 11.3). However, because Hume Coal is adhering strictly to the literal reading of the AIP, the total volume that will be licensed is 2,066 ML/yr in Year 17 which represents the water physically taken (sump), plus water that moves into the sealed and down-dip void areas but remains in the mine workings (void).

It should be noted that Figure 11.3 shows that volumetric inflow to the void (which mostly remains in the groundwater source) is greater than the volume of water that inflows to the sump (and physically taken) That is, Hume Coal's water licensing approach is conservative, having more licence than physically taken or used from within the greater groundwater source.

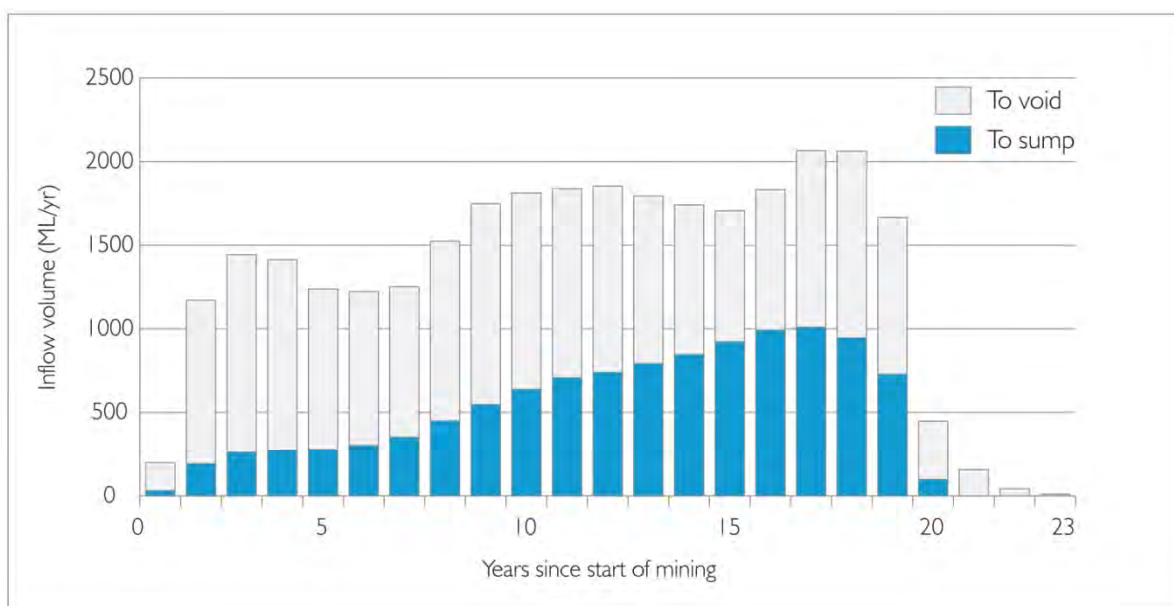


Figure 11.3 Annual water inflow volumes to the mine

As per the AIP, the total mine inflows must be licensed from within the source from which it derives. Therefore based on the latest predictive modelling estimates, the maximum volume required for licensing from each individual water source is:

- Nepean Management Zone 1 Sydney Basin Nepean Groundwater Source 2,059 ML/yr in year 17;
- Nepean Management Zone 2 Sydney Basin Nepean Groundwater Source 7.1 ML/yr in year 25;
- Sydney Basin South Groundwater Source 6.5 ML/yr in year 74; and
- Medway Rivulet Management Zone of the Upper Nepean and Upstream Warragamba Water Source, 19 ML/yr in year 21.

Maps showing the locations of these water sources / management zones are included in Figures 3.1 and 3.2 of Appendix 2.

The relative volumetric contributions from the Greater Metropolitan WSP groundwater sources are illustrated in Figure 11.4 (Sydney Basin Nepean Groundwater Source Management Zone 1) and Figure 11.5 (Sydney Basin Nepean Groundwater Source Management Zone 2, Sydney Basin South Groundwater Source, Medway Rivulet Management Zone).



Figure 11.4 Groundwater take: Nepean Management Zone 1

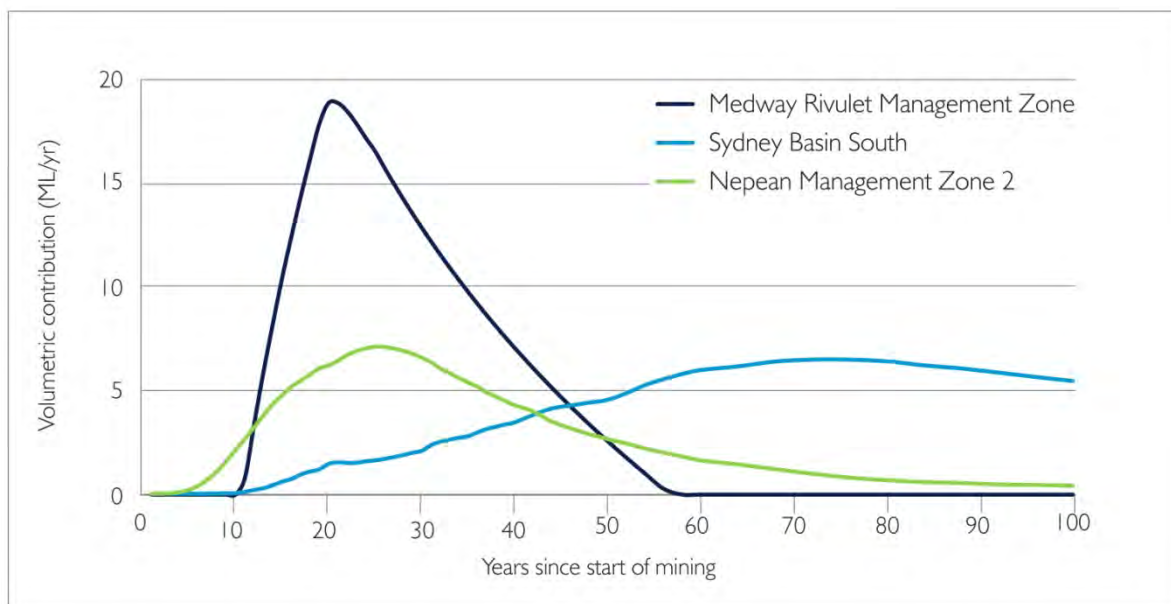


Figure 11.5 Groundwater and surface water take: Medway Rivulet Management Zone, Sydney Basin South, Nepean Management Zone 2

11.4.3 Timing of licence acquisition

There is no legal requirement to hold licences to cover the peak volumetric take from the commencement of the mine (or even from Project Approval or the lodging of the EIS). Nevertheless, Hume Coal has already acquired 93% of the required licences on the market over the last few years. Hume Coal will be able to acquire the remaining 7% of licence requirements before the commencement of the mine via the open market, and from controlled allocation releases. There are sufficient licences remaining in the market to purchase the remaining water licence requirements.

11.4.4 Surface water

The revised modelling and uncertainty analysis fully explore the conceptualisation of the surface and groundwater connectivity across the project area. Water table elevations have been considered in detail throughout this process and a more probable surface has been derived through the uncertainty analysis work. There are baseflow contributions to permanent streams in both the upper and lower catchment areas. In the upper catchment areas, most baseflow is derived from perched aquifers in the basalt areas. These springs are disconnected from the regional aquifer in the Hawkesbury Sandstone and will be unaffected by mining. In the lower catchment, rivers are incised into the regional Hawkesbury Sandstone aquifer and are commonly referred to as 'connected-gaining' streams.

11.4.5 Oldbury Creek embankment

The works on the existing dam wall (embankment) across Oldbury Creek will not increase the storage capacity of the existing dam and, as such, there is no requirement for additional water licences. Hume Coal does not intend to raise the dam wall but may consider upgrading the existing access track by widening the embankment, if necessary. Widening of the embankment will not affect how the dam spills during normal rainfall events. The existing spillway through the embankment will be maintained at the current level so that the water stored within the storage will not increase in volume.

It is noted that Section 6.1.3 of the Hume Coal Project Flooding Assessment (WSP PB 2016d) references that the embankment across Oldbury Creek will be raised and that it will also have poles for electricity lines installed. This statement is incorrect. As mentioned above, the embankment will not be raised but may be widened; this work will not affect the storage capacity of the existing dam. The electricity lines will be constructed at the other, upstream crossing of this dam.

11.5 Licence activation and impacts

OEH were concerned that should more licences be required, the impact of acquiring them needs to be considered in respect of agriculture production and other users.

Local council was concerned with sustainability of the groundwater resource given the existing Berrima mine is continually taking water. They feel that taking of additional water by Hume Coal will place more stress on the resource.

Concerns that the linking of purchased WALs to water supply works will need to be undertaken in consultation with the DI Water, and that the extraction rules placed on the work approvals are unknown at this stage.

NSW DPI raised concerns that impacts to the reliability of supply from Medway Dam will compromise town water supplies are raised.

Some interest groups were concerned that the purchase of water licences by the mine will drive up the price of water in the Management Zone.

Interest groups also expressed concerns that additional groundwater usage in the Management Zone may result in DI Water making an Available Water Determination (AWD) of less than 1 ML per share.

Community members expressed concerns that during drought the allocation for take on licences will be reduced by DI Water and Hume Coal will have insufficient allocation to cover their water inflows. They were also concerned that, during drought, additional licences will be required to cover their groundwater requirements.

DI Water is responsible for the management of groundwater across NSW. Pragmatically, this is achieved by quarantining all of the storage volume within a groundwater resource and also quarantining a percentage of the annual recharge for the environment. The remaining percentage of recharge is then allowed to be allocated to consumptive users and a proportion of this is physically extracted each year by water users. The volume that is allowed to be extracted each year is termed the Long Term Average Annual Extraction Limit (LTAAEL). The LTAAEL is then subdivided (via demand) into different categories of licence or 'basic rights'. Basic landholder rights are uses such as stock and domestic uses, and native title. Water Access Licence (WAL) categories are then considered as being local water utilities (ie town water supply) and other (high volume) consumptive uses (ie irrigation, industrial, mining etc).

The WMA establishes the priorities for access to water in NSW under Sections 5(3), 58 and 60(1). Share volumes could be reduced by an announced AWD by DI Water if monitoring suggested that groundwater supplies were diminishing, however the current level of groundwater entitlements (and use) in the Nepean Groundwater Source is small compared to the LTAAEL (and groundwater storage is very large) (see Figure 11.1) which should ensure continued access and availability of groundwater to all consumptive users during droughts. During an extreme drought, the water allocations for higher priority licences reduce at a lesser rate than the water allocations of lower priority licences. The priority of access is summarised in Table 11.2, which clearly shows that environmental provisions and basic landholder rights are afforded priority over all other uses and users. The second priority is for town water supplies, or those stock and domestic users that have a 'licence' for stock and domestic (different to basic landholder rights). All other users are the lowest priority for access, and this applies to agriculture, irrigation, industrial, mining etc. Within the general pool of access licences there is no priority order for different consumptive uses of water.

The trading market operates to allow new water users to enter the market and there is no 'market interference' with regard to the price of water or the percentages held by different industries. In some water sources across NSW, agriculture dominates this percentage, and in others, mining and industrial uses dominate.

Table 11.2 **Priority for access in the Water Management Act 2000**

Licence or rights	Licence category	Priority
Environmental	Environmental water	First
Basic landholder rights	Basic landholder rights (stock and domestic uses) Native title rights	
Aquifer Access Licences	Local water utility access licences Major water utility access licences Domestic and stock access licences	Second
	All other forms of aquifer access licences	Third

Prior to the development of the WSP for the Greater Metropolitan Groundwater Sources, embargoes on issuing of additional licences were progressively applied in what is now Zone 1. These were based on desktop studies of the Hawkesbury Sandstone regional aquifer and aligned to Parish boundaries (as opposed to having a sound hydrogeological basis). The concern at the time was unchecked groundwater development, the risk of potential future unsustainable levels of extraction, and the necessity to quarantine unassigned water for the future development of the Kangaloon borefield for emergency drought water supply for the greater Sydney region. The Zone 1 boundary excluded the Berrima Colliery workings, which was the largest user at the time, which is interpreted as the use from the mine was not a concern for management of groundwater in the Zone 1 area (ie it is likely that the mine impacts were considered acceptable and localised, and not of major concern to groundwater availability and sustainability in the area).

11.5.1 Global water source sustainability and impacts to users

In groundwater systems with very large storage to recharge ratios (ie very large saturated systems like the Nepean Groundwater Source), the storage buffers, the short term changes in recharge, discharge and water levels, and the overall sustainability of the resource is not compromised even though water levels will naturally fall during drought periods. Groundwater extraction increases during droughts, but under the current WSP and access licences that have been granted, the expected changes are not significant in the longer term sustainability of the resource.

The water available for extraction from the Nepean Management Zone 1 is capped at the current level of entitlement (as per the rules in the Water Sharing Plan). The licences required for the Hume Coal project have come from existing users in that system, and therefore the Hume Coal mine will not increase the overall potential take from the zone – these licences already exist. The concern of an additional ‘2.6 GL/yr’ being extracted needs to be put into context:

- Less than 50% of the mine water inflows will actually be extracted (predicted maximum is 1,010 ML in Year 17); the greater proportion of water will remain in the groundwater system (in the mine void) behind the bulkheads;
- The mine water inflows are variable and the peak inflows (predicted 2,066 ML) will not occur until Year 17 and will then quickly reduce as the mine closes; and
- Hume Coal will hold the peak licence requirement from all water sources prior to project approval, and this licensed volume is part of the current share of entitlements under the WSP and is not in addition to current entitlements.

The physical take of mine water slowly ramps up over time and in the first 8 years of mining is less than 500 ML per year. From Year 8 it increases to a maximum 1,010 ML in Year 17, and then drops back to less than 100 ML in Year 20. Physical water take ceases as soon as mining ceases. The total and physical take (peak) volumes represent just 2% and 1% respectively of the LTAAEL for the Nepean Groundwater Source.

Globally at the water source scale there will not be additional water extracted from the Sydney Basin Upper Nepean Groundwater Source – Management Zone 1, therefore there is not additional impact on this water source over and above what is currently allowable and licenced to occur. At the local scale, all impacts are mitigated and managed via make good provisions so that no adverse impact to individual users ability to access water occur.

11.5.2 Works approval

The Hume Coal project has purchased access licences, and will consult with DI Water with regard to work and use approval requirements after development consent. The requirement to hold work and use approvals under the WMA is exempt for major projects, however it is understood that miscellaneous work approvals can be issued with conditions and/or relevant conditions can be applied to the consent conditions.

11.5.3 Berrima Colliery

Council raised concerns about the Berrima inflow and it needs to be noted that this mine is in a separate management zone (Nepean Management Zone 2), which has available (unassigned) water that continues to be released by the NSW Government to new licensees via the controlled allocation process.

11.5.4 Licence price

The ability to purchase existing licences in the local water market has been demonstrated in recent years, with Hume Coal purchasing most of the licence requirement already from existing users. The price for the permanent trade of water across NSW is variable and like any market depends on supply and demand. This is the intended design of the market system, to allocate resources efficiently and provide access for new users to access the system based on market demand.

For areas with high demand and low availability, prices are generally above \$1,000 per ML, but in areas where there is minimal demand and where the NSW Government releases water under controlled allocations, water prices are sometimes lower than \$100 per ML. The Sydney Basin Nepean Management Zone 1 Groundwater Source was one area that was previously embargoed and therefore supply has been capped for some time. Accordingly, prices were accordingly relatively high prior to Hume Coal entering the market, and this situation is relatively unchanged.

11.5.5 Medway Dam

Impacts to surface water users are minimal and the revised modelling predicts a maximum annual loss of 19 ML from the water stored in Medway Dam. Hume Coal already holds sufficient licences to account for this surface water take. As shown in Figure 11.5, this peak take does not last for a long period. For comparison, this volume is 5 times smaller than the annual volume of water lost due to evaporation from the Medway Dam surface (approximately 100 ML per year). The reliability of Medway Dam will not be changed as a result of the project and its role as a potential back-up town water supply is not impacted. Medway Dam is currently not used (and has not been used in recent years) for the purpose of town water supply, so there are no impacts predicted to town water supply reliability.

11.6 Licence status

Government

NSW DPI and WaterNSW raised concerns regarding licence status, these are summarised as:

- Acquiring additional licence (contingency) could be considered if modelling predictions are thought to be not accurate and additional water may be required. In addition, consideration should be given to potential future reductions via available water determinations, or other licence restrictions.
- Comments that the EIS chapter 12 discussion of current licence acquisitions/holdings in Table 12.2 is not well defined and could be made clearer.
- Concerns from DI Water that there is insufficient clarity around whether sufficient licence is held, and whether it can be acquired prior to mining commencing. More detail is requested to clearly demonstrate that necessary water licences can be obtained.
- The peak annual take of water from the overlying Medway Rivulet zone is required to be licensed (and demonstrated it can be licensed), and not the average take.
- Consideration needs to be given to the results of any model updates and that licences will then need to be held for the most updated model.

- The licence number, potential location and/or licence bore number that will be used to supply water to the project needs to be considered.
- Concerns are raised that Hume Coal will look to trade licences (or seek approval to trade licences) from Zone 2 into Zone 1, which is not permitted under the Water Sharing Plan.
- Concerns that the required licence volume from within Zone 1 will not be available to be acquired, particularly in dry periods.
- Concerns that the EIS discusses the fact that the controlled allocation from the NSW Government does not apply to Zone 1, which is where the licence volume is mostly needed from.
- Uncertainty in the current status of licence holdings (ie licence ownership).

A clear pathway to acquire the remaining licence volume as required was requested. Concerns raised by interest groups regarding licences are summarised as:

Concerns that licences available for trade are only very small, and that licences are unlikely to be able to be purchased to cover the required volume for the Hume Coal mine. Concerns that the large volume required for licences will drive the licence price up so much that it will be unaffordable and Hume Coal will not be able to then purchase the required licence volume. Concerns that at the time of writing the EIS only 60% of the licence volume for the maximum take in Year 17 had been secured, and that the additional 40% will not be able to be purchased.

Community concerns were with regard to licensing status are that Hume Coal does not have sufficient licence to cover their take and that if the take is greater than predicted there is not sufficient licence available to be purchased on the water market.

11.6.1 Modelling accuracy

DI Water acknowledge in their submission that the volume of water licence is sufficient for project needs and capture of incidental water, and therefore licensing of water does not represent a risk for the project. DI Water agrees that based on the volume required (as per the EIS modelling) Hume Coal's strategy for obtaining sufficient licences is satisfactory and can be managed. Hume Coal is not seeking to trade water licences from Zone 2 (where they are readily available) into Zone 1 (which is effectively 'capped') as this is not permitted.

The potential uncertainty or inaccuracy of the modelling predictions is thoroughly discussed in Chapter 9 (Section 9.3.5). A detailed uncertainty analysis has been completed for the revised EIS model, following consultation with DI Water and the NSW Government independent peer reviewer Hugh Middlemis.

The results of the uncertainty analysis demonstrate that the uncertainty falls within a relatively narrow range for both groundwater inflow (take over time), and predictions of drawdown and recovery. Therefore the model predictions of inflow and drawdown in landholder bores can be relied upon. The original EIS model results and the revised results can be considered accurate and fit for purpose with additional confidence now the uncertainty analysis has been completed, and results demonstrate that there is a large degree of confidence in the model predictions.

The uncertainty analysis with respect to the mine inflow predictions, drawdown in landholder bores and the water table drawdown is taken to be the 67th percentile for consideration of potential inflow (ie not the 50th percentile which is the average scenario). This therefore represents a conservative approach for prediction of inflows. In accordance with the draft explanatory note from the IESC on uncertainty modelling (Middlemis and Peeters 2018), the 67th percentile represents the boundary between '*as likely to occur as not*' and '*unlikely to occur in normal circumstances*'.

The revised numerical model and 67th percentile results for inflows/losses have been accepted by the independent peer reviewer and are being used to determine final water requirements. There is only a small change in the predicted mine inflow volumes, with the modelling suggesting a small reduction in required licence volume (refer to Chapter 5).

Regarding the amount of water access licences required in Nepean Management Zone 2 and Sydney Basin South groundwater source, some licences were obtained via the controlled allocation process during May 2017. An additional volume (3 ML) is still required for Nepean Management Zone 2 to account for the migration of water from those water sources whilst all required licences for Sydney Basin South groundwater source have been acquired.

The revised and updated model indicates that there are minimal volumetric impacts to permanent streams within the overlying Upper Nepean and Warragamba unregulated surface water source and therefore no additional surface water licences are required to account for impacts.

Hume Coal is confident with the peak inflow predictions and these are calculated as a conservative number. Hume Coal does not envisage that their project water requirements will be in excess of their current share of the available water, provided the extra 150 ML is secured in Nepean Management Zone 1, predominantly for Years 17 and 18. Within this time period, model verification and recalibration will occur as necessary. This verification and recalibration will allow the model to be refined to even more accurately predict inflow volumes and the timing of peak flows. Should the licence requirement increase, then either additional entitlement will be purchased prior to these inflows occurring, or the mine plan will be altered to ensure that the volumetric take does not exceed the available licensed volumes.

11.6.2 Ability to acquire licences

The current licence holdings (ie updated Table 12.2 from the EIS) are presented in Table 11.3. Hume Coal have secured most of the required licence volume over the past few years, and can adequately account for all inflows in all years up to and including Year 16. There is a small deficient for Years 17 to 21. All water reporting to the sump and extracted for reuse is licensed in all years with the existing licences held by Hume Coal. Hume Coal believes that the required additional licences can be purchased on the open market in advance of project commencement. The water market is clearly functioning as intended as this new industry has enabled Hume Coal to acquire 93% of the licences required for the project.

At the time of submitting the EIS in 2017, Hume Coal held 60% of the required water licence shares in Sydney Basin Nepean Groundwater Source – Management Zone 1. Since that time the revised groundwater modelling and detailed uncertainty analysis has determined the predicted inflows and additional 508 ML of groundwater licence shares has been acquired. For the 67th percentile uncertainty analysis (ie more conservative than the most likely 50% case), Hume Coal currently hold 93% of the peak inflow predictions for the Sydney Basin Nepean Groundwater Source – Management Zone 1 (requiring an additional 150ML). Current licence volumes and required volumes are outlined in Table 11.3.

The EIS model assessment of surface water losses predicted the average annual licence requirement from Upstream Warragamba and Upper Nepean Unregulated River Water Source - Medway Rivulet Zone was 36.5 ML. The revised modelling, including localised Medway Dam model, and uncertainty analysis suggests a peak take of 19 ML in year 21 of surface water leakage from Medway Dam in the Medway Rivulet Management Zone and no additional baseflow loss from adjacent surface water sources. Hume currently hold 31 ML of entitlement in the Medway Rivulet Management Zone and plan to retain this licence for the medium term as contingency if surface water licences are required in the future.

Table 11.3 **WAL requirements and Hume Coal owned licensed volumes**

Water Source	WAL required (ML)	Volume of Hume Coal owned licence (ML)	Required additional volume (ML)
Sydney Basin Nepean Groundwater Source - Management Zone 1	2,059	1,909	150
Sydney Basin Nepean Groundwater Source - Management Zone 2	8	5	3
Sydney Basin South Groundwater Source	7	25	-
Upper Nepean and Upstream Warragamba Unregulated River Water Source - Medway Rivulet Zone	19	31	-
Total	2,093	1,970	153

Hume Coal currently hold sufficient licence volume in the Sydney Basin Nepean Groundwater Source Management Zone 1 to account for mine inflows in all years of mining, except for two years of operation (Year 17 and Year 18). For Sydney Basin Nepean Groundwater Source Management Zone 2, an additional 3 ML is required to be purchased from existing users or via controlled allocation release.

The acquisition of access licences for Hume Coal is continuing, and new opportunities to purchase the final water volumes are expected in the coming years. Landholder circumstances change over time, properties change hands, and Hume Coal is a willing buyer. Based on the recent sales history, Hume Coal sees no impediment in gaining these additional licences.

11.6.3 Water share prices

As stated in Section 11.5 above, as the Sydney Basin Nepean Management Zone 1 Groundwater Source was one watersource that was previously embargoed and supply was capped for some time, prices were accordingly relatively high prior to Hume Coal entering the market. This situation is relatively unchanged. Given that Hume Coal has secured 93% of licences required for the project already, it is extremely unlikely that Hume Coal's attempts to secure the remaining small volume (150 ML) will drive up the licence share prices substantially enough for them to become financially unaffordable for the project.

In addition, given that Hume Coal already have the majority of required licence shares, and obtained them in recent years when annual rainfall was average or below average (refer to Figure 2.3 of Appendix 2), Hume Coal is confident that the remaining 150 ML of licence shares required for Sydney Basin Nepean Management Zone 1 will be able to be obtained via market trading regardless of whether dry periods persist.

The operational water supply source for the project in its early years may be taken directly from the Hawkesbury Sandstone aquifer rather than from the mining void and sump. The water will be sourced by using existing access licences in the early phases of the project (ie in those years where minimal groundwater will be intercepted by mining). The final bore location/s (for water supply) have not been selected and once this occurs Hume Coal will discuss the location and volumes with DI Water and provide relevant details ahead of drilling.

12 Agriculture, land and soil resources

This chapter responds to submissions on matters relating to agriculture, land use and soil resources.

12.1 Post-mining land and soil capability

12.1.1 Hume Coal Project

Concerns were raised about the decrease in land and soil capability (LSC) over 58 ha of land, and the subsequent loss of an agricultural resource, as a result of the Hume Coal Project. The DPE - Division of Resources and Geoscience (DRG) requested further justification for this reduction in LSC in the project area.

The DRG and DPI – Agriculture submitted that options to increase the post mining LSC in the areas where it will decrease should be considered, including any mitigation measures such as the use of biosolids which would address the harvested topsoil deficit and result in no net loss of agricultural value as a result of the project. This may also include a consideration of offsets to account for the reduction in LSC over the 58 ha.

The decrease in land and soil capability (LSC) class across 58 ha (just 1.1% of the project area) is based on a highly conservative and carefully considered assessment, as described further in this section. Notwithstanding, options to improve the LSC class of rehabilitated areas post-mining will continually be assessed throughout the mine life as new options become available such as appropriate ameliorants, particularly as part of the conceptual closure plan that will be periodically reviewed and updated throughout the life of the mine.

The LSC classes of the Hume Coal Project area were assessed as part of the Soil and Land Resources Assessment prepared for the EIS (EMM 2017a). The assessment was conducted in accordance with the requirements of the *Land and soil capability assessment scheme* (the LSC scheme) (OEH 2012), which involved assessment using data sourced from field soil survey observations, desktop analysis of the existing environment and land use, and soil laboratory analysis.

As reported in Chapter 8 of the Hume Coal Project EIS, the LSC class of the project area is mostly Class 4 (moderate capability land), covering 44% of the project area and associated with the large area of Kandosol soils. Kandosols are soils which lack strong texture contrast, and have massive or only weakly structured B horizons with a clay content that exceeds 15% in some part of the B2 horizon. These soils are most suitable for grazing and occasional cultivation with suitable soil conservation measures implemented. 32% of the project area is Class 6 (low capability land), while Class 5 (moderate to low capability land) was found to occur over 14% of the project area. Small areas of Class 7 (very low capability land) and Class 3 (high capability land) occur in 6% and 3% of the project area, respectively. The remaining 1% of the project area is covered by the Hume Highway or water bodies.

Of the 117 ha to be subject to direct disturbance through the construction of surface infrastructure, post-mining the LSC class of approximately 58 ha of land is predicted to change following rehabilitation of the mine. Therefore, within the 5,051 ha project area, 4,993 ha (or 99%) will not be subject to any change in land and soil capability class as a result of the project. Within the 58 ha to be subject to change, the pre-mining LSC class (a combination of 3, 4 and 5) will change to LSC Class 6. Specifically, 3 ha of Class 3 land, 37 ha of Class 4, and 18 ha of Class 5 land will change to Class 6. The reasons for this change are explained below.

The anticipated post-mining LSC class of areas to be rehabilitated upon closure of the mine was assigned based on an assessment in accordance with the requirements of the LSC scheme (OEH 2012). Rehabilitation activities in the project area will involve the application of stockpiled soil to the final landform to a depth of 300 millimetres (mm) (either topsoil only or topsoil and subsoil placed as a soil profile). It is expected that there will be a slight deficit in suitable soil for use in rehabilitation as the small areas of hydrosols in the disturbance footprint, which are sodic and highly erosive, are unlikely to be useful in rehabilitation works. The 300 mm depth is therefore based on the anticipated suitable soil resources that will be available for rehabilitation, in consideration of these small areas of hydrosols. This soil depth is equivalent or higher than industry standards for mine site rehabilitation. For example, the *Leading Practice Sustainable Development Program for the Mining Industry* (Department of Industry, Tourism and Resources 2006) states that applying 100 mm to 200 mm of topsoil to saline or sodic spoil will usually result in the satisfactory establishment of native species or improved pasture for grazing.

Table 15 of the LSC scheme (included as Table 12.1 below) imposes the LSC Class 6 to the rehabilitated surface infrastructure area due to the proposed depth (300 mm) of the applied soil profile. The LSC scheme says in relation to Class 6 land:

"...This land requires careful management to maintain good ground cover (maintaining grass or cover taller than 8 cm is a guide). Grazing pressures need to be lower than those used on Class 4 and 5 land. Rotational grazing systems with adequate recovery time for plant regrowth are essential. It is important to minimise soil disturbance, retain perennial ground cover and maintain high organic matter levels...."

Table 12.1 LSC class for shallow soils and rockiness hazard (Table 15 of LSC scheme)

Rocky outcrop (% coverage) ¹	Soil depth (cm)	LSC Class ²
Nil	>100	1
<30 (localised) ¹	>100	2
	75-<100	3
	50-<75	4
	25-<50	6
	0-<25	7
30-50 (widespread) ¹	>100	4
	75-<100	5
	25-<75	6
	<25	7
50-70 (widespread) ¹	>100	6
	50-<100	6
	25-<50	7
	<25	7
>70	n/a	8

Notes: 1. Rock outcrop limitation from soil landscape report.

2. Based on rocky outcrop and soil depth.

Therefore, continuation of grazing as per the pre-mining land use will still be a viable option for the rehabilitated land in the surface infrastructure area, even with a lower LSC class compared to pre-mining. Applying soil management activities as recommended in the Hume Coal Project Soil and Land Resources Assessment (EMM 2017j) ('the soil assessment') and appropriate grazing management practices will ensure the rehabilitated project area is capable of supporting the intended post mining land use of grazing.

However, it is also important to note that the assumption the LSC class will reduce across 58 ha to Class 6 is highly conservative, and based on the assumption that the soil depth will be less than the original soil profile in the rehabilitated landform. As discussed in Section 7.3 of the soil assessment, there are three factors that may come into effect regarding the definition of soil depth in the LSC scheme in accordance with the *Australian Soil Classification* and OEH's Soil and Land Information System (SALIS), as follows:

- depth to a hardpan in the mining landscape (ie land which has been compacted by heavy machinery, noting that the impact of trafficking can be overcome by deep ripping);
- depth to rock (ie vegetation cannot grow in rock because of low plant available water capacity and inherent fertility); and
- most importantly the presence of a C horizon (ie the layer of soil above bedrock, which is defined as weathered rock or a mixture of weathered rock and newly developed soil in the *Australian Soil Classification*).

It is anticipated that most of the fill to be used in construction of the surface infrastructure area will be sourced from the excavation of the underground mine access (ie drift portal) and will therefore be a mixture of soil and rock. In the rehabilitated land, areas that are likely to be underlain by rocky fill are equivalent to having a C horizon of weathered rock, so only the returned topsoil is counted as the overall soil depth.

Some surface infrastructure may be underlain by subsoil; however, the depth of soil may also be constrained by chemical inhibition such as high salinity. Salt is highly soluble (in water) and mobile and there is some potential that it may become concentrated overtime creating a chemical inhibition layer. In assigning a post-mining LSC class to rehabilitated areas, it was therefore conservatively assumed that salt will build up under the infrastructure. If it is found after rehabilitation that the subsoil is not constrained by chemical inhibition then the overall soil depth may increase from the conservative assumption of class 6, resulting in a higher capability LSC class.

Notwithstanding, in order to amend the anticipated rehabilitated LSC class to a higher class than class 6, according to Table 15 of the LSC scheme the soil depth would need to be at least 0.5 m in soil profile with a rockiness of <30% (localised). This would result in a LSC class 4 being applied to the soil. To achieve this, at least 116,000 cubic metres (m³) of ameliorant would be required over 58 ha to provide the additional 200 mm of soil depth. While additional materials such as biosolids, mulch or topsoil alternatives may provide additional amelioration where testing shows these materials are physically and chemically suitable, the volume required would be expected to exceed the NSW guidelines for biosolids reuse based on nutrient and contaminant loadings. Sourcing and transporting materials is both cost prohibitive and introduces significant risks to both the rehabilitation and the final LSC class if found to be unsuitable.

As part of the rehabilitation process, stocktakes of the topsoil and subsoil stockpiles will be undertaken prior to rehabilitation planning to ensure that any deficit which would result in less than 0.3 m of topsoil application is addressed. Also at this stage of the planning process, ameliorants and additional rehabilitation options will be further considered to enhance the end result of rehabilitation. However, as discussed above it is not expected that a sufficient volume could be applied to all 58 ha to increase the depth in order to reclassify the land capability while meeting minimum impact requirements.

Importantly however, class 6 land will still be suitable for grazing and improved pasture, allowing the continuation of the agricultural land use post-mining. For this reason, and that the predicted reduction in LSC class is a highly conservative prediction, it is also not considered reasonable or necessary to consider offsets to account for the reduction in LSC class for 58 ha.

12.1.2 Berrima Rail Project

DPI – Agriculture noted that the reduction in LSC class for 31.4 ha of land in the Berrima Rail Project area represents a loss of agricultural land potential productivity. As for the coal mine, alternative measures need to be investigated to address how the soil can be returned to its original or similar capability class for the 31.4 ha of land identified as changing to class 7 or 8, which is unsuitable for agricultural use.

The Class 8 land referred to by DPI-Agriculture is the Berrima Branch Line, where no change is proposed to the LSC class.

As described in Section 14.4.2 of the Berrima Rail Project EIS, most of the land within the project area will be returned to grazing; however, the post disturbance LSC class (once rehabilitation has been completed) will be reduced across 14% of the project area. This will result in an increase in the area of land classified as Class 7 (approximately 24 ha), which is assumed will occur over the footprint of the new railway line, based on a conservative assumption of the projected depth of re-spread topsoil being no deeper than 250 mm.

Similarly to the coal project, the sourcing of additional soil materials or ameliorants such as biosolids, mulch or topsoil alternatives may be undertaken in order to increase the depth of soil replaced during rehabilitation in some locations where testing shows these materials are physically and chemically suitable. However, it is not expected that a sufficient volume could be applied to all 24 ha to increase the depth in order to reclassify the land capability; while meeting minimum impact requirements.

The change in LSC class to Class 7 will occur along the corridor of the rail line. This corridor is a small, narrow area in the context of the broader region, and thus will not impact on the overall agricultural productivity of area.

12.2 Impacts on agricultural businesses due to project related groundwater impacts

Farmers for Climate Change and the Australia Institute's submission on the local economic impacts of the Hume Coal Project, as well as business and community respondents, raised concerns over the detrimental impacts the project could have on agriculture in the area if water supplies were affected due to impacts on groundwater. Concerns were raised over local agricultural businesses becoming unviable if bores were affected by the project.

Hume Coal is committed to the implementation of make good measures for all bores predicted to be significantly impacted by the project, so that there are no negative impacts to landholders relying on the supply of groundwater for agricultural purposes. A 'make good' strategy for these bores was developed as part of the Hume Coal Project EIS, and a further detailed strategy is attached as part of Appendix 2 to this report (Revised Water Assessment, EMM 2018a). A summary of the strategy is also discussed in Chapter 9. Consultation that has been undertaken relating to make good measures is described in the response below (Section 12.3.1).

12.3 Landholder consultation

12.3.1 Make good arrangements (Hume Coal Project)

DPI-Agriculture submitted that landholder consultation in relation to groundwater management needs to be transparent and consistent, and that an open dialogue with landholders to implement the 'make good' arrangements is appropriate and should be implemented.

Hume Coal are committed to open and transparent consultation with all potentially affected bore owners. A 'make good' strategy was prepared as part of the EIS (EMM 2017c), which identified all bores predicted to be affected by groundwater drawdown as a result of operation of the mine.

The make good strategy noted that consultation with potentially affected landholders by Hume Coal commenced in 2017 via individual letters, and that landholders would be contacted again during the bore verification process, which is the next step in determining the required make good measure at individual bores. This verification process involves inspections of each bore to obtain information on groundwater levels and quality, as well as bore construction and pump details. This information is required to determine the pre-project conditions at individual bores, providing a reference point for comparison with subsequent bore assessments.

In May 2017, Hume Coal sent personalised information packages via registered post to all potentially affected landowners. The package included information on the modelled impacts predicted to be experienced by the landowner's groundwater bore, a copy of the groundwater baseline assessment form, the NSW Aquifer Interference Policy (NOW 2012), a plan detailing the Hume Coal's understanding of the bores location, and schematics of the proposed mitigation measure specific to the landowner's bore. Hume Coal will continue to consult with local landowners regarding the impacts of the proposed mining operation, and where access is granted, continue to undertake baseline monitoring of the current bore condition.

Once the bore verification process is complete, legally binding make good agreements will be negotiated with each affected landholder where possible, on a case-by-case basis. The development of make good provisions for individual bores is a complex process that requires sufficient time to firstly understand the potential impacts (as was done in the Hume Coal Project EIS), undertake the next step of bore verification, and negotiate make good agreements. Extensive, individual engagement will be undertaken as individual make good agreements are negotiated and finalised.

12.3.2 Operation of the rail line (Berrima Rail Project)

DPI-Agriculture noted that consultation should take place with private landholders in the vicinity of the rail line affected to ensure:

- i. livestock access across the rail line is acceptable;
- ii. flooding impacts are acceptable and appropriate mitigation measures are identified; and
- iii. where livestock access is provided under the rail line, that the access itself is not subject to flooding.

i Livestock access

The land subject to the new rail line is owned by Hume Coal and Boral. No private landowners are affected. Access for livestock will be considered during the detailed design phase of the project.

ii Flooding impacts

Flooding impacts as a result of the project were assessed by WSP PB (2017) as part of the surface water assessment conducted for the project. As described further below, there will be no flooding related impacts on privately owned land.

The 100 year Average Recurrence Interval (ARI) flood extent was modelled by PB for the existing situation, and with the Berrima Rail Project constructed and in operation. Comparison of the 100 year ARI flood extents shows that changes in land affected by flooding during operation of the rail infrastructure from the existing flooding regime will occur:

- upstream of where the rail line crosses Oldbury Creek south west of Berrima Cement Works;
- just upstream of the Hume Highway on a tributary of Oldbury Creek; and
- in the vicinity of the rail loop.

Figure 12.1 (which is a reproduction of Figure 13.9 from the Berrima Rail Project EIS), illustrates the flood extent with the Berrima Rail Project in operation. As shown, the changes in flood extent all occur on land owned by Hume Coal or Boral, and will not affect any private landholders. Further, the increased flood extent that will occur is upstream of the Hume Highway on Hume Coal owned land and is minor.

The flooded land area for the 100 year ARI event for each phase of the project life is as follows, indicating that the flood extent increases by around 9% during operation but reverts to close to existing conditions following rehabilitation:

- Existing: 127.2 ha
- Operation: 138.3 ha
- Rehabilitation: 127.3 ha

The increase in flood levels up to the probably maximum flood (PMF) to the south west of Berrima Cement Works has no impact on the works or the associated pit.

In relation to flood levels, generally minor afflux impacts will occur. Importantly, most land located along the Berrima Rail alignment is owned by Hume Coal or Boral. Predicted afflux at private properties downstream is within the acceptability criteria (ie less than 250 mm).

iii Livestock access under the rail line and flooding

As described in the response in section i, the land is owned by Hume Coal and Boral. Access for livestock will be considered during the detailed design phase of the project.

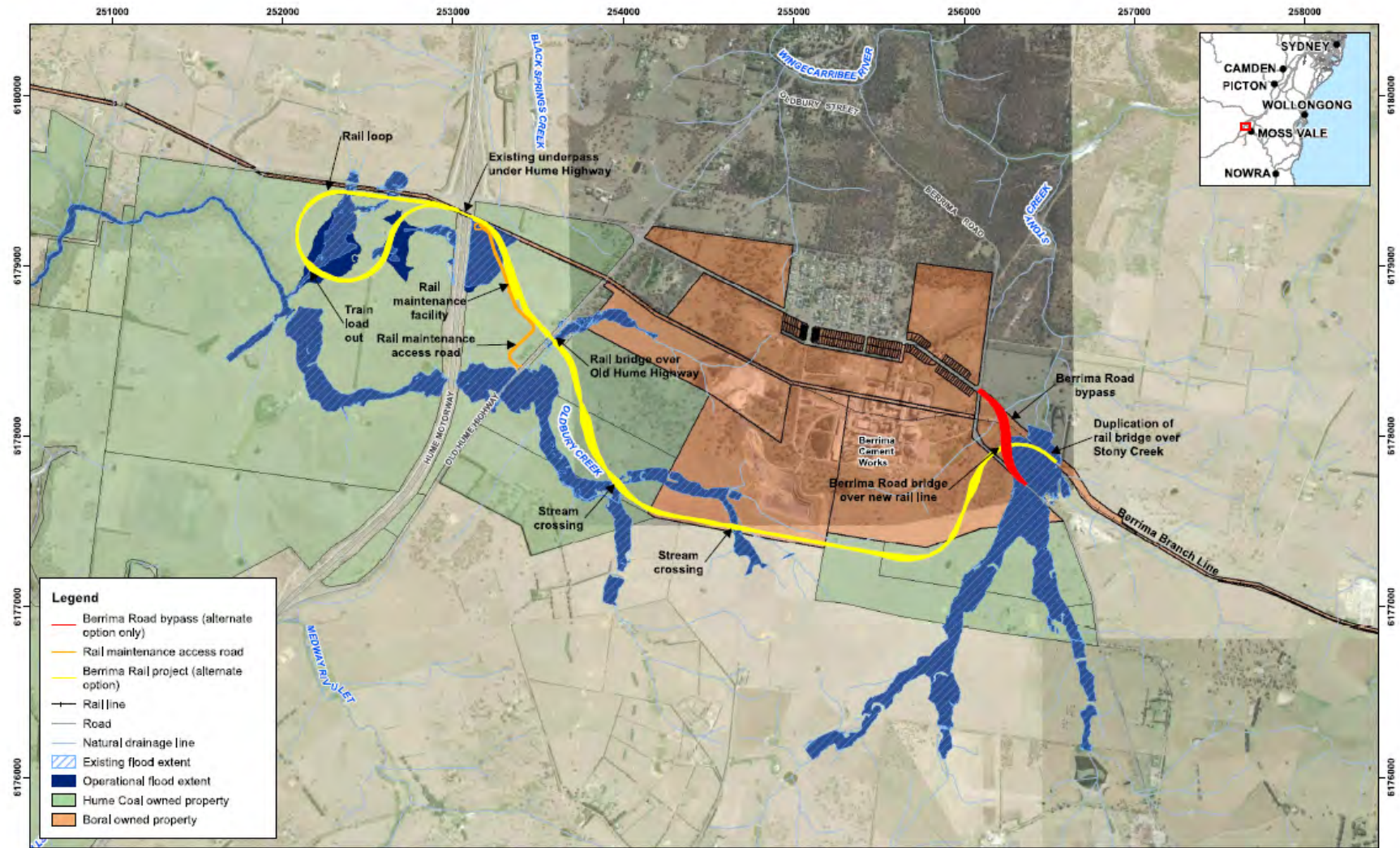


Figure 12.1 100 yr ARI flood extent (alternative option)

12.4 Management of Hume Coal owned land

Grazing strategies: DPI-Agriculture submitted that the EIS for the Hume Coal Project does not propose any grazing strategies, (noting that the Agricultural Impact Statement (AIS) states pasture species will be chosen to suit the chosen grazing strategy), or provide any information to substantiate that improved pastures could sustain the high stocking rates suggested for land owned by Hume Coal.

Land management: Further, the Australia Institute raised concerns about the land management practices of the agricultural land owned by Hume Coal. They claim there was no tender process for managing the land, and that locals working on the farms were sacked in favour of managers from Goulburn.

12.4.1 Grazing strategies

The stocking rates quoted in the AIS (EMM 2017k) were applicable as at July 2016. Section 5.4.3 of the AIS identifies weed management and soil improvements made to the properties which facilitated the higher stocking rates. The influence of these inputs on the soil productive capacity may vary over time resulting in stocking rates being adjusted.

Similar to any other agricultural enterprise, stocking rates will be reviewed on a regular basis depending on the status of the site (eg weather, feed availability, amelioration inputs) and other factors that may influence decisions, such as industry change or economic factors. Stocking rates on Hume Coal owned land will continue to be managed so that no degradation to grazing areas occurs as a result of stocking during the operation of the mine, and the site will be rehabilitated to support grazing on improved pastures following operations.

If approved, Hume Coal will be required to produce a Rehabilitation Management Plan (RMP) as part of the conditions of the development consent. The RMP will detail proposed rehabilitation plans, including a progressive rehabilitation schedule for the entire life cycle of the mine and define key risks and opportunities that need to be addressed to achieve successful rehabilitation. Included in this will be a consideration of the post-mining land-use and the pasture species required to achieve this land use. The pasture species to be seeded on rehabilitated areas once surface infrastructure is removed at closure will be further investigated during the detailed closure planning process. This investigation will involve an analysis of species used on Hume Coal land and other agricultural land in the region to confirm the most appropriate species to use, and will also be informed by grazing strategies that have been adopted on the surrounding land (such as around the surface infrastructure area). The detailed closure plan, which will be prepared within five years of closure, will detail these pasture species and proposed grazing strategies.

12.4.2 Land management

Upon purchase of land in and surrounding the project area, Hume Coal's primary objectives for the farms were to:

- return the farms to productive agriculture business; and
- demonstrate that coal mining and agriculture can beneficially coexist by restoring the production capacity of the farms in an environmentally responsible manner.

At the end of 2014 a study was conducted of the farms now under Hume Coal ownership to determine the overall productivity and profitability of the farms. The study found:

- the farms were running at a loss;
- some current farm workers lacked current best practice farming knowledge;
- Hume Coal's own management skills are in coal mining;

- \$2,500,000 capital injection was required to return the farms to a productive agriculture business;
- a farm manager to oversee the farms would need to be employed; and
- it would take approximately five years to return the farms to a profitable state.

Hume Coal then examined all the private expressions of interest that it had received upon purchase of the farms, selecting Princess Pastoral as the farm manager due to the company's level of experience, innovation, professionalism and adoption of leading agricultural practices.

Following the take-over of land management by Princess Pastoral, the improvement in productivity has been significant. Princess Pastoral's aim is to significantly enhance the agricultural productivity of the properties, and to run the properties together as a successful, sole agricultural commercial entity. Leading pasture improvement and cropping practices have been implemented by Princess Pastoral Company enabling this aim to be achieved. The methods in use are based on the farming experiences from their other properties outside the local area, which have significantly improved productivity and profitability. This includes cropping using the speed-tilling process, which causes minimum impact on soil and improves the productivity and build-up of organic matter in the soil which improves its long-term stability and fertility. Stocking rates achieved are between 14.8 and 19.5 Dry Sheep Equivalents (DSE) per hectare, which is far superior when compared to the average stocking rate of 9 DSE/ha for the Southern Tablelands region, as reported by DPI 2016. Analysis of farm performance 12 months after Princess Pastoral commenced management showed that on average, pastures improved by 534%, sheep production by 2,532% and stock production by 385%. Furthermore, large areas of weeds have been eradicated. There are also now 22 people living on the properties.

12.5 Co-existence of mining and agricultural land uses

Many community submissions and some submissions from local agricultural businesses and special interest groups raised concerns about the co-existence of mining and agricultural land uses, suggesting that the two land uses are in conflict, food will be jeopardised, and that there will be irreversible impacts on agricultural business in the area, particularly due to impacts to water supply.

Other submissions claim that the mine is located within a region of prime agricultural land, where the highest value rural lands and associated rural residential landholdings in regional NSW are located, and that the mine is taking fertile food producing land ('Sydney's food bowl'). It was also suggested that the mine will cause a shift away from agriculture to industrialisation of the area.

12.5.1 Land use conflict

The AIS identified risks to agricultural resources, including businesses, as being low with the proposed mitigation measures in place. The mine design avoids many of the risks on agriculture that are common for an underground coal mine, such as significant subsidence and associated erosion risks. The disturbance footprint has also been minimised to avoid the loss of agricultural land, with just 117 ha (2%) of the project area to be temporarily removed from agricultural land use during the operational phase of the mine.

In relation to concerns regarding water supply, whilst 94 privately owned bores will be impacted by drawdown as a result of the proposed mining operation, make good arrangements have been investigated and identified for each individual bore with the potential to be impacted by 2 m or more. As mentioned in Section 12.2, detailed discussion on these make good measures is provided in Chapter 9, and in the make good strategy presented in the Hume Coal Project Revised Water Assessment Report (refer to Appendix 2). Once agreed to and implemented, these make good measures will effectively mitigate the impact of the mine so that water supplies will continue with no impact to those relying on groundwater supplies.

12.5.2 'Prime' agricultural land

The land on which the mine is located is not biophysical strategic agricultural land (BSAL) as it does not meet the requirements for high value, or prime, rural land. The LSC class across the project area ranges from predominately Class 4 (moderate capability land), with smaller areas of Class 3, Class 6 and Class 7, all of which are not classed as high value. High value, or prime, rural land is generally classed as Class 1 and Class 2.

As reported in the Hume Coal Project AIS (EMM 2017k), the area of land in the Wingecarribee LGA suitable for agriculture is estimated to be approximately 73,000 ha (ABS 2011b). However, farms with an estimated value of agricultural operations (EVAO) greater than \$5,000 per year (the target population for the ABS agricultural census and surveys), cover a combined area of only about 16,900 ha. Within the actively productive land:

- approximately 1,900 ha is cropped, with less than approximately 1,000 ha cultivated; and
- approximately 15,000 ha is managed for grazing.

While the beef cattle industry is the largest agricultural industry in the Wingecarribee LGA, it represents less than 1% of the beef cattle industry in NSW. Horse studs account for almost 2.5% of horse studs in NSW.

The gross value of the agricultural production (GVP) for the Wingecarribee LGA was \$44.8 million in 2010-2011 (ABS 2011c). This represents 0.38% of the gross value of agricultural production in NSW. In terms of the value of GVP in 2011, there were only six substantive enterprises in the Wingecarribee LGA; cattle, milk, nurseries and cut flowers, vegetables and hay.

The majority of businesses are small in the LGA, with an annual turnover of less than \$50,000, in the major agricultural production regions. Further, the great majority of agricultural businesses are non-employing, using only owner operator and family labour, throughout the Wingecarribee LGA. In the Fitzroy Falls and Southern Highlands regions roughly 10% of businesses have a turnover in excess of \$500,000; in the remaining regions they are generally less than 5% of farms. Very few farms employ more than four individuals on a full time equivalent basis.

Notwithstanding the above, the project has been designed to avoid impacts on agricultural land as much as practicable, primarily through the mine design and mining method to be used so as to avoid subsidence impacts, and the emplacement of rejects underground so as to eliminate the need for a permanent surface waste emplacement. Disturbance of agricultural land will be limited to areas required for construction and operation of surface infrastructure. This represents approximately 2% of the total project area. This land will be rehabilitated after the cessation of mining to restore the pre-mining agricultural land-use of grazing on improved pastures. The remainder of the project area during operations will remain available for the continuation of current agricultural land uses.

12.6 Impacts on farm improvements

DPI-Agriculture stated that the Hume Coal Project EIS does not address potential impacts on farm improvements located across the project area, such as outbuildings, dams, access tracks, fences and yards.

The disturbance area identified in the Hume Coal Project EIS is the only area where existing agricultural infrastructure or farm improvements such as dams will be impacted (as a result of the construction of surface infrastructure). Internal access roads will be realigned and existing utilities relocated where required, including the realignment of some internal farm roads. Some existing farm tracks will be upgraded. No existing dams will be used for the project. It is unlikely that remedial work will be required on any buildings or built features. In addition, all of this land is owned by Hume Coal, who will work with the leaseholder to adapt their farming enterprise to suit the mine infrastructure area.

The subsidence assessment that the impact of subsidence will be negligible due to the type of underground mine methodology proposed, and there will be no impacts to the existing farm infrastructure noted above. The disturbance area has been clearly identified and all remaining farm improvement infrastructure within the project footprint will not be disturbed as a result of the mine development. The predicted negligible subsidence associated with the project has been confirmed through the three-dimensional numerical modelling undertaken of the mine design, as discussed in Chapter 16.

12.7 Impacts on agricultural support services, processing and value adding industries and regional employment

DPI-Agriculture requested additional information on the following:

- i. Processing and value adding industries - the EIS does not assess whether there would be any adverse impacts on processing and value adding industries such as the Berrima Feed Mill (other than the Southern Regional Livestock Exchange).
- ii. Local and regional employment - clarify what percentage of local recruitment would be drawn from agricultural-related businesses, does not specifically address whether the temporary construction village or increased housing demand would affect accommodation available for agricultural-related labour. Table 5.4 (risk register) of the Hume Coal Project AIS also identifies there could be potential negative impacts on agricultural labour (such as loss of jobs, lower income). The proponent states that these impacts would be managed and mitigated through a Stakeholder Engagement Plan. Information provided by the proponent is not sufficient for an assessment to be made.

12.7.1 Processing and value adding industries

The project will not result in any negative impacts on the Berrima Feed Mill. The train movements associated with the feed mill were taken into account in the design of the Berrima Rail Project. These train movements will continue unimpacted by the additional train movements associated with the Hume Coal and Berrima Rail Projects.

In their submission DPI-Agriculture note that the predicted reduction in throughput for the Southern Regional Livestock Exchange as a result of the project ranges from 0.5-1.1%. The estimated changes are expected to be below the 5% level recommended by NSW DPI as a significant threshold (NSW DPI AIS technical notes, April 2013, Section 4.3, p.19).

The predicted reduction of the livestock production for the Wingecarribee region is 1.9% during construction, and only 0.8% during operations, and therefore will have a negligible impact on the regional agricultural support services and processing industries. Further, this means that critical mass thresholds are not required to be estimated (Section 4.3 of AIS technical notes, DPI 2013). As described in the AIS (EMM 2017k), there will be an increase in throughput from the improved productivity of the rest of the Hume Coal affiliated properties.

12.7.2 Employment

The agriculture sector is a relatively small employer in the region. The agricultural industry directly employs 3.3% of total employed people within the Wingecarribee LGA (ABS 2011c). Further, the existing skills base in heavy manufacturing, rather than agriculture, is expected to fill many of the jobs created by the project. Therefore it is unlikely that a large percentage of the workforce will be drawn from the agricultural sector.

Further, the Economic Impact Assessment (prepared for the project (BAEconomics 2017) considered the potential impact on agricultural related employment as a result of the small reduction in agricultural land use through the construction of the mine's surface infrastructure area. The assessment concluded that just 0.2 full time equivalent (FTE) positions would be lost in the sector.

Neither the temporary construction accommodation village, nor increased housing demand will affect accommodation available for agricultural-related labour. Hume Coal will develop and provide accommodation during the construction phase. The Construction Accommodation Village will have capacity for 400 workers, which is enough to house the vast majority of estimated non-local construction workers required for the Hume Coal Project as well as the associated Berrima Rail Project. This will mean the construction workforce's demand for accommodation will not induce inflationary and availability pressures. As construction progresses the capacity of the Construction Accommodation Village will be wound-down as the size of the non-local workforce decreases.

The availability of housing and potential demand as result of the operation of the Hume Coal Project and Berrima Rail Project was investigated in the Social Impact Assessment. Assuming (conservatively) that 50% of workers re-locate to the area, there would be a maximum demand for up to 150 dwellings in the Wingecarribee LGA, assuming all migrating workers require their own home. If current building approval rates continue, the construction industry in the Wingecarribee LGA could accommodate this demand for housing without impacting availability for other industries such as agriculture. In the remaining LGAs, the demand for dwellings due to the project is far lower. A comparison of the expected dwelling demand in each of these LGAs with residential building approvals shows each of them could accommodate any future dwelling demand.

As part of preparation of the AIS, a risk assessment was conducted to identify potential risks on agriculture that may result, if unmitigated, as a result of the project. It followed the process outlined in the *Guideline for Agricultural Impact Statements at the Exploration Stage* (NSW Government 2015a).

The project will temporarily remove 117 ha of land from agricultural production due to the construction of mine related surface infrastructure. The potential impact of this temporary removal of land from agricultural production was acknowledged in the risk assessment, and was given a risk rating of 5D, which is the lowest possible risk ranking. The '5' ranking relates to the possible consequences if the impact was to occur, which is rated from 1-5. In accordance with the guidelines, 5 is defined as a very minor impact which can be effectively managed as part of normal operations. 'D' relates to the likelihood that the impact is going to occur to the agricultural industry. D is 'unlikely'.

Given the very low risk, which can be effectively managed as part of normal operations, no additional mitigation measures are required. Notwithstanding, Hume Coal have committed to the preparation of a Stakeholder Engagement Plan for the project that will outline stakeholders to be consulted with and how they will be engaged, and will include local landholders in and surrounding the project area. This ongoing engagement with local landholders will enable any concerns these landholders have about the operation of the mine to be identified and addressed.

Hume Coal will also develop and operate in accordance with an Environmental Management System (EMS). This EMS will include a number of management plans which have been committed to throughout the EIS, which includes the Stakeholder Engagement Plan. These plans will be prepared in consultation with the relevant government agencies (including DPI Agriculture) after development consent is granted.

13 Biodiversity

This chapter responds to submissions relating to biodiversity matters, including terrestrial biodiversity and groundwater dependant ecosystems (GDEs).

In their submission OEH noted they have no major issues with the Hume Coal and Berrima Rail Project's direct impacts upon biodiversity and that overall, the project design avoids the majority of potential impacts upon biodiversity in what is now a largely cleared rural landscape. Where unavoidable biodiversity loss will arise, residual impacts have been mitigated and offset requirements outlined. OEH also acknowledged the layout of the project has led to minimal direct impacts upon native vegetation, and has restricted the impacts to degraded patches of vegetation.

13.1 Adequacy of terrestrial biodiversity assessment

13.1.1 Plant Community Types

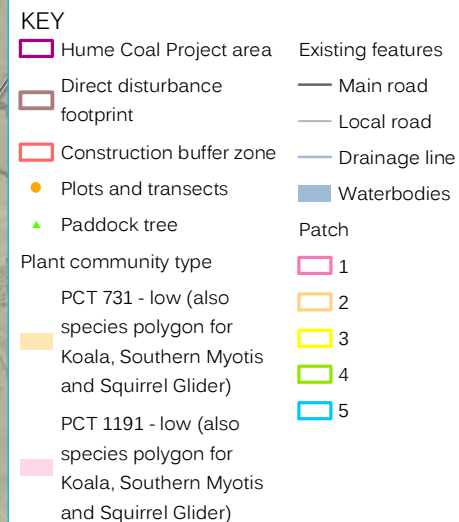
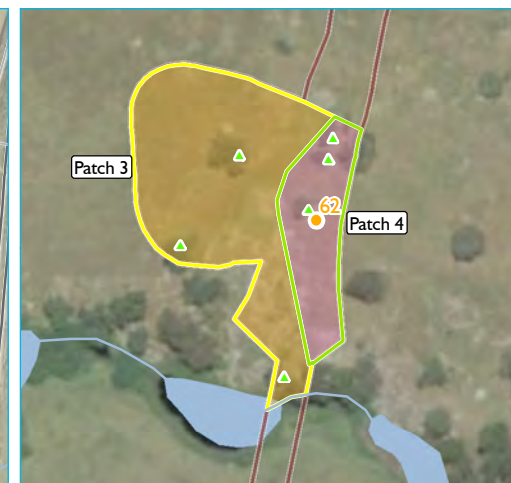
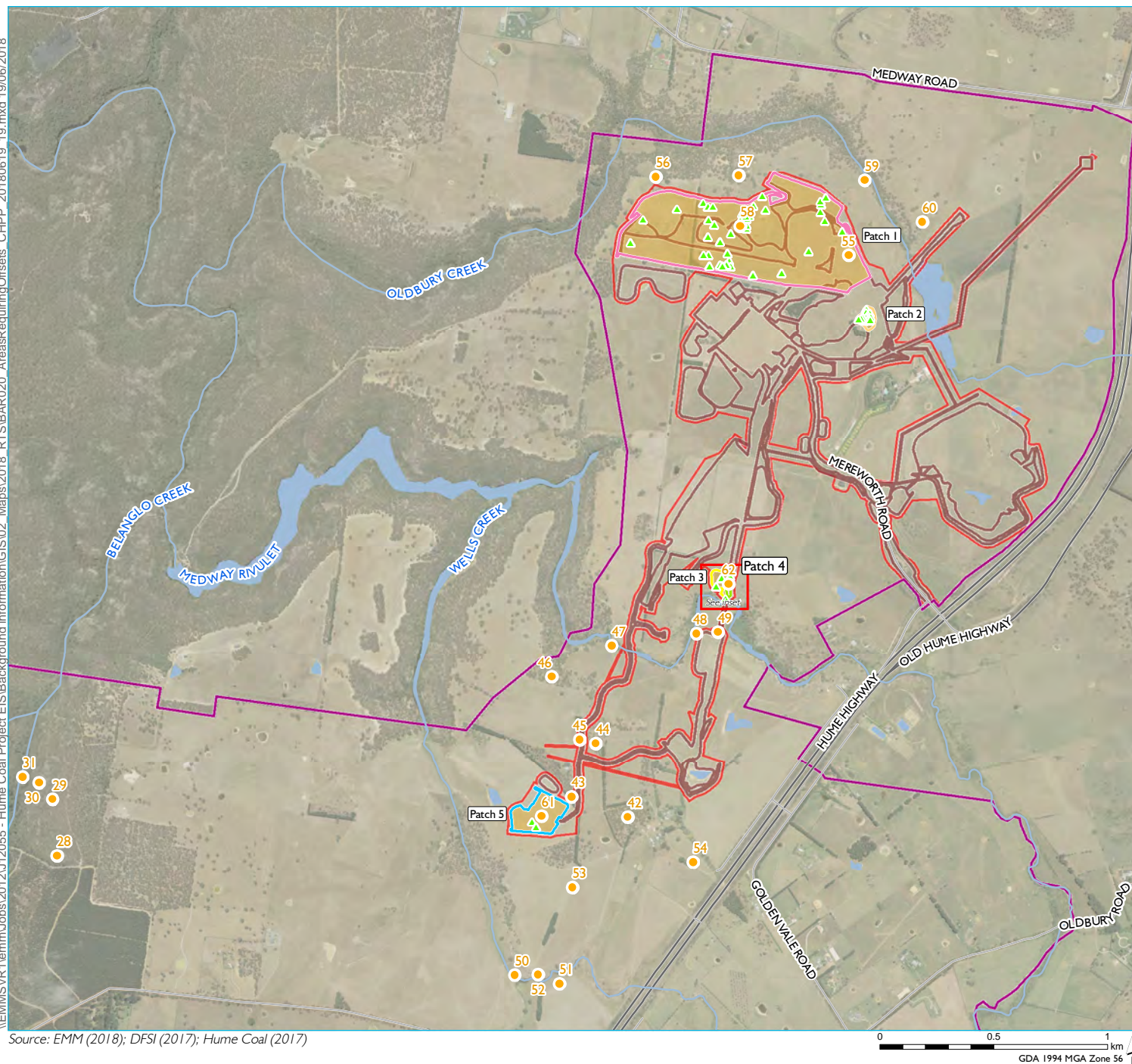
In their submission OEH state they did not identify any major issues with the Project's direct impact upon biodiversity; however they did state that some aspects of the biodiversity assessment in accordance with the NSW Framework for Biodiversity Assessment (FBA) require amendment. Whilst acknowledging the difficulty in assigning Plant Community Types (PCTs) due to the highly cleared nature of the vegetation, OEH stated that in their opinion, the vegetation mapping for the Hume Coal Project area does not reflect the best fit PCT for some patches. OEH suggests modifying patches 1 and 2 to PCT 731, and patch 3 to PCT 1191. Patch 1, 2 and 3 are identified on Figure 5.2 of the Biodiversity Assessment Report (BAR) (Appendix H of the Hume Coal Project EIS, EMM 2017e, p113).

OEH also submitted that the areas of PCT 1191 in the Hume Coal Project area are representative of the 'Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland' Endangered Ecological Community (EEC) under the TSC Act. Although in a degraded state, this vegetation is still representative of the EEC and the OEH suggest that the BAR and FBA assessment be amended to rectify this.

Other required rectifications relevant to the biodiversity assessment, as requested by OEH, are covered in Section 13.2.1(i) (clearing associated with the ventilation shaft in Belanglo State Forest), and Section 13.4.2 (offsets) of this chapter. This section also responds to queries from OEH relating to inputs to the FBA calculator.

OEH inspected the surface disturbance areas with EMM ecologists during the exhibition period and have commented that the Hume Coal Project design avoids the majority of potential biodiversity impacts, and residual impacts have been mitigated and offset requirements outlined. OEH acknowledged the difficulty in assigning PCTs in a highly modified landscape. EMM has reached agreement with OEH over the re-classification of patches 1, 2 and 4 to PCT 731.

EMM conducted an additional site visit on 16 November 2017 to re-assess PCTs in patch 3. The patch was found to contain a mixture of two plant community types, namely PCT 731 and PCT 1191, and was therefore split into two patches; patch 3 and patch 4 as shown on Figure 13.1. An additional plot was conducted in the area containing PCT 1191 (patch 4) to characterise the vegetation and allow the revision of BioBanking calculations. The area of PCT 1191 contained one live Snow Gum (*Eucalyptus pauciflora*) tree, one fallen tree and an exotic-dominated understorey. The area of PCT 731 contained three Narrow-leaved Peppermint (*E. radiata*) trees and an exotic-dominated understorey. The additional plot data collected for PCT 1191 is provided in Appendix 4.



Plant community types - areas requiring offset in the surface infrastructure area

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 13.1



EMM has also reached agreement with OEH over the classification of PCT 1191 in patch 3 as Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland' EEC, now listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) following the repeal of the *Threatened Species Conservation Act 1995* (TSC Act). Although PCT 1191 exists as Snow Gum trees with an exotic dominated understorey, the NSW Scientific Committee final determination (NSWSC 2011) does not specifically set a condition threshold for patches that do not fully represent the listed community. The final determination recognises that the community is threatened by the intensification of agriculture which has resulted in a simplification of vegetation structure, dieback, an increase in exotic grasses (particularly Chilean Needlegrass and Serrated Tussock (*Nassella neesiana*), which were recorded in the additional plot, Appendix 4) and the loss of native grasses and forbs. All of these threats are occurring within the PCT 1191 within patch 3 and within the patch affected by the Berrima Rail Project, greatly reducing the community's ecological integrity and function.

A community respondent also questioned the mapping and classification of native vegetation (PCT) and Threatened Ecological Communities (TECs) in the project area. The respondent's comments relate to the adequacy of the EIS assessment, with the following items noted:

- i. PCT 838 is listed in the EIS, but the correct reference seems to be to 858.
- ii. Vegetation mapping in the Belanglo State Forest was questioned, submitting that whilst it has been broadly adequately, other areas are treated simplistically or incorrect. For instance, two pine plantation compartments are mapped as native forest. Fire Dam Creek's gully only retains native vegetation in the eastern section, most of which is better mapped as 1152 on the high ground, with 1086b or 1107 in the more sheltered portion of the gully.
- iii. It was submitted that the PCT 1093 termed 'Gully Gum Scribbly Gum Woodland' mapped in the EIS would generally be better classified as 1152. It was submitted that *E. racemosa* is a misidentification of *E. Sclerophylla*. Another form of PCT 1093 is described in the EIS as 'Brittle Gum/ Scribbly Gum shrubby woodland'. This PCT has alone not been described in the LGA, suggesting it is better described as PCT 1152.
- iv. The mapping of PCT 1107 in Knapsack Gully was questioned, again claiming it is better classified as either highly modified bushland full of pines or PCT 1152.
- v. The EIS maps a form of PCT 731 and terms it 'Gully Gum Narrow-leaved Peppermint Tall Open forest' with dominants of *E. radiata* and *E. smithii* over an exotic pasture and pasture weed understorey. It was submitted that *E. smithii* (Gully Gum) has been confused with *E. elata* (River Peppermint). Whilst acknowledging this area may be difficult to classify properly given the apparent severity of modification for agriculture, it is claimed that most of the area identified as PCT 731 should be mapped as PCT 1097 (Tablelands Basalt Forest TEEC) with some areas of 944 (Southern Highlands Shale Woodland TEC) and/or 731. The EIS maps and describes 'Snow Gum Black Sallee grassy woodland and Paddys River Box population' as PCT 677. The respondent suggests that PCT 1191 and PCT 1100 are better allocations in the study area.
- vi. The respondent claims that the EIS confused the Endangered *E. macarthurii* with the Vulnerable *E. aggregata* in some instances.
- vii. The method for conducting the database search for Rare or Threatened Australian Plants (ROTAPs) was questioned, submitting it is inadequate as it did not detect a substantial number of ROTAPs known from the study area or a 10 km buffer beyond it.
- viii. The study area and environs includes the highly degraded Medway Rivulet catchment, which is in need of large-scale revegetation. The respondent notes that this would benefit several threatened species and ecological communities.

- i. The reference to PCT 838 in the EIS is a typographical error and should be 858.
- ii. From aerial photography, it would appear as if the two polygons mapped as PCT 858 and Gully Gum/Narrow-leaved Peppermint Forest contain pine forest only. However, two plots were completed in these locations and were found to contain native vegetation communities invaded by Radiata Pine. Plots and rapid assessments were also undertaken along Fire Dam Creek which contains thin lenses of native vegetation associated with the creek and gully.
- iii. It is stated in the EIS that PCT 1093 is a poor fit for the Gully Gum Scribbly Gum Woodland community given its differences. However, there is not an adequate PCT description to fit this community and therefore the PCT of closest fit was assigned. The Scribbly Gum (*E. racemosa*) was originally identified during early surveys, however was later revised to its correct identification of the Scribbly Gum (*E. sclerophylla*). This is a typographical error, and therefore any references to *E. racemosa* should be taken to be *E. sclerophylla*.

Areas mapped as PCT 1093 have been revised to PCT 731 following consultation with OEH botanists. It was agreed that PCT 1093 is more representative of a tablelands community. Areas of PCT 677 have also been revised to PCT 1191 as a result of consultation with OEH.

- iv. Knapsack Gully was walked on foot and a floristic plot was completed that confirmed the presence of native vegetation in this area, which exists as a narrow corridor surrounded by pine forest. Pines had also invaded this vegetation community, however species representative of PCT 1107 were present, comprising River Peppermint (*E. elata*), Ribbon Gum (*E. viminalis*). This area was also found to be invaded by Radiata Pine (*Pinus radiata*), as with other native vegetation Belanglo State Forest. This is likely attributable to the large number of Yellow-tailed Black Cockatoos (*Calyptorhynchus funereus*) in Belanglo State Forest observed flying with pine cones in their mouths and presumably dispersing them to areas of native vegetation where the pine cones were found on the ground, in areas that did not contain pine trees.
- v. The form of PCT 731 referred to as Gully Gum Narrow-leaved Peppermint Tall Open Forest was found to be predominantly an exotic pasture with isolated paddock trees of Narrow-leaved Peppermint (*E. radiata*) and Gully Gum (*E. smithii*). While River Peppermint (*E. elata*) was found along creeks and gullies in Belanglo State Forest, it was not found to occur in Gully Gum Narrow-leaved Peppermint Woodland. The Gully Gums were tall at approximately 30-40 m height and had fruit typical of Gully Gum, with a globose shape, raised disc and exerted valves. These could not be confused with the fruit of River Peppermint which has smaller fruit with a depressed disc and enclosed valves. Given the high level of modification, the closest plant community type was chosen for this area, which comprised PCT 731.
- vi. Several individuals of Black Gum (*E. aggregata*) were assumed to occur off Oldbury Road in Sutton Forest. This location was visited and the records of this species previously recorded were within private property and could not be seen from the roadside. Therefore, the records could not be verified. It was also assumed that an individual species occurs north of the project area, in a private property north of Medway Road and two individual species were also assumed to occur north of the project area along Wingecarribee River. Targeted surveys were completed within the project area in areas that could be accessed for the species. None were recorded; however individuals of Paddy's River Box (*E. macarthurii*) were recorded. All of these trees have been avoided by a careful design process. The EIS makes a commitment to monitoring these trees to determine if any changes to hydrology are adversely affecting their health, with appropriate mitigation to be determined and implemented should adverse impacts be detected.

- vii. The initial ROTAP search was conducted by searching for all ROTAP species within the Wingecarribee LGA on Plantnet. The search showed that 35 ROTAP species had been previously recorded in the LGA. The primary purpose of flora surveys was to detect threatened flora species listed under the TSC Act, (now repealed, and replaced with the BC Act) in the surface infrastructure disturbance area so that impacts on these could be avoided and/or minimised through the design, and any residual impacts offset. There is no formal protection or offsetting for ROTAPs other than those that are listed under the TSC Act, BC Act or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Accordingly, the focus of the surveys was not to complete detailed surveys across the entire project area for all threatened species and ROTAPs.
- viii. It is acknowledged that large-scale revegetation could benefit threatened species and ecological communities in the degraded Medway Rivulet catchment. *The Framework for Biodiversity Assessment: NSW Offsets Policy for Major Projects* (OEH 2014) focuses on the avoidance, minimisation and offsetting to manage biodiversity impacts from major projects. The project has avoided and/or minimised impacts on threatened species and communities through an iterative design process with offsets provided for any residual impacts that could not be avoided and/or minimised through the design. The proposed offset would protect vegetation along Oldbury Creek to compensate for the residual impacts of the project, comprising the clearing of paddock trees. Accordingly, large-scale revegetation does not fit within this framework.

13.1.2 Hume Coal Project

i Species identification

A community respondent noted that the Hume Coal Project EIS did not identify many species of significance. The respondent's search of the Atlas of Living Australia revealed 4,423 records of 793 flora and fauna species, including white-bellied sea-eagle, gang-gang cockatoos, glossy black cockatoos, masked owl, spotted quail-thrush bird, scarlet robin, koala, yellow-bellied glider, squirrel glider and greater glider, dwarf phyllota, Bynoe's Wattle, Black Gum, Paddy's River Box, Cabbage Kunzea, Mittagong Geebung and Silky Pomaderris.

Biodiversity surveys undertaken in the Hume Coal Project area recorded one threatened flora, nine threatened bird and nine threatened mammal species, with a further eight bird, three mammal and two reptile species not recorded, but predicted to occur.

Records from the Atlas of Living Australia cannot be specifically filtered for threatened species and will provide all species (including common species) recorded within a given search area. The Atlas of Living Australia also displays historical records. These combined factors result in a large number of records generated by the Atlas of Living Australia.

The biodiversity assessment for the project was undertaken in accordance with the *Framework for Biodiversity Assessment: NSW Offsets Policy for Major Projects* (OEH 2014) (the FBA), as required by the SEARs, to inform an accurate assessment of the project's residual surface impacts on terrestrial biodiversity. As described in Chapter 2 of the Hume Coal Project BAR (EMM 2017e), a combination of desktop and field-based techniques were used to identify biodiversity values associated with the terrestrial study area, and in particular any threatened species, populations or ecological communities listed under the EPBC Act and/or TSC Act (now the BC Act), or their habitats present or likely to occur. Detailed field surveys were completed in all accessible parts of the project area to identify threatened biodiversity and inform the mine planning process. Targeted surveys were completed when the surface infrastructure area was more clearly defined, in accordance with the FBA.

13.1.3 Berrima Rail Project

A community respondent questioned the adequacy of the ecological assessment for the Berrima Rail Project, submitting that some of the threatened species may not been detected. Specific concerns and questions raised were:

- The EIS finding that no Black Gum exists in the project area was questioned, citing Photograph 6.1 of the EIS (looking south from Medway Road towards the maintenance siding location in the background, east of the Hume Highway) which it was submitted shows several trees in the mid-ground that are suspected to be Black Gum. Another community respondent added that the likelihood of the Black Gum growing in the project area is extremely high.
- The predicted impact to one Paddys River Box tree was questioned, submitting that records of Paddys River Box are publicly accessible on BioNet where 100 Paddys River Box records are noted. The submission claims the preferred and alternative options will directly adversely affect around 50 of the recorded Paddy River Box trees.
- Concerns were raised about the possible presence of hollow bearing trees in the project area, questioning whether the 2 ha identified in the EIS of potential habitat for the Squirrel Glider, a species credit species, includes the hollow bearing trees identified.
- In addition, the respondent states that cumulative impacts of the project with the impacts of the WSC Berrima Road Deviation Project should be considered.

Detailed ecological surveys were completed by experienced and suitably qualified ecologists in accordance with the FBA (OEH 2014), and therefore the Berrima Rail Project EIS has adequately assessed biodiversity impacts, mitigation and offsets for the project.

Given the proximity to records north of the project area, trees in the rail loop of the Berrima Rail Project were inspected to determine if they were Black Gum. The trees were identified to be Paddy's River Box, as has been recorded in different parts of the project area. Direct impacts on these trees have been avoided by the design. The EIS makes a commitment to monitoring these trees to determine if any changes to hydrology are adversely affecting their health, with appropriate mitigation to be determined and implemented should adverse impacts be detected. In addition, OEH did not raise any issues with regard to the assessment of Black Gum in their submission.

Targeted surveys for Paddy's River Box were completed by identifying each individual tree in the preferred and alternate alignments of the Berrima Rail Project. While one tree in the preferred option and several trees in the wider project area (which will be protected) were identified as being Paddy's River Box, the majority of trees in this were identified as being Broad-leaved Peppermint (*Eucalyptus dives*) and Narrow-leaved Peppermint (*E. radiata*). Therefore, the claim that around 50 Paddy's River Box will be affected by the project is inconsistent with the study's findings. In addition, OEH did not raise any issues with regard to the assessment of Paddy's River Box in their submission.

The potential presence of the Squirrel Glider in the 2 ha of potential habitat to be cleared was based upon the presence of hollow-bearing trees for denning, and non-hollow-bearing trees for foraging. Accordingly, species credits calculated for the Squirrel Glider have accounted for the loss of hollow-bearing trees.

Cumulative biodiversity impacts with the Berrima Road Deviation were not considered in the Berrima Rail Project EIS (EMM 2017b) as the Biodiversity Assessment was finalised and lodged for adequacy review with the DPE in November 2016, while the preliminary environmental investigation (PEI) for the Berrima Road Deviation was released in February 2017. The Berrima Road Deviation PEI reports that 23 Paddy's River Box trees will be removed for the deviation. As one Paddy's River Box tree will be removed for Berrima Rail Project (preferred alignment only), the cumulative impact will be the removal of 24 trees. The Berrima Road Deviation PEI reported that it was unlikely that the Squirrel Glider was present, and therefore there will be no cumulative impact on the species when combined with the Berrima Rail Project.

13.2 Terrestrial biodiversity impacts

13.2.1 Hume Coal project

i Ventilation shaft in Belanglo State Forest

The OEH asked whether the BAR considered clearing associated with the ventilation down shaft in the Belanglo State Forest. If not, the biodiversity impacts will need to be addressed.

Section 7.1.1(i) of the Hume Coal Project BAR (EMM 2017e) assesses the biodiversity impact of the downcast shaft in Belanglo State Forest. The downcast shaft will be located in an area that contains pine forest, and therefore native vegetation and threatened species habitats will not be impacted.

ii Direct impacts to threatened species, including potential habitat

A number of community respondents and special interest groups submitted that the Southern Highlands has a unique ecosystem that many native plants and animals depend on, some of which are endangered. Respondents claimed that the project will negatively impact on the varied and multiple wildlife of the district, causing significant disruption to habitats and biodiversity in the local area through the building of infrastructure, wind drift pollution and the disruption of the water cycle. Specific issues raised included:

Location of the surface infrastructure area: The Southern Highland Greens (SHG) submitted that the site of the surface infrastructure is in a particularly sensitive location, being in close proximity to the Wingecarribee River, the Belanglo State Forest, Koala habitat and nearby properties acting as private nature reserves.

1. Hollow bearing trees: Potential impacts to hollow bearing trees were raised, questioning why these trees are being removed, with animals only being given only 24 hours for relocation by one personnel.
2. Impacts to threatened species, including koala habitat: Some community respondents see the removal of 64 paddock trees across the project area as a threat to native habitats including threatened species. A report prepared by Perica and Associates Urban Planning Pty Ltd noted that the proposal results in the removal of 8.3 ha of Broad-leafed Peppermint trees and Red Stringybark open forest trees, which includes potential habitat for koala, southern myotis and squirrel gliders. Another community respondent objected to the removal of native habitat in the project area, raising concerns it is koala habitat.

Community respondents raised concerns about local bird species including black swan breeding grounds, gang gang cockatoo feeding grounds, stopover areas for water hens, pelicans and blue cranes and the wet areas and dams. Other specific concerns raised were about the EPBC Act threatened fauna species including the koala and large-eared pied bat, as well as local platypus population, kangaroos and wallabies, giant dragonfly and several species of rare frogs.

Potential impacts to koalas were raised in many submissions. The SHG made mention of the WSC's Koala Study, and adds that the clearing of significant trees increases the risk of Koalas moving through the bushland corridors in the vicinity of the proposed mine infrastructure site.

1. Water management system and potential impacts: Concerns were raised about the local platypus populations that can be directly threatened by the project runoff pollution, including runoff from onsite recycled toilet water, runoff from dam spills, and water to wash the coal.
2. Hanging swamps: Another community respondent queried the impact to hanging swamps in the area, which were labelled as insignificant in the EIS.

It is acknowledged that the wider Hume Coal Project area and the Southern Highlands contain unique and threatened biodiversity values as mentioned in some submissions. Given the wider area's biodiversity values, care was taken during project planning to identify areas of threatened and unique biodiversity so that impacts to these could be avoided and/or minimised. Given the avoidance and minimisation measures incorporated into the project design, no significant biodiversity impacts were predicted. Impacts on habitats outside the direct impact area have been assessed in Section 7.1.2(iv) of the Hume Coal Project BAR (EMM 2017e). The specific issues raised in the submissions are responded to in the sub-sections below.

Location of the surface infrastructure area

The majority of the project area, including proposed surface infrastructure areas, comprises cleared land dominated by exotic grasses and herbs. Remnant native vegetation is mainly restricted to the north-west of the project area, though some occurs in the central northern area, associated with creeks, and there are isolated paddock trees in places. There are also scattered patches of poorer condition native vegetation in agricultural areas in the centre of the project area, generally comprising isolated stands of native trees with an exotic groundcover. Remnant native vegetation covers approximately 1,800 ha (or 20%) of the project area.

Hume Coal looked for options within and adjacent to the project area for the location of the surface infrastructure area, and identified several sites that met all or most of the above criteria. Numerous locations and variations to these were considered, which can all be summarised in four general areas shown indicatively in Figure 7.1 of the Hume Coal Project EIS (EMM 2017a). The chosen location and layout has the advantage of meeting each of the afore-mentioned criteria and is also viable in terms of functionality, cost and efficiency. A full description of the alternatives considered is provided in Chapter 7 of the Hume Coal Project EIS.

Hollow bearing trees

The project avoids the majority of potential biodiversity impacts to areas of intact native vegetation including Belanglo State Forest, and residual impacts in areas of disturbed native vegetation have been mitigated and offset requirements outlined. While some hollow-bearing trees are being removed for the project, the loss of hollows in areas of intact native vegetation has also been avoided by an iterative design process that enabled avoidance and minimisation of biodiversity impacts. A procedure will be detailed in the Biodiversity Management Plan for the clearing of hollow-bearing trees that may contain fauna species. The 24 hour period is allowed for fauna to self-relocate prior to clearing, which is far less stressful on an animal than direct handling. Any longer than a 24 hour period could result in the fauna re-occupying the tree and being present during clearing operations.

Impacts to specific threatened species, including potential Koala habitat

As part of the evaluation process of alternative surface infrastructure location options, ecologists surveyed proposed infrastructure areas. Areas of potential sensitivity were identified, such as areas containing threatened species and communities, riparian vegetation and waterways as well as areas of 'low constraint', which represented opportunities for positioning surface infrastructure with minimal impact. In particular, a narrow corridor of vegetation along Oldbury Creek was found to provide habitat for threatened microbats and Koalas. The original CPP design extended much closer to Oldbury Creek than what is now proposed. Management and mitigation measures were recommended to address potential impacts. However, Hume Coal went beyond these measures and moved the proposed CPP site south to avoid this area and the associated potential for ecological impacts.

The layout was also reconfigured to fit within a smaller footprint to avoid the catchment of Medway Dam, and a number of sites containing the endangered Paddys River Box (*Eucalyptus macarthurii*) trees and Snow Gum Black Sallee Candlebark grassy woodland. The resultant design avoids and/or minimises direct impacts to these threatened species and communities.

Hume Coal implemented further avoidance measures when considering the location of the surface infrastructure area's direct disturbance footprint. The administration buildings, bathhouse and workshops were originally designed to avoid all direct impacts to an area of Southern Highlands Shale Forest and Woodland south of Medway Rivulet (shown in Figure 5.1), a Threatened Ecological Community (TEC) listed as endangered under the BC Act and critically endangered under the EPBC Act. Despite avoidance of direct impacts to these listed communities by the structures themselves, the mine infrastructure area would have required an asset protection zone (APZ) for the purposes of bushfire protection. This APZ would have required the clearing or thinning of 3.9 ha of Southern Highlands Shale Forest and Woodland to meet the objectives of the APZ. This portion of the infrastructure area was then moved north to its preferred location in an area of exotic pasture south of the proposed CPP, avoiding all direct impacts to Southern Highlands Shale Woodland, and habitat for several threatened species.

OEH has not raised any issues regarding bird breeding areas, impacts on the Koala or EPBC Act listed fauna given the measures implemented through the design to avoid the most intact parts of their habitat. Previous versions of the surface infrastructure design would have impacted parts of these intact areas of bird and Koala habitat. However, the final surface infrastructure design was amended such that these intact and continuous areas of native vegetation and fauna habitat would be retained, and residual impacts would be restricted to areas of modified and suboptimal bird and Koala habitat would be impacted. These measures are in accordance with impact hierarchy prescribed in the FBA in that avoidance and minimisation measures were incorporated into the design, and the residual impacts of clearing in disturbed areas will be offset. In addition, fencing would be maintained to separate the CPP from adjacent grazing areas and Koala habitat in this area.

Impacts on the giant dragonfly and on groundwater dependent ecosystems that represent potential Koala habitat are addressed in Section 13.3.

Water management system and potential impacts

The water management system for the project is detailed in Section 2.3.2 of the Hume Coal Project Revised Water Assessment Report (Appendix 2, EMM 2018a). The water management system will be implemented during early stages of construction to prevent contamination of local waterways. Surface water runoff from areas of the surface infrastructure area in direct contact with coal will be fully contained within the mine water management system to prevent discharge to local water ways. The water management objectives are to reuse water on site and minimise the release to more sensitive environmental areas. Runoff from areas where there is low risk of coal contact (SB03 and SB04 catchments) may be discharged to local creeks after collection of the first flush has been diverted into mine water dams and monitoring shows that post-first flush runoff is an acceptable quality to discharge. These potential releases from SB03 and SB04 to Oldbury Creek have been modelled as part of the surface water assessment and have been found to be compliant with the neutral or beneficial effect (NorBE) criteria. Results of the surface water quality impact assessment are presented in Hume Coal Project Revised Water Assessment Report (Appendix 2).

In relation to 'recycled toilet water', sewage from the administration and workshop areas will be treated and reused on site. Black water will be subject to tertiary treatment and harvested for reuse in the CPP; therefore no runoff of this treated wastewater stream will occur. Grey water will be subject to primary treatment and used for drip irrigation of landscaped areas. The drip irrigation system will be designed and operated in accordance with the relevant guidelines at the time, such as the document *Environment Guidelines – Use of effluent by irrigation* (NSW Department of Environment and Conservation 2003), so that there is no offsite impacts associated with the sewage treatment system.

Hanging swamps

Wingecarribee Swamp is approximately 13 km east of the project and therefore is outside the zone of direct surface impacts and influence of potential groundwater impacts. Refer to Section 13.3 and Figures 13.2 and 13.3 for further detail.

iii Indirect impacts on fauna

Some community submissions and business groups raised concerns about the 24 hours per day, seven days per week operation, and the impact this could have on birds and other native animals, particularly as a result of noise, light and dust emissions and water pollution. The SHG are concerned about how these factors will influence the habitat of koalas and other native animals in the vicinity of the project. It was claimed that the proximity will be exacerbated by the direction of the prevailing winds that will carry the noise in the direction of the river and large tracts of pristine bushland. Community respondents also noted that noise adds to the decline of species populations and the risk of extinctions, which it was claimed was not addressed in the EIS.

Bulwarra Bees submitted that their primary concern is the susceptibility of bees to airborne contaminants, claiming that if the Hume Coal Project is approved bees will be the first to be impacted.

It is acknowledged that without management, there is potential for increased noise and light impacts in adjoining areas of native vegetation. Noise impacts during construction and operation of the project will be managed in accordance with the measures specified in the Noise and Vibration Impact Assessment (EMM 2017I) and discussed in Chapter 14 of this report. Importantly, and as discussed in Chapter 14, the results of the noise modelling for the project showed that with the mitigation measures committed to by Hume Coal in place, the general amenity of the area will remain the same or otherwise satisfy EPA recommended amenity criteria, with only a few properties to the north of the project boundary predicted to be impacted to a level where they will be entitled to voluntary mitigation or acquisition. This area immediately to the north of the project area predominantly consists of cleared, rural residential blocks of land.

Light impacts will be minimised by installing directional lighting where possible in the mine infrastructure area and coal handling and processing plant such that it faces away from native vegetation and fauna habitats. These lighting measures will be further developed and documented in the Biodiversity Management Plan.

In relation to potential dust impacts, it is important to note that air emission sources from the mine will be limited due a number of factors including the underground mining method to be employed, the emplacement of rejects underground eliminating the need for an active surface emplacement over the life of the project and resultant dust emissions, and the covering of coal wagons. Dispersion modelling of potential dust emissions undertaken by Ramboll Environ (2017a) found that all emissions from the project will be well within the relevant EPA criteria. Dust emissions will also be managed in accordance with the measures specified in the Air Quality Impact Assessment (Ramboll Environ 2017a). Further discussion on potential air quality impacts is provided in Chapter 15.

Bulwarra Bees is located over 12 km from the proposed surface infrastructure area of the Hume Coal Project. The results of the dispersion model developed as part of the air quality impact assessment show that concentrations of dust are predicted to be very low at or beyond the project area boundary in all directions from the proposed surface infrastructure area. Dust concentrations were specifically predicted for Bowral, situated between the Hume Coal Project and Bulwarra Bees. Concentrations at Bowral are near zero for all pollutants and averaging periods; consequently concentrations at Bulwarra Bees and the surrounding area would also be negligible.

Given the distance from the Hume Coal Project surface infrastructure area, as well as the minimal emissions predicted as described above, no impact on these bees is predicted.

Given that the project is in and adjacent to the Great Eastern Ranges Corridor, some community submissions claimed that it may deter certain species from accessing the corridor due to both noise and light pollution, resulting in a detrimental impact, especially to nocturnal creatures. It was also submitted that the cumulative impacts of the project and climate change will exasperate this issue.

Concerns were also raised about the impacts to parks, reserves and gardens within the area, including the Belanglo State Forest. Respondents noted that the Hume Coal Project will be within 100 m of land reserved for national park and declared Wilderness Areas. The national park has old growth forests, which the EIS does not refer to.

Questions were also raised regarding impacts to fauna in Belanglo State Forest, in particular due to the claimed drying of the forest. Clearing of native vegetation, loss of hollow bearing trees, removal of dead wood and dead trees are all key threatening processes, and it was submitted that their activation with the project approval is likely to push threatened species closer to extinction and push common species closer towards being threatened.

As discussed above, it is acknowledged that without management, there is potential for increased noise and light impacts in adjoining areas of native vegetation. Noise and light impacts have been minimised through the design refinements described above. Noise impacts will be managed in accordance with the measures specified in the Noise and Vibration Impact Assessment (EMM 2017I). Light impacts will be minimised by installing directional lighting where possible in the mine infrastructure area and coal handling and processing plant such that it faces away from native vegetation and fauna habitats. These lighting measures will be documented in the Biodiversity Management Plan which will be developed and implemented for both the construction and operation of the project.

OEH did not raise any issues regarding negative wildlife impacts on the Great Eastern Ranges Corridor given the measures implemented through the project design to avoid intact areas of native vegetation, particularly those that are continuous along creeks in the surface infrastructure area. Previous versions of the surface infrastructure design would have impacted these intact areas. However, the final surface infrastructure layout was amended such that these intact and continuous areas of native vegetation and fauna habitat would be retained, and areas of modified and suboptimal bird and Koala habitat would be impacted. These measures are in accordance with the impact hierarchy prescribed in the FBA (OEH 2014), in that avoidance and minimisation measures were incorporated into the design, and the residual impacts of clearing in disturbed areas will be offset.

The project avoids the majority of potential biodiversity impacts to areas of intact native vegetation including Belanglo State Forest, and residual impacts in areas of disturbed native vegetation have been mitigated and offset requirements outlined. Further, OEH did not raise any concerns regarding impacts on national parks, wilderness areas or Belanglo State Forest.

While there are no conservation areas within the terrestrial study area for the project, there are some national parks and nature reserves in the surrounding region. Bangadilly National Park (NP), Kerrawarry Nature Reserve (NR) and Tarlo River NP are located around 5, 10 and 20 km west of the project area, respectively. Nattai NP is approximately 18 km north of the project area, and Morton NP is 5 km to the south. The Upper Nepean State Conservation Area is around 18 km north-east of the project area.

The closest declared wilderness areas to the Hume Coal Project are Nattai National Park and North Ettrema, approximately 18 km north and 10 km south, respectively. Accordingly, there will be no direct impacts on National Parks and Declared Wilderness Areas. Direct impacts on Belanglo State Forest were avoided very early in the design process due to the threatened species recorded during biodiversity surveys.

In relation to the claimed 'drying out' of the Belanglo State Forest, potential impacts to groundwater dependant ecosystems (GDEs) are discussed in detail in Section 13.3. As shown, no 'drying out' of the forest as a result of project-related groundwater drawdown will occur.

13.2.2 Potential impacts on Key Fish Habitat

DPI – Agriculture noted that several aspects of infrastructure related to the mine will require works within waterways mapped as Key Fish Habitat (KFH). These include water pipelines, conveyers, internal roads, sediment basin outlets and scour protection. Each of these items has the potential to have adverse impacts upon fish habitats if poorly designed or constructed. DPI – Agriculture requested that if development consent is granted, the conditions of approval should require that detailed designs for any item located within or adjacent to a KFH waterway be referred to DPI Fisheries for consideration and advice prior to construction.

Furthermore, it was noted that in order to ensure that the crossings facilitate fish passage, the floor of proposed pipes and culverts must be recessed by at least 100 mm below the existing bed level of the creek.

A number of waterways traversing the project area are mapped as KFH, particularly Medway Rivulet, Belanglo, Black Bobs and Wells creeks. However, when these sites were sampled, the habitat available was classified as minimal to unlikely fish habitat. Four sites supported moderate fish habitat (SWQ01 on Black Bobs Creek, Medway Dam on Medway Rivulet, SWQ05 on Wells Creek and Habitat C at Medway Rivulet).

The waterway crossings and culverts will be designed and constructed in accordance with the national guidelines entitled '*Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*' (Fairfull and Witheridge 2003), *Policy and Guidelines for fish habitat conservation and management* (DPI 2013) and *Guidelines for watercourse crossings on waterfront land* (NOW 2012). DPI Fisheries will be consulted for consideration and advice on suitable crossing design during development of the Biodiversity Management Plan. So that the crossings facilitate fish passage, the floor of the proposed pipes and culverts will be recessed below the existing bed level of the creek, in accordance with Fairfull and Witheridge (2003).

13.3 Impacts on groundwater dependent ecosystems

13.3.1 Hume Coal project

Some special interest groups and community submissions raised concerns about the effects of a reduced water table, removal of trees, vegetation clearing and development activities, which could pose detrimental risks and have an irreversible and unquantifiable impact on threatened species and other wildlife. One of the main objections was that if the trees above the mined area are to die, then entire ecosystems in the area will also be affected.

The Australian Institute (Submission on Economic Assessment) stated that in a number of sites throughout the project area the groundwater depth is less than 10 m, which is shallow enough to intersect with, and potentially be relied upon, by the overlying vegetation. They question the assertion in the EIS that the vegetation within and directly surrounding the project area is considered to mainly depend on rainfall. Given the evidence presented in the groundwater section of the EIS, the Australian Institute claims that it is almost certain that groundwater will be drained in these areas, which therefore poses a considerable risk to the overlying flora and fauna. Other respondents, including Lock the Gate Alliance, also claim that a desktop review of Hume Coal's own information shows little or no information about how groundwater loss will impact on these ecological communities (and in particular "high priority" GDEs including EPBC Act listed species and communities) and no indication of baseline data nor plan for ongoing monitoring.

Numerous community respondents also raised concerns about the water drawdown below under the overlying vegetation and within the planned mining activity area, in particular below Belanglo State Forest, Berrima, Sutton Forest, private properties, gardens, parks and vineyards. It was claimed that during the hot, dry summers the trees rely on the deep groundwater reserves for survival, and if these are depleted or nonexistent many will be severely stressed or die. Concerns were raised about the Paddys River Box, Dwarf Phyllota and Broad Leaf Sally, transitional shale forests of the Belanglo State Forest, and one community respondent noted that while the EIS makes mention of the lowering of the water table and minimal affect on the root zone of the few naturally occurring Eucalypts, it makes no mention of how it will affect all the remaining trees. Additionally, a community respondent raised concerns about the likelihood of old trees in the area covering 6,000 ha dying out.

DPI – Agriculture also noted that "decline of native riparian vegetation along NSW water courses" has been listed as key threatening process under the FM Act, and that therefore it is important to ensure that groundwater drawdown does not adversely affect riparian vegetation.

i Revised groundwater dependent ecosystem impact assessment

The groundwater model was revised following the exhibition period, as described in Chapter 4, with the results summarised in Chapter 5. Accordingly, a revised impact assessment has been completed for groundwater dependent ecosystems (GDEs), and is provided below.

Terrestrial vegetation in the terrestrial study area, as well as Long Swamp and Stingray Swamp were identified as potential GDEs within the biodiversity study area. Adjacent to this study area, and within the groundwater model domain, are other potential GDEs, comprising Jumping Rock Swamp, Hanging Rock Swamp, Paddy's River Wetlands and Wingecarribee Swamp. Wingecarribee Swamp is identified as a high priority GDE in the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.

Terrestrial vegetation along streams in the study area has been classified as having a facultative (opportunistic) dependence on groundwater. Facultative (opportunistic) ecosystems will use groundwater where available, but can exist without the input of groundwater, as long as there is no prolonged drought. Long Swamp, Stingray Swamp, Jumping Rock Swamp, Hanging Rock Swamp, Paddy's River Wetlands and Wingecarribee Swamp have been classified as having a facultative (proportional) dependence on groundwater. Facultative (proportional) ecosystems take a proportion of their water requirements from groundwater; however, there is no absolute threshold for groundwater availability below which ecosystem structure or function is impaired, and can respond to changes in groundwater at any level (NOW 2012).

The groundwater drawdown predicted as a result of the project was assessed against the aquifer interference policy (NOW 2012) to determine the likely impact to potential groundwater dependent ecosystems. To assess the potential for project-related impacts on terrestrial vegetation and downstream ecosystems (ie the abovementioned swamps and wetlands), drawdown contours from the groundwater model prepared for the project were plotted in GIS and cross-referenced with the potential GDE locations and the pre-mining water table levels. Predictive drawdown simulations provided the extent of the groundwater depressurisation effects as a result of the project. The full groundwater impact assessment is contained within the Revised Water Assessment prepared for the project (refer to Appendix 2).

An ecosystem drawdown risk assessment matrix was developed to assess the level of risk to terrestrial vegetation associated with drainage lines in the terrestrial study area and the abovementioned swamps and wetlands. The risk matrix is shown in Figure 13.2, and the resultant map of the predicted risk of impact to GDEs as a result of the maximum predicted groundwater drawdown is shown in Figure 13.3.

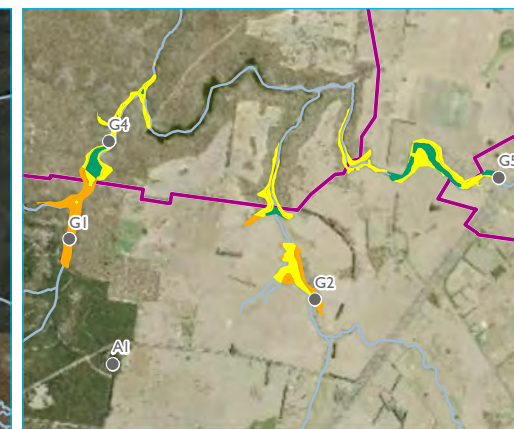
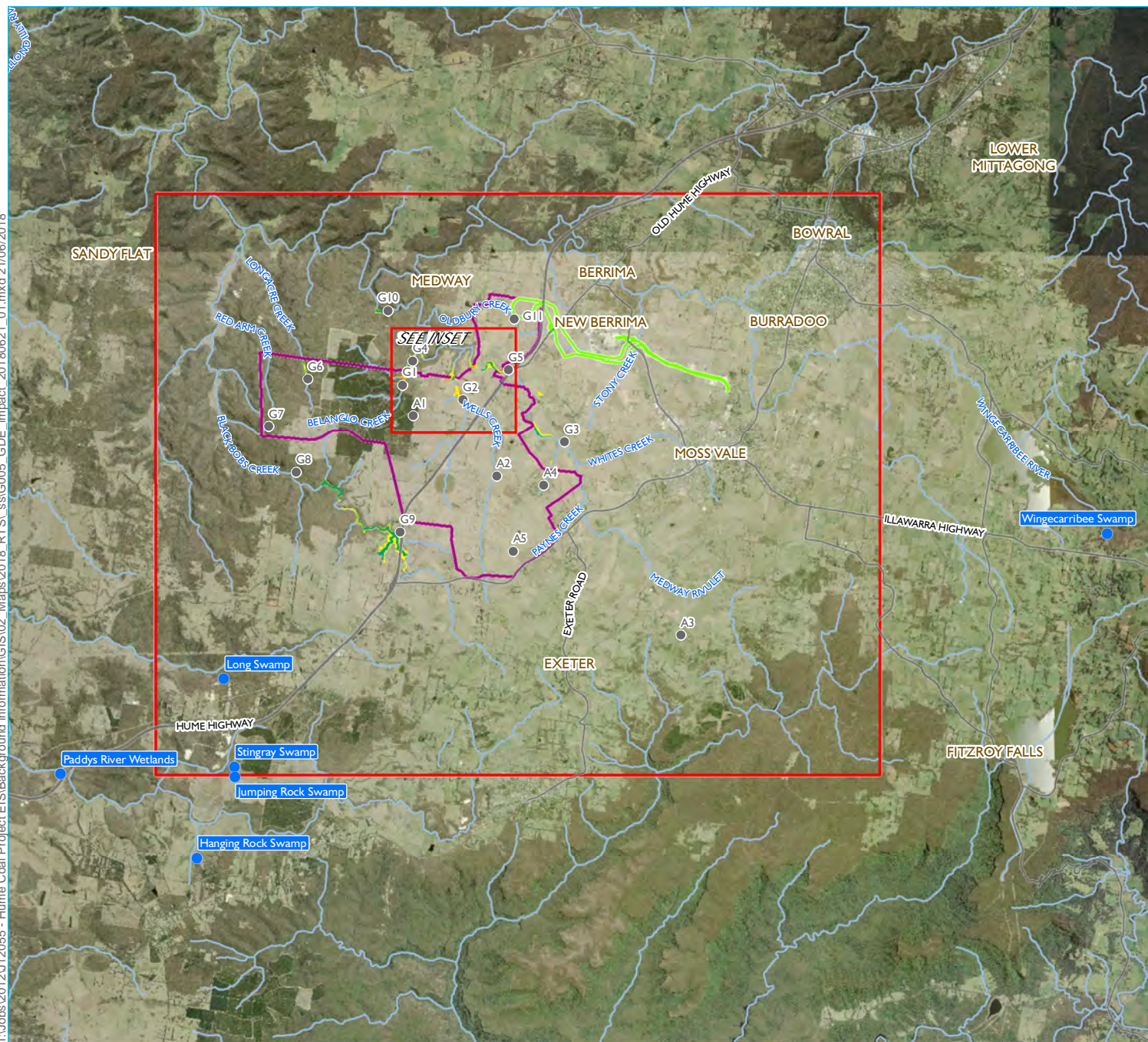
Water table drawdown				
Pre-mining water table height (mbgl)		2-10 m water table drawdown	>10 m water table drawdown	Ecosystem drawdown risk
	0-3 mbgl High potential for groundwater interaction	Low risk	Moderate risk	
	3-5 mbgl Moderate potential for groundwater interaction	Moderate risk	High risk	
	5-10 mbgl Low potential for groundwater interaction	Moderate risk	High risk	

Figure 13.2 Ecosystem drawdown risk assessment

The ecosystem drawdown risk assessment uses the pre-mining water table level (0-3, 3-5 and 5-10 metres below ground level (mbgl); shown in Figure 4.7 of the biodiversity assessment report (EMM 2017e) for the Hume Coal Project EIS) as an indication of the water table height prior to mining. The water table drawdown (2-10 m and >10 m) was then determined for the above areas where the water table was at 0-10 mbgl, based on the uncertainty analysis from the revised groundwater modelling (refer to Appendix 2). The biodiversity assessment in the EIS previously included water table drawdown from 0-2 m as part of the risk assessment. The 0-2 m category was removed from the revised assessment to account for natural fluctuations.

The ecosystem drawdown risk (ie low, moderate or high risk) was then assessed by determining the maximum water table decline as a result of the project. It is noted that the maximum drawdown (Figure 13.3) is predicted to be achieved at different times for different areas as a result of mine activity and propagation of pressure changes in physical space over time.

Given the facultative (opportunistic) use of groundwater by terrestrial vegetation, an ecosystem drawdown risk is defined as the level of reduction in groundwater availability for terrestrial vegetation during periods of long drought. Based on the above water table drawdown matrix, a low to moderate ecosystem drawdown risk is predicted where the water table height is predicted to stay within the root zone of eucalypts (ie up to 10 mbgl), while a high ecosystem drawdown risk is predicted where the water table level falls below 10 mbgl. Drawdown of a shallow water table to greater than 10 mbgl has been identified as the threshold for potential impact. This is based on the assumption that tree roots will access shallow groundwater up to 10 mbgl, following Serov (2012). The ecosystem drawdown risk for terrestrial vegetation and for swamps and wetlands are discussed in the following sections.



KEY

- Hume Coal Project area
- Berrima Rail Project area
- Biodiversity study area
- Virtual piezometer locations
- Swamps and important wetlands

Existing features

- Main road
- Watercourse

Risk assessment matrix

	Drawdown impact (m)	
	2-10	>10
Pre-mining water level (mbgl)		
0-3		
3-5		
5-10		

Potential groundwater dependent ecosystem impacts at maximum drawdown

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 13.3



a. Terrestrial vegetation

Progressive reductions in the availability of groundwater may lead to a gradual decline in the health of an ecosystem and/or a reduction in its spatial extent. Decreasing water tables can result in plant water stress and reduced live biomass (Serov 2012).

A low risk of impact is expected for terrestrial vegetation with a high potential for groundwater interaction (ie a pre-mining water level of 0-3 mbgl) where 2-10 m drawdown is modelled, as groundwater will remain within the expected root zone (up to 10 mbgl) of the eucalypts that comprise the main components of the ecosystem that would access groundwater during periods of prolonged drought.

A moderate risk of impact to the ecosystem is expected in areas of with a high potential for groundwater interaction (pre-mining water table level is 0-3 mbgl) and greater than 10 m water table drawdown is expected. A moderate risk of impact is also expected in areas with moderate potential for groundwater interaction (pre-mining water table level of 3-5 mbgl) where 2-10 m of drawdown is modelled, and in areas with low potential for groundwater interaction (pre-mining water level of 5-10 mbgl) where 0-10 m of drawdown is modelled. These scenarios have a moderate potential for impact as the water table could be around 10 mbgl at its lowest level, when drawdown is at a maximum, which would reduce the availability of groundwater to the eucalypts in the ecosystem during periods of prolonged drought.

Areas with low and moderate potential for groundwater interaction (pre-mining water table of 5-10 mbgl and 3-5 mbgl) and where >10 m of drawdown are expected to have a higher risk of impact to the ecosystem, as groundwater availability would already be limited due to the lower water table height prior to mining, and drawdown as a result of mining would reduce the ability of the eucalypts in the ecosystem to draw on groundwater during periods of prolonged drought.

Areas of low, moderate and high ecosystem drawdown risk as a result of the modelled maximum drawdown are shown in Figure 13.3. According to the ecosystem risk matrix, terrestrial vegetation in parts of Medway Rivulet and Black Bobs Creek show a low to moderate risk of impact. These drainage lines contain known and potential habitat for threatened species, including Paddy's River Box, Koala, Large-eared Pied Bat and Southern Myotis and Tablelands Snow Gum Black Sallee, Candlebark and Ribbon Gum Grassy Woodland EEC. The abovementioned ecosystems are not predicted to be impacted by drawdown given their facultative (opportunistic) dependence on groundwater and as the water table is predicted to be maintained at or above 10 mbgl during mining. This is within the root zone of the eucalypts, which would be the major component of the ecosystem drawing opportunistically on subsurface groundwater.

The upper reaches of Belanglo Creek and a patch of terrestrial vegetation south of Wells Creek are predicted to have a high risk of impact (approximately 13 ha and 6 ha, respectively). Belanglo Creek contains known habitat for the Koala and potential habitat for the Large-eared Pied Bat, Southern Myotis and Yellow-bellied Sheathtail Bat, while the patch of terrestrial vegetation south of Wells Creek represents Southern Highlands Shale Woodland; a critically endangered ecological community (CEEC). The water table is predicted to exceed 10 mbgl for these ecosystems during mining and therefore has a higher risk of drawdown impact during periods of prolonged drought. Vegetation predicted to have a risk of impact along Medway Rivulet (east of the Hume Highway) is predominantly cleared and dominated by exotic species, and therefore this does not pose a risk to biodiversity.

Hydrographs from virtual piezometers were reviewed for Belanglo Creek and Wells Creek to determine the modelled time of maximum drawdown and recovery at these streams. The locations of the virtual piezometers are shown in Figure 13.3. Hydrographs are presented in Figure 13.4.

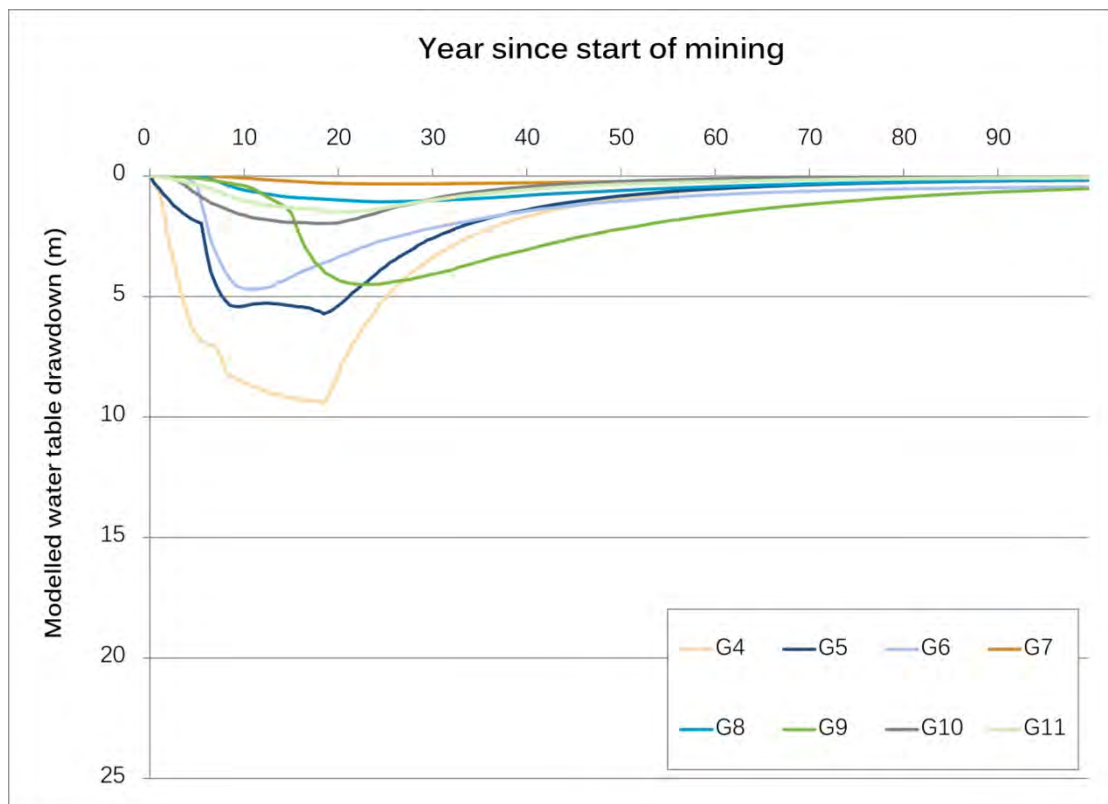
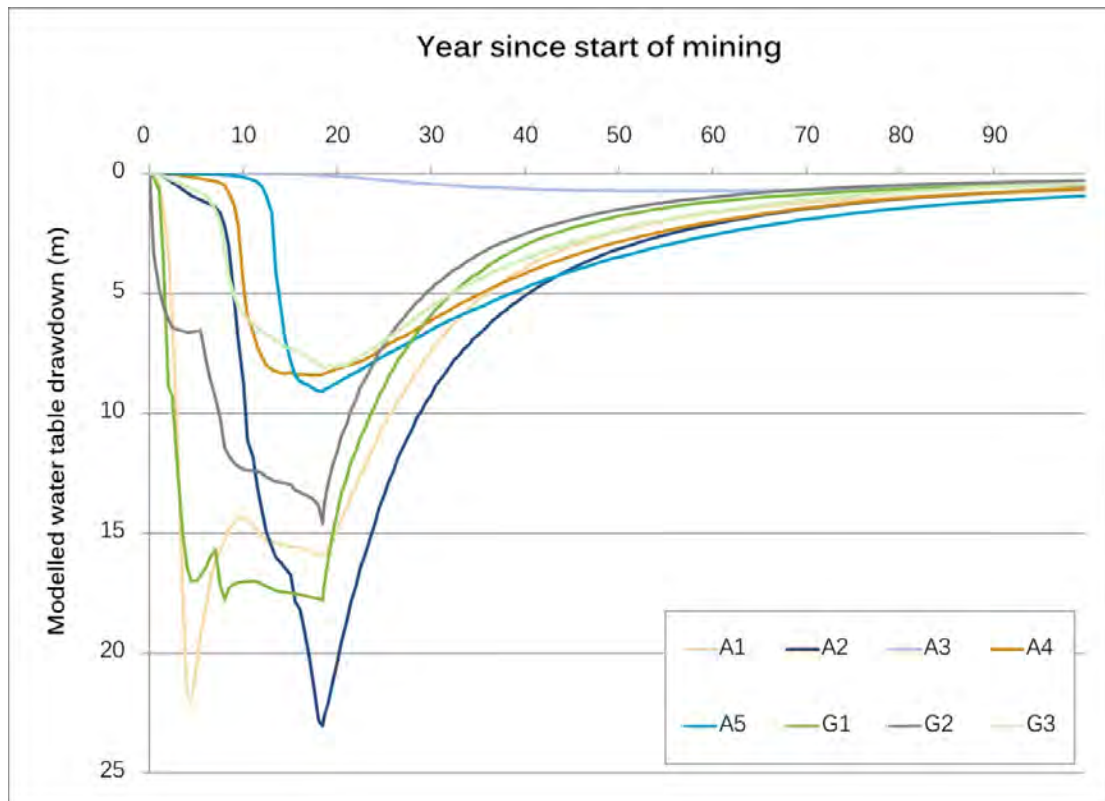


Figure 13.4 Drawdown at the water table at virtual piezometer sites

Drawdown of greater than 10 m is shown at virtual piezometers G1 on Belanglo Creek, and G2 and A2 in areas on Wells Creek. There is a patch of Southern Highlands Shale Woodland CEEC on Wells Creek. Drawdown greater than 10 m is not predicted to occur at any other virtual piezometer located in an area where potential groundwater dependant ecosystems might be present. For G1 on Belanglo Creek, drawdown occurs from about year 3 of operations, with recovery starting from year 18 of mining; the water table recovers to within 10 m of pre-mining level at approximately 23 years following start of mining at G1. For G2 and A2 on Wells Creek, drawdown occurs from about 7-10 years, with recovery starting from year 18 of mining; the water table recovers to within 10 m of the pre-mining level at approximately 21 -29 years following the commencement of mining.

The risk of drawdown impact in the ecosystems identified in Figure 13.3 must be interpreted in the context of the level of dependence of these ecosystems on groundwater. If the ecosystems had an entirely/obligate dependence on groundwater, any changes to the system would likely result in a permanent impact on the ecosystem's function. Terrestrial vegetation has a facultative (opportunistic) dependence on groundwater, but can exist using other water sources outside of periods of prolonged drought. Accordingly, no impacts are expected to these ecosystems on Belanglo Creek and south of Wells Creek if periods of prolonged drought are not experienced during mining. Monitoring and management triggers are therefore proposed in the BAR (also refer to Section 13.3.1(i)(a) below) for terrestrial vegetation in the event of prolonged drought during mining.

b. Long Swamp and Stingray Swamp

Long Swamp and Stingray Swamp contain Montane Peatlands and Swamp of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions, listed as an EEC under the BC Act, and Temperate Highland Peat Swamps on Sandstone, listed as an EEC under the EPBC Act. Long Swamp and Stingray Swamp have potential to provide habitat for threatened and migratory species including Paddys River Box, Broad-leaved Sally, Dwarf Phyllota, Giant Dragonfly, Littlejohns Tree Frog, Australasian Bittern, Australian Painted Snipe, Giant Dragonfly, Great Egret and Cattle Egret.

Temperate Highland Peat Swamps on Sandstone have been classified into the following three categories (Commonwealth of Australia 2014):

- headwater swamps - formed near catchment divides where topographic gradients are shallow;
- valley infill swamps - occur in steeper topographies filling the valley of incised second or third order streams; and
- hanging swamps - occur on steep valley sides where there is groundwater seepage.

Headwater swamps exist in the Southern Coalfield (Commonwealth of Australia 2014), particularly on the Illawarra and Woronora Plateaus. However, it is not clear whether any of the Southern Highlands swamps (including Long Swamp and Stingray Swamp) are considered to be headwater swamps. Stingray Swamp is on shallow topography near a stream headwater, and therefore is likely to be a headwater swamp.

Headwater swamps are often perched above the watertable and usually connected to a shallow perched groundwater system in the underlying sandstone. Headwater swamps (ie Stingray Swamp) are unlikely to be connected to the watertable as they occur in flat terrain in elevated topographies where regional groundwater is deep and perched groundwater systems are unlikely to be intersected by the swamp. Accordingly, the dominant water source for headwater swamps is from rainfall and surface runoff.

The regional water table is unlikely to be connected to the perched groundwater systems that provide water to the swamps and the dominant water source is from rainfall and surface runoff. Drawdown on the water table will not affect water contained in perched groundwater systems. Therefore, it follows that Temperate Highland Peat Swamps and the threatened species it supports at Stingray Swamp will not be impacted by the project.

Long Swamp is located along Long Swamp Creek (a fourth order stream), which has a steeper topography and therefore is likely to be a valley infill swamp. Valley infill swamps are fed to some extent by perched groundwater systems in the underlying strata. However, the steeper incision of valley infill swamps into underlying sandstone means that swamps are more likely to intersect the water table. Water sources for valley infill swamps comprise rainfall, surface runoff and groundwater (ie a facultative (proportional) ecosystem). Water flows through valley infill swamps as either sheet flow along the surface of the peat, up through the peat or through channels within the peat (Commonwealth of Department of the Environment 2014).

Although the water table may be shallow at Long Swamp (refer to Figure 4.7 of the Hume Coal Project biodiversity assessment report (EMM 2017e)), it is not located in an area predicted to be impacted by drawdown as shown on Figure 13.3 and Figure 9.14 (refer to Chapter 9).

c. Monitoring and management for terrestrial groundwater dependent ecosystems

Terrestrial vegetation along Belanglo Creek and south of Wells Creek will be monitored during extended periods of drought to determine if progressive reductions in groundwater availability are leading to a gradual decline in ecosystem health or spatial extent. An appropriate response will be determined if the condition of the groundwater dependent ecosystems potentially impacted along Belanglo Creek and Wells Creek are observed to be in decline, and the decline is attributable to Hume Coal operations.

ii Response to submissions

Following the *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Serov et. al 2012), potential GDEs were categorised, based on their degree of dependence on groundwater. GDEs are divided into three main categories, comprising:

- non-dependent (ie do not access groundwater);
- facultative (have some degree of dependence on groundwater; and
- entirely dependent/obligate (ie essential to ecosystem functioning).

As described in the revised GDE assessment in section i above, terrestrial vegetation along streams within and surrounding the project area are classified as having a facultative (opportunistic) dependence on groundwater, meaning that the ecosystems mainly fulfil their water requirements from rainfall and runoff, and supplement their water requirements with groundwater when these other sources are less available (ie during extended drought). Although shallow groundwater occurs along streams and riparian areas (eg parts of Belanglo State Forest) negligible impacts are predicted to occur in this and many other areas.

Based on the locations of GDEs and the predicted project-related drawdown, potential groundwater dependent ecosystem impacts are predicted to be restricted to the areas shaded as per the risk matrix in Figure 13.3. The detailed assessment undertaken does not support the notion that there will be large scale 'drying out' of trees across the project area. The area potentially impacted along Belanglo Creek contains known habitat for the Koala and potential habitat for the Large-eared Pied Bat, Southern Myotis and Yellow-bellied Sheath-tail Bat, while the patch of terrestrial vegetation south of Wells Creek represents Southern Highlands Shale Woodland, a CEEC. As these areas have a facultative dependence on groundwater, they are only predicted to be impacted during periods of extended drought when they would rely more heavily on groundwater.

To adequately manage potential impacts on habitat for the Koala, Large-eared Pied Bat, Southern Myotis, Yellow-bellied Sheath-tail Bat and Southern Highlands Shale Woodland CEEC, Hume Coal has committed to the collection of baseline data and ongoing monitoring (as described above in section c), with appropriate management to be determined. This will occur in consultation with representatives of OEH and DPI. A monitoring plan will be designed as part of the CEMP to detect impacts, including water stress, to the areas potentially impacted. The CEMP will also include appropriate management measures designed in consultation with the abovementioned government agencies, and implemented to protect and support the threatened ecological communities and species habitats during periods of extended drought.

13.4 Biodiversity offset strategy

13.4.1 Inputs to the FBA calculator

The OEH noted that the identification of vegetation types will have implications for the proponent's biodiversity offset requirements. OEH noted that there are some minor miscellaneous inputs into the FBA and associated online biodiversity credit calculator that should be rectified. These changes will have subtle implications for three final offset requirements. The Division of Resources and Geosciences (DRG) added that it requires consultation with the Proponent in development of the biodiversity offset strategy prior to submitting offset plans for the approval.

A teleconference was held with OEH on 7/11/17 to determine the minor miscellaneous inputs into the offset calculations that required rectification. These inputs related to the classification of PCTs as detailed in Section 13.1(i) of this report, minor updates to maps and calculator inputs and the re-classification of patches in low condition to moderate to good condition. The requested changes have been made to the offset calculations for the Hume Coal Project and Berrima Rail Project, resulting in a minor change to the credits required.

The Hume Coal Project EIS reported that the project would require 101 ecosystem credits and 582 species credits to offset the project's impacts on biodiversity, whilst the Berrima Rail Project EIS identified that a total of 6 ecosystem credits would be required. There is no change to the predicted species credit requirement of the Berrima Rail Project.

The revised credit calculations are summarised in Table 13.1 and Table 13.2, and the credit reports are provided in Appendix 4.2 (Hume Coal Project) and 4.3 (Berrima Rail Project).

Table 13.1 Summary of revised ecosystem credits required

Plant community type	Area	Credits required
Hume Coal Project		
PCT 731 ¹	8.0	146
PCT 1191 ²	0.2	6.0
Total	8.2	152
Berrima Rail Project		
PCT 731 ¹	1.90	0.00
PCT 1191 ²	0.20	7.00
Total	2.10	7.00

Notes: ¹ Broad-leaved Peppermint – Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion.

² Snow Gum – Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion.

Table 13.2 **Summary of revised species credits required**

Plant community type	Area or individuals	Credits required
Hume Coal Project		
Koala	8.2	213
Southern Myotis	8.2	180
Squirrel Glider	8.2	180
Berrima Rail Project		
Squirrel Glider	2.00	44
Paddys River Box, Camden Woollybutt	1.00	14

Hume Coal will consult with the OEH and DRG prior to submitting the offset plans to DPE for approval.

13.4.2 Development of the Biodiversity Offset Strategy

Submissions relating to the biodiversity offset strategy raised a number of aspects as follows:

- i. OEH recommends a Statement of Commitments for the implementation of offsets identified in the Biodiversity Offset Strategy (BOS) within 12 months of approval.
- ii. A number of concerns were raised by community and specialist interest groups in relation to the BOS. A community respondent questioned why Hume Coal commits to purchasing the offset credits only for koalas and myotis, but will wait until the mine is approved to buy offset credits for squirrel gliders.
- iii. Concerns were raised regarding the lack of detail on the BOS, which is proposed to be implemented within 12 months of approval. It was submitted that the available options and negotiation position of the NSW Government is compromised by this and the proposed approach should be dismissed and mitigation measures committed to that are clear and realisable with the proposal. The Nature Conservation Council of NSW (NCC) submits it is unsatisfactory that specific details on the BOS or identification of offsets are not provided in the EIS.
- iv. The NCC also claimed there is evidence from existing offsetting agreements in NSW that the current biodiversity offset policy is lacking in intellectual and scientific credibility. A community submission also noted that it cannot be assumed the offsets for biodiversity will be successful, submitting that the concept of offsetting is proving to be ineffective.

- i. Hume Coal maintains its commitment to the implementation of offsets in the BOS within 12 months of project approval, as previously discussed with OEH and stated in the Hume Coal Project EIS (EMM 2017a).
- ii. A targeted survey will be completed to confirm the presence (or otherwise) of Squirrel Gliders during development of the Biodiversity Management Plan. Accordingly, the presence of Squirrel Gliders would require the need for species credits to be generated, while the absence would not. The OEH has not raised any issue with this approach.

- iii. In relation to further detail on the biodiversity offset package, an analysis of vegetation in the wider Hume Coal Project area was completed during preparation of the EIS to inform development of the BOS. A preliminary analysis was completed to determine if Hume Coal-owned land contains a sufficient number of ecosystem credits for the PCTs and species credits for threatened species to be impacted by the Hume Coal and Berrima Rail Projects combined. Given the large area of native vegetation and threatened species habitats that will not be impacted on Hume Coal-owned land, it was determined that the area contained sufficient credits to offset the project's impacts. This preliminary offset analysis will be used as a basis for developing a final biodiversity offset package for the project, which will be refined with the revised calculations described above, and the results of the targeted Squirrel Glider survey. In accordance with the FBA, only an overarching BOS is required at the EIS stage, with the finalised offset package to be developed post-approval. Importantly, it has been demonstrated that suitable offsets are available within the project area, and therefore the BOS has fulfilled the requirements of the FBA. In addition, OEH have not raised any concerns regarding the approach to the BOS, given it is in accordance with current and relevant government policy.
- iv. In relation to the effectiveness of current biodiversity offset policy, this is a matter for Government and not Hume Coal. However, it is noted that it is mandatory to assess the impacts of the Hume Coal and Berrima Rail projects in accordance with the FBA as it was required by the SEARs. Accordingly, alternative offset mechanisms cannot be considered. Further, the Hume Coal and Berrima Rail projects will impact disturbed native vegetation and retain intact patches of native vegetation. The proposed offset site identified for the Hume Coal Project and Berrima Rail Project would protect and improve the values of one of these patches of retained and intact native vegetation along Oldbury Creek. This vegetation is of higher biodiversity value than the areas to be cleared for the Hume Coal and Berrima Rail projects, resulting in a balanced offset outcome.

13.5 Biodiversity monitoring, mitigation and management

i Hume Coal project

DPI-Agriculture recommended that monitoring of the groundwater dependent vegetation deemed to be at high or moderate risk occurs on at least an annual basis. It was also submitted that an appropriate response strategy to alleviate impacts, should they be detected, needs to be developed prior to mining commencing. Clear parameters need to be established to define how a decline would be considered to be attributable to mine activities. DPI-Fisheries noted that monitoring is only proposed in the areas of high risk, which it does not consider to be adequate.

OEH suggested that monitoring of terrestrial vegetation along Belanglo Creek and south of Wells Creek needs to be commenced at the time of approval (or within 12 months) to establish baseline conditions for the "ecosystem health".

The DRG requested consultation with the proponent in development of the biodiversity offset strategy.

The use of fencing as a mitigation measure for potential impacts on fauna was questioned, claiming it will be inadequate. A community respondent was also concerned that Hume Coal has no intention of monitoring threatened species during the life of the mine.

As described in Section 10.4.2 of the Hume Coal Project EIS (EMM 2017a), a construction environmental management plan (CEMP) and an operational environmental management plan (OEMP) will be prepared for the project. A biodiversity management plan (BMP) will be included in the CEMP and OEMP. The BMP will be developed in accordance with the relevant government agencies, such as OEH, and will describe the measures to manage, monitor and report on biodiversity during the life of the project. This will include an appropriate response strategy, as well identifying where monitoring will take place and the frequency of monitoring.

Fencing is proposed to be installed in strategic locations to protect retained Paddy's River Box trees from construction activities and to prevent Koalas, recorded along Oldbury Creek, from entering the surface infrastructure area where heavy machinery will be in operation. The Paddy's River Box fencing will not be designed to keep fauna out, and only create a physical barrier between the trees and construction activities that could adversely impact them. Fencing for the Koala is only proposed to form a physical barrier between the surface infrastructure area and the intact Koala habitat along Oldbury Creek, and will allow Koalas to travel unimpeded along the creek corridor to access their habitats to the west.

A detailed biodiversity monitoring program will be documented in the Biodiversity Management Plan; the development and implementation of which will be required as a condition of the development consent should the Hume Coal Project and Berrima Rail Project be approved.

ii Pest control

A community submitter raised concerns about the potential pest control issues due to the project, as direct neighbours of the Hume Coal project.

A construction environmental management plan (CEMP) and an operational environmental management plan (OEMP) will be prepared for the Hume Coal Project in consultation with OEH, that will include the biodiversity management measures. A biodiversity management plan (BMP) will be included in the CEMP and OEMP. The BMP will describe the measures to manage, monitor and report on biodiversity during the life of the project.

As described in Section 6.2 of the Biodiversity Assessment Report for the Hume Coal Project (EMM 2017e), the CEMP and OEMP will set out methods for the management of noxious weeds and pest animals to be employed, such that adjacent habitats and properties are not impacted by additional weed and pest invasion. As described, areas not disturbed by surface infrastructure will be actively managed for weeds and access will be restricted to these areas.

Pest management activities will be reported on in the Annual Environmental Management Report (the 'Annual Review'), which Hume Coal will be required to prepare each year and submit to relevant government authorities.

14 Noise and vibration

This chapter responds to issues raised relating to noise and vibration.

14.1 Methodology and assessment approach

14.1.1 Hume Coal Project

In relation to environmental risk management, the EPA submitted that scenarios could occur where risks and costs are increased, such as where the noise footprint is larger than expected.

Some community, special interest group and business submissions questioned the accuracy of the noise model and assessment, suggesting that operational and construction noise levels will be much higher than predicted. Specific aspects raised included:

- the appropriateness of weather data used and why official local meteorological data wasn't used;
- clarification on how the Project Specific Noise Levels (PSNLs) were derived;
- appropriateness of the background noise data used;
- whether the results include a cumulative assessment of noise and vibration from both the coal and rail projects;
- a number of community members also questioned why their property was not specifically assessed in the noise assessment;
- another submission questioned the source of LAeq 9 hour 45 dBA contour level shown midway along the conveyor (Figure 5.4 in the Hume Coal Project EIS), asking that the source be confirmed and quantified; and
- why noise from helicopters moving to and from the proposed helipad was not assessed.

i Accuracy of the model

The noise and vibration assessment (EMM 2017i) was undertaken by experienced acoustic specialists from EMM in consultation with the EPA. It is EMM's specialist's experience that noise modelling presented in the assessment is conservative based on post validation of noise at other industrial developments. The scope and methodology of the noise assessment was in accordance with the SEARs (issued by the DPE) and the relevant guidelines including:

- NSW Environment Protection Authority (EPA) 2013, *Rail Infrastructure Noise Guideline* (RING);
- NSW EPA 2000, NSW Industrial Noise Policy (INP);
- NSW Department of Environment and Climate Change (DECC) 2009, *The Interim Construction Noise Guideline* (ICNG);
- NSW Department of Environment, Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP); and
- NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline*.

The accuracy of noise modelling techniques have been tested and documented with papers written by various specialists in this field. This includes extensive field validation with a special focus on adverse weather influences on noise propagation. It is EMM's experience with such validation work that noise models typically overestimate overall site contributions during adverse weather. Commercially available software adopted for this project (Predictor by Brüel & Kjær) applies the ISO 9613 standard, including the CONCAWE algorithm for meteorological effects on noise. The standard and algorithm used within the software are widely accepted by international, national and local practitioners including those in government. The CONCAWE algorithm provides a conservative estimation of noise propagation in our experience and as documented in technical papers. 'Predictor' calculates total noise levels at assessment locations from concurrent operation of multiple noise sources. The model considers factors such as the lateral and vertical location of plant, source-to-receptor distances, ground effects, atmospheric absorption, topography of the site and surrounding area and applicable meteorological conditions. Applying an approach of concurrent operation of multiple noise sources, as modelled, is conservative since such an operating scenario is unlikely in practice. The noise 'footprint' is not expected to be larger than predicted and hence the environmental risk from this aspect of the project is considered relatively low.

The assessment included quantitatively modelling and assessing the project's predicted noise and vibration emissions from a range of scenarios. Conservative assumptions were used to provide upper bound estimates of the project's impacts, including concurrent operations of all listed plant combined with adverse weather. Further, the region's background noise environment is well characterised as a result of a comprehensive long term noise monitoring program which was commenced by Hume Coal in 2011.

Further, as described in Chapter 1, DPE commissioned Renzo Tonin & Associates to undertake a review of the Hume Coal Project and Berrima Rail Project noise assessment (2017I and 2017m, respectively). The Independent Noise Advice report prepared by Renzo Tonin & Associates (dated 1/9/2017) states:

In our opinion, subject to a satisfactory response to the queries in this report, the modelling methodology appears appropriate and accords with INP guidelines.

Based on the above, it is anticipated actual noise emissions from the operations (if approved) will be no higher than predicted.

ii Meteorological data

The Hume Coal Project and Berrima Rail Project noise assessment used site specific meteorological data. As described in the Noise and Vibration Assessment report for the Hume Coal Project (EMM 2017I) in Section 2.5, weather data obtained from two weather stations in the project area were considered separately and analysed in accordance with NSW EPA policy. By considering the data from these two locations separately, this produced additional 'prevailing' weather conditions that were modelled in the assessment, and hence increasing the possible variables being tested in modelling. This approach meant that evening and night time wind directions assessed for the project noise predictions included the majority of the standard 16 directions possible and adopted the highest wind speed assessable (3m/s) according to the NSW EPA policy. These wind inputs result in worst case influences on site noise sources with respect to residential assessment locations. Hence, irrespective of the weather station used, the noise modelling has accounted for worst case conditions and the predictions reflect this. Furthermore, the data from the two weather stations exceed the minimum requirements stipulated by the NSW EPA for determining representative weather conditions. The EPA encourages the use of site specific weather data wherever possible in lieu of more distant weather stations such as those operated by the Bureau of Meteorology (BoM). To that end, Chapter 4 of the Air Quality Assessment for the Hume Coal Project (Ramboll Environ 2017a) details an analysis comparing the BoM weather station at Moss Vale (approximately 11.5 km east southeast of the proposed surface infrastructure area) to the data recorded at the Hume Coal weather stations. This provided added confidence in the approach adopted for noise impact assessment purposes.

iii Derivation of Project specific noise levels

The project specific noise levels (PSNL) were derived in accordance with NSW EPA Industrial Noise Policy (INP) as described in the Noise and Vibration Assessment (NVA) report (EMM 2017I) for the Hume Coal Project in Chapter 3. The INP provides a framework and process for deriving noise criteria for consents and licences. For this project, the intrusiveness criteria is the limiting criteria and relies on long term monitoring data at numerous locations representing potentially affected residences. The intrusiveness criteria is derived by adding 5 dB to the representative rating background level (RBL) measured at the adopted monitoring locations. The land surrounding the project was divided into seven noise catchment areas (NCA) (refer to Figure 14.1). Each NCA contains a number of residences and each NCA (and residences within it) was attributed a set of criteria based on the monitoring location deemed most representative of that area. This was done on the basis of proximity to the monitor, proximity to prominent noise features (eg the Hume Highway, or existing neighbouring industrial facilities) or otherwise based on similar acoustic environments determined through field observations. It is important to note that daytime PSNLs for NCAs 1, 2, 4 and 5 would increase if the newly released *Noise Policy for Industry* (NPfI) (NSW EPA 2017) were to be applied, having a minimum derivable intrusiveness criterion of 40 dB $L_{Aeq,15minute}$, in lieu of the adopted 35 dB.

iv Background noise data

The baseline monitoring used to derive background noise levels was completed in accordance with the INP (NSW EPA 2000). The NSW EPA's noise policy requires a minimum of seven days of 'valid' monitoring data to be captured to ensure a representative data sample is used to establish baseline noise levels. The monitoring used in this project significantly exceeds the EPA's minimum requirements. Hume Coal undertook quarterly unattended baseline noise surveys from Spring 2011 to Spring 2015, during which background noise levels at 17 locations were progressively sampled. The final data set adopted from each relevant monitoring location was the period representing the quietest noise levels to ensure a conservative assessment approach.

The adoption of the government's lowest possible (quietest) representative background level of 30 dB (eg at NCA 1, 2, 4 and 5) provided for a conservative assessment. Furthermore, any logger data that included extraneous or unusually loud noise events were discarded and not used further to define baseline noise.

The amount of data collected at a number of locations and over a large period of time afforded great confidence in this data and the data presented in the EIS is conservative.

v Cumulative assessment

A cumulative assessment of noise from both the Hume Coal Project and the Berrima Rail Project has been included in the Noise and Vibration Assessment report for each project.

Although the two projects will be two separate entities operating under separate development consents and assessable in accordance with NSW EPA amenity noise targets, a conservative approach was tested by combining worst case $L_{Aeq,15minute}$ noise levels from the industrial components of both projects (essentially assuming they were one project). As described in the Noise and Vibration Assessment for the Hume Coal Project in Section 5.3, no changes to possible entitlements under the Voluntary Land Acquisition and Mitigation Policy (VLAMP) (NSW Government 2014) were found.

A number of community members questioned why their property was not specifically assessed in the noise assessment.

The noise and vibration assessment considered 74 potentially noise sensitive assessment locations (i.e. residential properties) or 75 dwellings (location 14 was identified as having two dwellings on the property) surrounding the Hume Coal Project, primarily focussed around the proposed surface infrastructure site. These are described as assessment locations and shown in the NVA (Figure 2.1) and in this report in Figure 14.1.

The adopted assessment locations were initially identified using land ownership registrations, aerial photography and verification in the field where locations were visible from public roads.

The assessment locations identified are considered representative of all residential locations and catchments surrounding the site. Within the identified predicted zone of impacts, the above-mentioned sources of land ownership information were used so that it can be reasonably assumed all privately owned landholders in this zone have been identified. It is unlikely that a residence has been missed, but nonetheless a noise result can be inferred from a near neighbour if this has occurred. The final predicted noise levels confirm the area of impact has been appropriately defined by the extent of the adopted assessment locations.

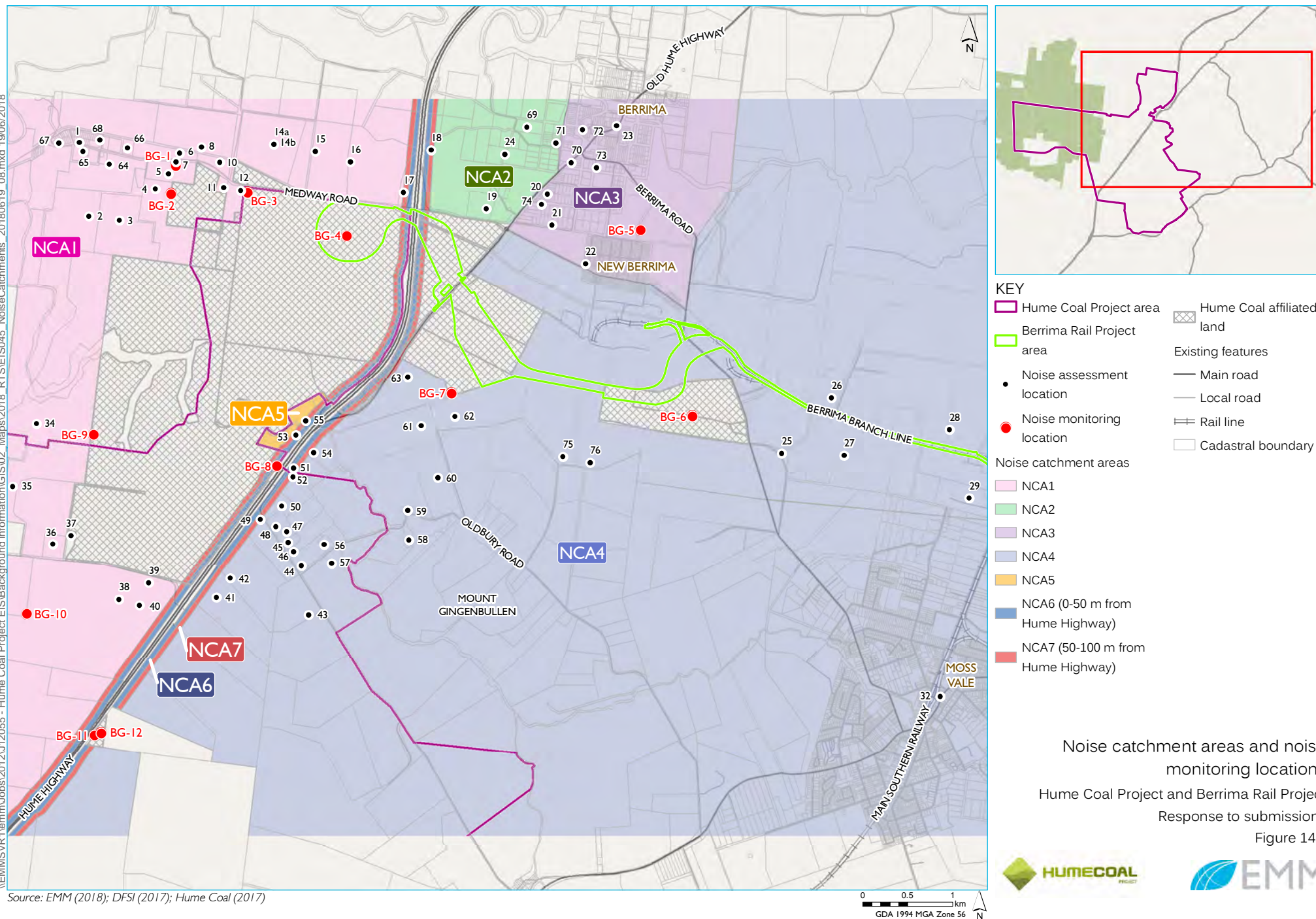
Locations further away (eg the central area of Berrima, Moss Vale and Bowral) were not considered potentially impacted and this has been verified by the predicted noise level results at adopted locations, being relatively closer to the project area.

Further to this, at the time of preparation of the Hume Coal EIS one property along Medway Road was in the process of being purchased by Hume Coal and was therefore not included as an assessment location. However, an agreement was unable to be reached and therefore predicted noise levels are presented below and shown in revised Figures 14.2 to 14.4, which puts this property (location 11) into acquisition entitlement as per the VLAMP. Conversely, location 13, which was found to be subject to an acquisition entitlement due to noise level predictions in the EIS, has since been acquired by Hume Coal and therefore removed from the noise assessment results. The net effect of these two changes is nil in terms of the total number of remaining private properties entitled to acquisition, which remains at two (now being locations 11 and 12).

The predicted noise levels at assessment location 11 are as follows:

- 43 dB $L_{Aeq,15min}$ daytime (refer to Figure 14.2);
- 39 dB $L_{Aeq,15min}$ night time calm weather (refer to Figure 14.3); and
- 43 dB $L_{Aeq,15min}$ night time adverse weather (refer to Figure 14.4).

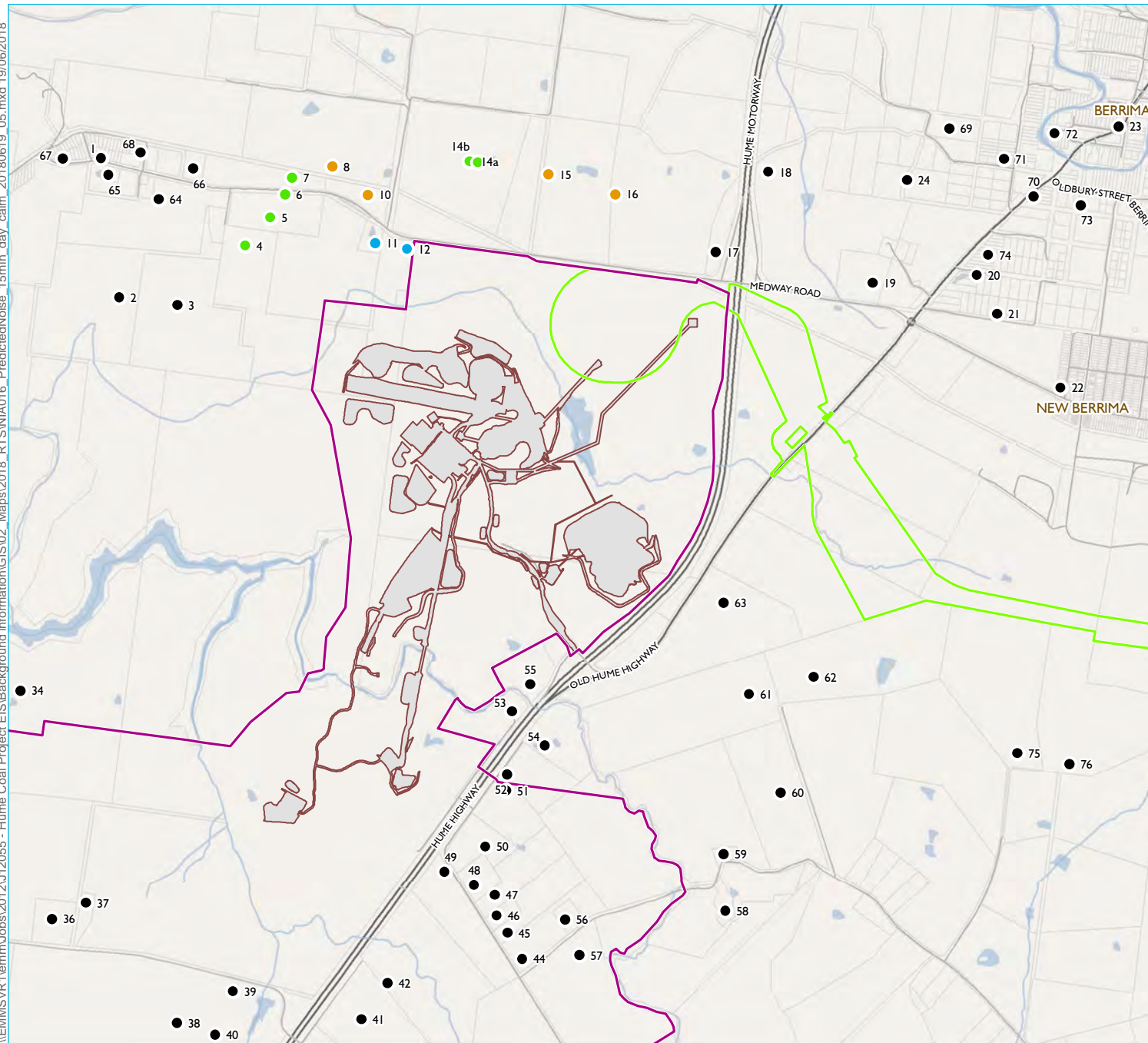
\\EMMSVR1\emm\Jobs\2012\12055 - Hume Coal Project EIS\Background Information\GIS\02_Maps\2018_RTS\EIS045_NoiseCatchments_20180619_08.mxd 2018/06/19



Noise catchment areas and noise monitoring locations
Hume Coal Project and Berrima Rail Project
Response to submissions
Figure 14.1



\\EMMSVR1\emmm\Jobs\2012\U12055 - Hume Coal Project EIS\Background Information\GIS\02_Maps\2018_RTSNIA016_PredictedNoise_15min_day_calm_20180619_05.mxd 19/06/2018



KEY

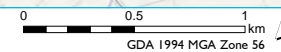
- Hume Coal Project area
- Berrima Rail Project area
- Surface infrastructure area direct disturbance footprint
- Noise modelling results
 - 1 to 2 dB above PSNL - negligible noise impact (6)
 - 3 to 5 dB above PSNL - dwelling entitled to voluntary mitigation (4)
 - > 5 dB above PSNL - dwelling entitled to voluntary acquisition (2)
 - Complies with PSNL
- Existing features
 - Main road
 - Local road
 - Drainage line
 - Waterbody
 - Cadastral boundary

Predicted $L_{Aeq,15min}$ noise levels for operations, day, calm weather

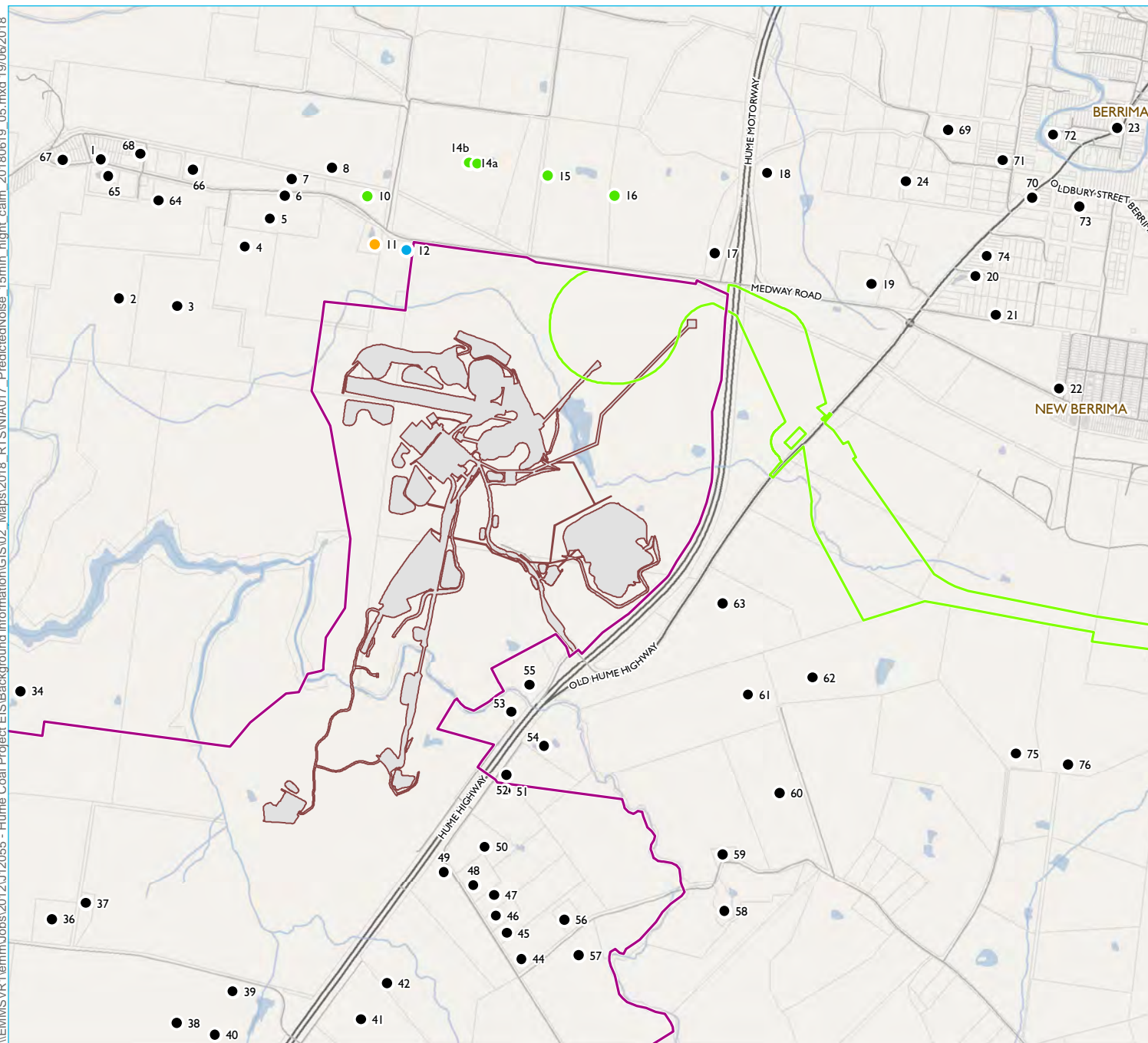
Hume Coal Project and Berrima Rail Project
Response to submissions
Figure 14.2



Source: EMM (2018); DFSI (2017); Hume Coal (2017)



\\EMMSVR1\emm\Jobs\2012\U12055 - Hume Coal Project EIS\Background information\GIS\02_Maps\2018_RTSNIA017_PredictedNoise_15min_night_calm_20180619_05.mxd 19/06/2018



KEY

- Hume Coal Project area
- Berrima Rail Project area
- Surface infrastructure area direct disturbance footprint

Noise modelling results

- 1 to 2 dB above PSNL - negligible noise impact (5)
- 3 to 5 dB above PSNL - dwelling entitled to voluntary mitigation (1)
- > 5 dB above PSNL - dwelling entitled to voluntary acquisition (1)
- Complies with PSNL

Existing features

- Main road
- Local road
- Drainage line
- Waterbody
- Cadastral boundary

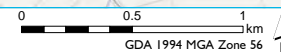
Predicted $L_{Aeq,15min}$ noise levels for operations, night, calm weather

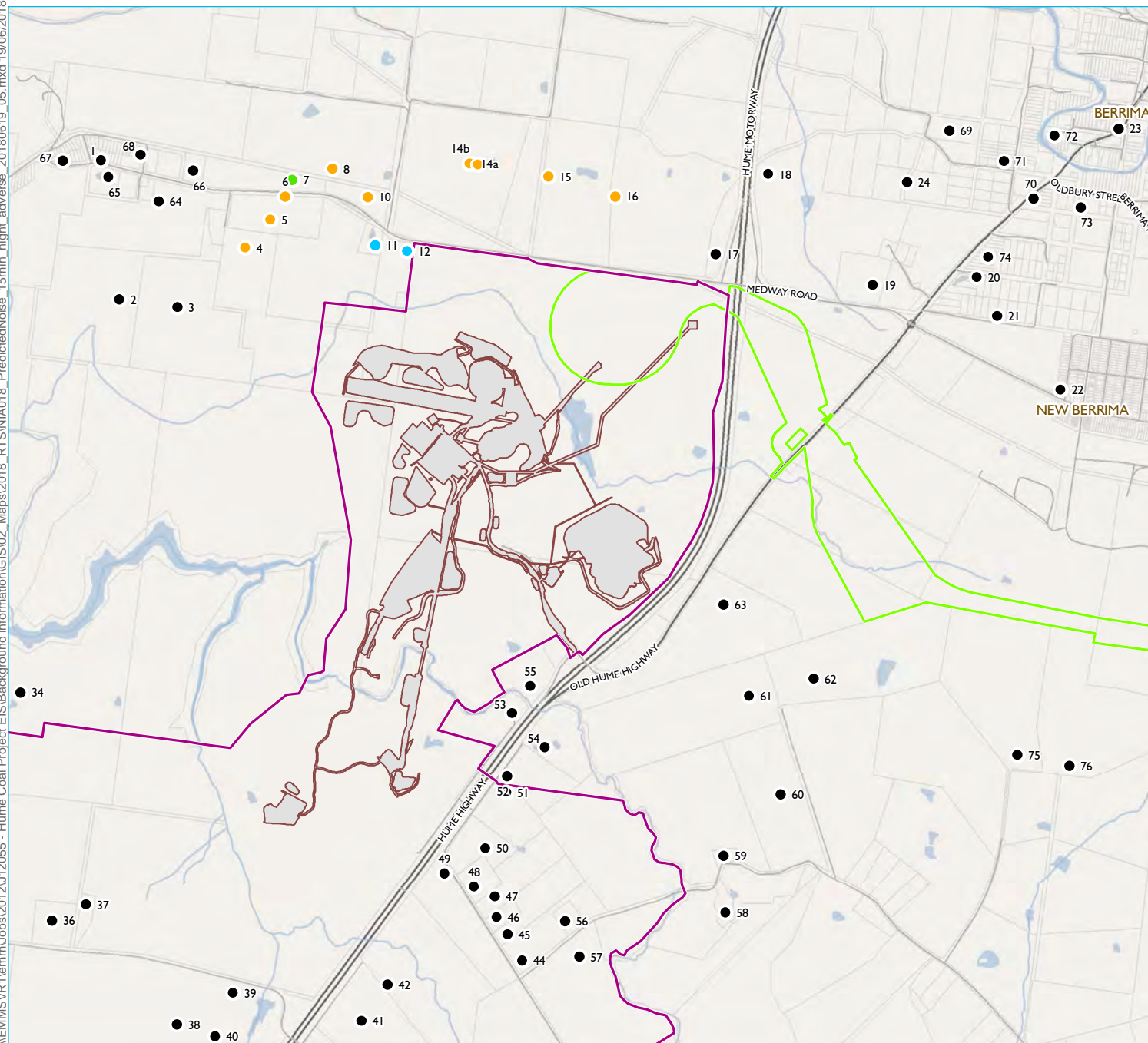
Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 14.3



Source: EMM (2018); DFSI (2017); Hume Coal (2017)





KEY

- Hume Coal Project area
- Berrima Rail Project area
- Surface infrastructure area direct disturbance footprint

Noise modelling results

- 1 to 2 dB above PSNL - negligible noise impact (1)
- 3 to 5 dB above PSNL - dwelling entitled to voluntary mitigation (9)
- > 5 dB above PSNL - dwelling entitled to voluntary acquisition (2)
- Complies with PSNL

Existing features

- Main road
- Local road
- Drainage line
- Waterbody
- Cadastral boundary

Predicted $L_{Aeq,15min}$ noise levels for operations, night, adverse weather

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 14.4



vii $L_{Aeq,night}$ 45 dBA contour level

One submission requested that the source of the noise be identified and noise quantified as per the displayed $L_{Aeq,9hour}$ (or $L_{Aeq,night}$) noise contour.

The $L_{Aeq,night}$ noise contour (shown in Figure 5.4 of the NVA report) was generated by modelling all surface infrastructure plant as listed in Table 4.2 of the Hume Coal Project NVA report. This includes the overland conveyor proposed between the surface infrastructure area and the mine portal access. The indicative sound power levels are shown in Table 4.2, and include 65 dB and 75 dB per lineal meter (modelled as a 'line' source) of conveyor for the east side and west side of the conveyor respectively. This difference is attributed to the proposed cover and sheeting on the east side of the conveyor.

The presented noise contours in Figure 5.4 have been checked by EMM and it is confirmed that these contours are correct. The issue raised in relation to the $L_{Aeq,9hour}$ night 45 dB noise contour in Figure 5.4 of the Hume Coal Project NVA report is related to the resolution of the grid used to develop the contour. The model and output for this contour plot has been further reviewed in response to this query.

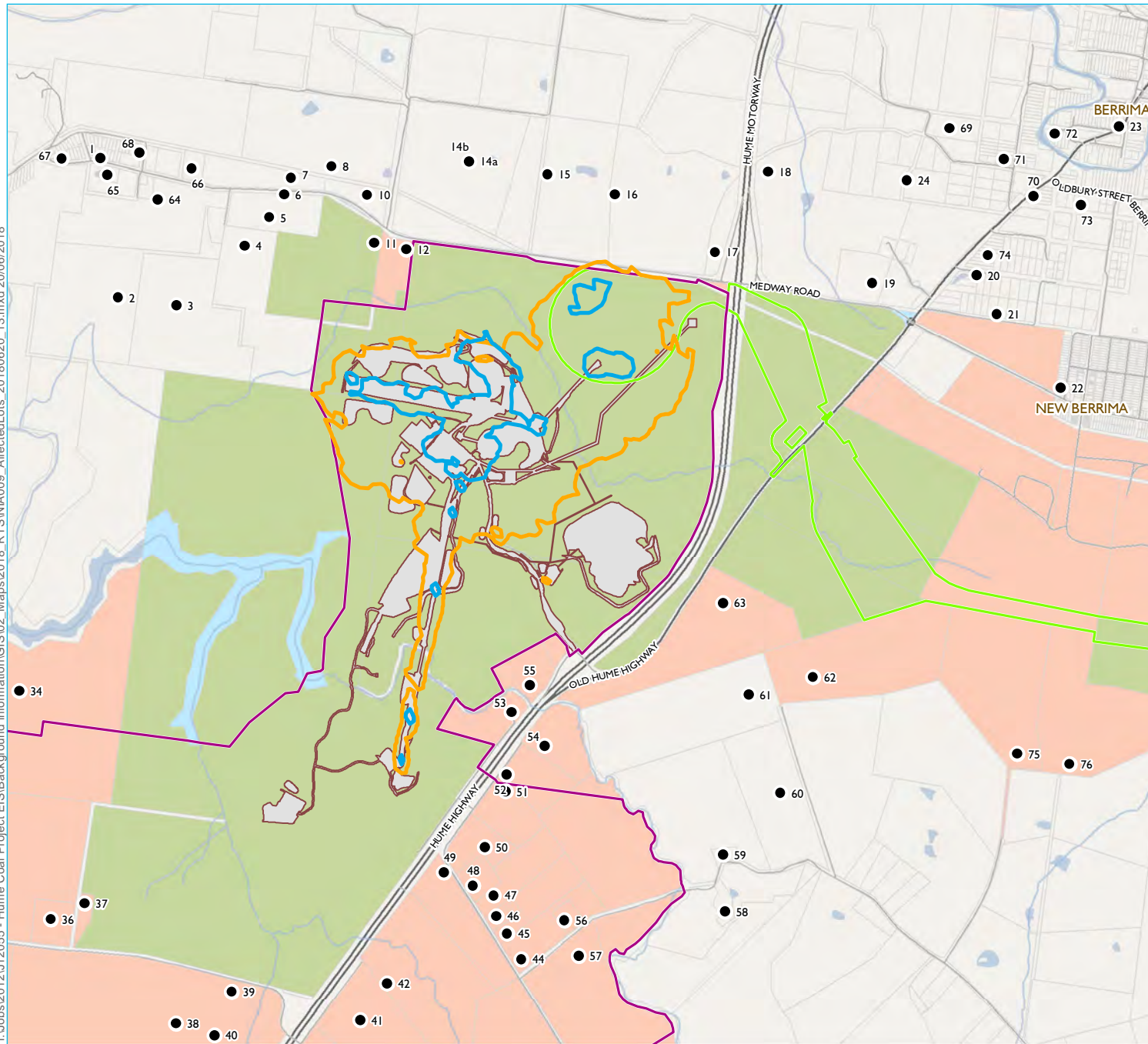
The grid used for contouring was 200 m and the conveyor alone does not produce 45 dB $L_{Aeq,9hour}$ or higher at a 200 m offset from it. Hence, there needs to be grid points nearby in order for the contour to 'appear'. This happens part way along the conveyor, where a relatively small number of grid points exist near enough to the conveyor, resulting in the isolated noise contour shown. This contour figure has been reproduced to demonstrate this issue as shown in Figure 14.5.

Noise contours are not as refined as single point calculations provided for all the assessment locations and hence this issue does not alter any findings or conclusions regarding the potential impacts of the Hume Coal Project.

viii Helicopters

Helicopters will not be used as part of the normal operations of the mine. They will only be used in an emergency. The building of a helipad is part of normal mining emergency planning and preparation.

Therefore helicopter noise does not fall into the jurisdiction of noise licensing or consent requirements for normal operations of an industrial site.



KEY

- Hume Coal Project area
- Berrima Rail Project area
- Surface infrastructure area direct disturbance footprint
- Noise contour - Day (55dB L_{eq,period})
- Noise contour - Night (45dB L_{eq,period})
- Land tenure in and around Hume Coal Project and Berrima Rail Project areas
 - Freehold (Government)
 - Freehold (Hume Coal affiliated)
 - Freehold (other private)
 - Crown
- Existing features
 - Main road
 - Local road
 - Drainage line
 - Waterbody
 - Cadastral boundary

L_{eq,period} noise contours and privately owned lands assessment - day and night

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 14.5



14.1.2 Assessment of impacts on Berrima

A number of community submissions and a special interest group submitted that the noise assessment did not adequately consider noise impacts on the township of Berrima.

Concerns raised included questions over the adequacy of background noise monitoring to characterise the noise environment used given no monitoring was conducted in Berrima.

It was also questioned why a discussion on cumulative impacts on Berrima from siding operations and rail movements, including on the proposed elevated rail overpass over the Old Hume Highway, was not included in the noise assessment.

i Noise impact assessment on township of Berrima.

The potential for noise impacts on the township of Berrima from both the Hume Coal Project and the Berrima Rail Project were assessed.

Assessment locations 19, 20, 21, 23, 24, 69, 70, 71, 72 and 73, which can be seen in Figure 14.4 and all of which are in Berrima, were included to represent that group of residences. The results of the noise model at these locations (and all locations east of the Hume Highway) show that predicted noise levels are below (ie satisfy) criteria for industrial operations (refer to Figures 5.1 to 5.3, and Table 5.1 of the NVA for the Hume Coal Project (EMM 2017l) and Tables 5.1 and 5.2 of the Berrima Rail Project (EMM 2017m)). Furthermore, as these locations are found to the south of Berrima and closest to the Hume Coal Project and Berrima Rail Project, noise impacts to any other residences further north would be expected to be less.

Furthermore, rail operational noise provided in Table 5.3 of the Berrima Rail Project NVA (EMM 2017m) confirms noise levels are predicted to be well below (ie satisfy) criteria at assessment locations that are much closer to the proposed rail spur than the Berrima residences.

ii Adequacy of background noise monitoring in relation to Berrima

Given the predicted 'less than 35dB' $L_{Aeq,15min}$ noise levels at closer locations to the Hume Coal Project (such as assessment location 19, refer to Figure 14.1) satisfies the EPA's strictest possible criterion (ie 35 dB), noise levels at Berrima township (located a further 2 km to the north east of location 19) will be even lower and therefore residents will be afforded the same lowest derivable criterion. As such, background noise levels are inconsequential to the assessment of impacts at Berrima, which was completed in accordance with NSW EPA policy.

iii Cumulative impacts on Berrima

The potential noise levels from rail sidings and rail movements along the whole of the proposed Berrima Rail Project area were assessed in accordance with NSW EPA policy. This is detailed in the Berrima Rail Project NVA report (EMM 2017m), including predicted noise levels in Chapter 5.

The cumulative noise levels of the Hume Coal Project, the Berrima Rail Project (including the elevated rail overpass over the Old Hume Highway) and the other industrial sites in the area, were assessed and reported on in Section 5.3 of the Berrima Rail Project NVA, as per the INP (EPA 2000). The assessment found that noise levels due to the operations would not lead to cumulative noise impacts.

14.2 Low frequency noise

14.2.1 Assessment approach

The EPA notes in their submission that the noise and vibration assessment in the EIS used an approach to assessing low frequency noise (LFN) from the EPA's draft Industrial Noise Guideline (the Guideline). At the time of writing their submission, the Guideline had been exhibited for public consultation but was not yet government policy. Therefore, the EPA requested the approach be rigorously and scientifically justified, and that an assessment of operational noise from the proposal which includes a 5 dB modifying factor adjustment if the mine noise L_{Ceq} is predicted to be 15 dB or more greater than the L_{Aeq} provided.

Since the time of the EPA's submission, the draft Industrial Noise Guideline was finalised and released as government policy as the *Noise Policy for Industry* (NPfI), effective 27 October 2017. This new policy replaces the INP.

In conjunction with the release of the NPfI, a new application note for the INP was released relating to Section 4 which provides guidelines for applying 'modifying factor' adjustments to account for certain noise characteristics such as low frequency noise emissions. The application note requires that this section of the INP be replaced by the provisions in Fact Sheet C of the NPfI. The EIS assessment is consistent with the NPfI approach to low frequency noise.

Therefore, this submission is considered addressed as the EIS already applies current government policy with respect to low frequency noise.

14.2.2 Impacts

One community submission raised concerns in relation to low frequency noise levels from the CPP, stating that LFN is difficult to manage, questioning the adequacy of the control measures proposed for the project, and that it is likely LFN will be very intrusive at night-time. The submission also suggested LFN can be particularly disturbing and sensitivity varies from person to person.

Questions were also raised about the approach to the LFN assessment stating that the assessment failed to account for differences in noise levels in specific bands within the spectrum.

Hume Coal has designed the CPP to mitigate noise including LFN. The design includes being fully enclosed in metal cladding, using variable voltage and variable frequency drives, concrete platforms for screens, increased steel work to stiffen the structure. LFN has been assessed as per the guidelines for both day and night and it can be concluded that potential increased impacts due to potential LFN are contained to properties identified as those already entitled to voluntary acquisition or mitigation due to operational noise. Hume Coal is committed to quantifying LFN during mine operations through regular compliance noise monitoring. If potential LFN impacts are identified by Hume Coal in accordance with the guidelines/ policy entitlements commensurate with the level of impacts would be offered.

The Hume Coal EIS accounted for differences in noise levels in specific bands within the spectrum. The assessment applied the NSW EPA's approach which is based on the UK's Department of Environment Food and Rural Affairs (DEFRA) curve to LFN. The curve addresses one-third octave band centre frequencies between 10Hz to 160Hz. As described in the response in Section 14.2.1, this is the current government noise policy for low frequency noise assessment, and hence accounts for the noise source spectrum. This methodology is current best practice assessment for LFN and reflects the government's recent extensive work in this area.

14.3 Noise impacts – Berrima Rail Project

14.3.1 Rail alignment and rail curve noise

- i. The EPA note that the proposed rail link alignment will introduce several tight radius curves to the rail link, which are likely to introduce significant curve noise greater than the curve gain (up to 8 dB) allowed for in modelling. The EPA would like Hume Coal to explain how the proposed rail link alignment was chosen, or why the old alignment through the cement works to Medway Colliery was not used instead, to minimise the number of curves and maximise curve radius.
- ii. The EPA also raised the issue of controlling rail curve noise, noting that the Berrima Rail Project propose to control curve noise primarily through grinding and gauge widening. The EPA notes the recent Planning Assessment Commission determination for Stage 1 of the Moorebank Precinct East Intermodal terminal where best practice mitigation measures and rolling stock were required, as well as research by Transport for NSW, and others, which suggests that wheel squeal is largely caused by poorly [designed] steering bogies, and that gauge face lubrication and top of rail friction modifiers can significantly reduce the incidence of curve noise. The EPA submits these controlling factors were not addressed in the EIS.
- iii. The EPA also queried the latest generation AC traction locomotives with electronically controlled pneumatic brakes, stating that the technology is likely to reduce, but not eliminate, bunching noise, and added that neither impact assessment predicted the L_{Amax} noise level from train bunching or horn use.

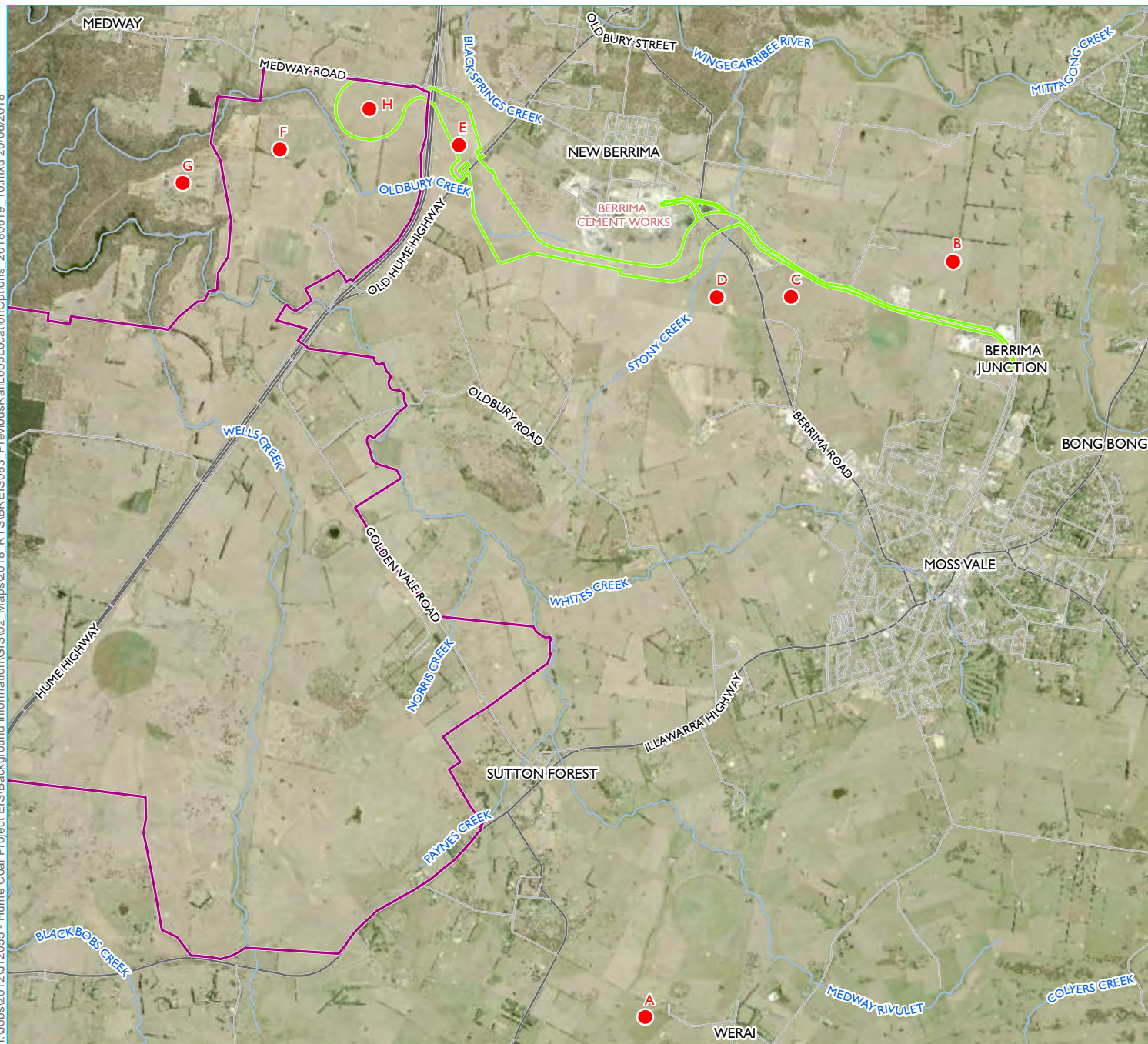
i Rail alignment

Chapter 3 of the Berrima Rail Project EIS (EMM 2017b) describes the various options considered for the rail link alignment. Each of the main alternatives considered, and reasons for not proceeding with each particular option, are summarised in Table 14.1 (reproduced from Table 3.1 of the Berrima Rail Project EIS). Using the old rail alignment through the Boral cement works was considered. This cannot be used because the constraints to Boral's business from eight Hume Coal train movements per day would be too great an imposition, and hence an agreement with Boral could not be achieved. The alternative locations considered for the rail loop are illustrated in Figure 14.6.

Table 14.1 **Alternative rail loop location options**

Alternative rail loop location	Description	Comments and reasons for rejecting or selecting
A - Rail siding at Weraí	Rail loop or siding off the Main Southern Rail Line at Weraí.	This option was based on an alternative surface infrastructure location for the Hume Coal Project near Weraí. This pit-top location was rejected very early in project planning for reasons including the fragmented nature of land ownership and road access, and hence this rail loop location was also rejected.
B - Berrima Junction loop	New spur off the Main Southern Rail Line, immediately north of Berrima Junction, with a rail loop on the northern side of Collins Road (north of the Berrima Junction).	This option would require coal to be transported around 7 km by overland conveyor from the Hume Coal surface infrastructure area to the rail load-out on the rail loop. This was rejected due to the proximity to semi-rural residences, the significant capital costs associated with the conveyor, land acquisition required for the conveyor and loop, and noise impacts of the long overland conveyor. This option would also have likely required significant signalling upgrades on the ARTC-controlled track at Moss Vale.
C - Douglas Road loop	Rail spur off the Berrima Branch Line, with a new loop between Douglas Road and Berrima Road.	As per the above Berrima Junction loop option, this rail loop location would also require construction and operation of an overland conveyor to transport coal to the rail loadout. It was therefore also rejected due to land acquisition costs, noise impacts of the overland conveyor, and the associated significant capital cost.
D - Leets Vale loop	Rail spur off the Berrima Branch Line, with a new loop west of Berrima Road and south-east of the cement works on the "Leets Vale" property.	Once again this option was rejected due to the associated capital cost of overland conveyor construction and noise impacts of the conveyor, as well as constrained site geometry.
E - Eastern Mereworth loop	Rail spur off the Berrima Branch Line, with a rail loop between the Old Hume Highway and Hume Highway on the "Mereworth" property and conveyor from the product stockpile.	The site geometry of this location was found to be unsuitable for the required size and layout of the rail loop/conveyor arrangement, as well as likely higher capital costs.
F - Loop around the stockpiles and CPP	Rail spur off the Berrima Branch Line and rail loop around the outside of the stockpiles and CPP.	This location was found to have Aboriginal heritage and ecological constraints, as well as site geometrical constraints, and likely higher capital costs.
G - Evandale loop	Rail spur off the Berrima Branch Line and rail loop north of Medway reservoir on the "Evandale" property.	The topography of this potential location was found to have adverse grades, as well as unsuitable site geometry and likely significant capital costs.
H - South of Medway Road	Rail spur off the Berrima Branch Line, with a rail loop south of Medway road and west of the Hume Highway.	Chosen option due to appropriate site geometry, proximity to the Hume Coal surface infrastructure area, and no significant ecological or heritage constraints. A detailed justification for the project and chosen project design is provided in Chapter 18.

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KEY

■ Hume Coal Project area

■ Berrima Rail Project area

● Indicative location of options considered for rail loop/siding

Existing features

— Main road

— Local road

- - Existing rail line

— Drainage line

Options considered for the rail loop location

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 14.6



Source: EMM (2018); DfSI (2017); Hume Coal (2017)

0 1 2 km
GDA 1994 MGA Zone 56

ii Rail curve noise

The approach to rail squeal was considered given the operational parameters of the rail loop and Hume Coal's commitment to best practice track/rail noise mitigation.

The quoted correction for rail squeal can be found referenced in a technical paper by Basutu et al (2015). The paper makes recommendations that are based on a series of measurements of different train types conducted on a network rail line. Importantly, the paper acknowledges that train speed affects the level of curve gain. In its concluding statement, a recommendation to expand the current study to include measurements of train speed and rail roughness is provided.

Some causes and a case study of freight-car wheel squeal reduction (Tickell et al 2004) also acknowledges that train speed affects the level of wheel squeal. This paper reviews a case study, whereby a reduction in wheel squeal was achieved through reducing the train speed from 40 km/h to 20 km/h.

Based on these technical papers, EMM's view is that the curve gain corrections are not critical to the rail loop given that:

- the train speed on the curved section of the rail track will be less than 10 km/h;
- it is a private rail line, whereby Hume Coal can manage the train speed without impacting other users; and
- Hume Coal is committed to best practice rail/track noise mitigation including grinding, lubrication, and top-of-rail friction modifiers. Hanson et al (2014) suggest that rail wheel squeal can be reduced significantly with track lubrication and top-of-rail friction modifiers. Measurements of track lubrication specifically demonstrated a greater than 90% reduction in wheel squeal. More recent research has found that the ability for three piece bogies (or wagons) to negotiate tight curves have been a key factor to wheel squeal due to poor rotation of the centre plate and high levels of bogie (or wagon) warp. The paper by Hanson et al goes on to state that this can be mitigated by using cross bracing or steering arms to reduce the warping affect.

In summary, if wheel squeal is still found to be an issue at the slow train speeds proposed, there are a number of measures that Hume Coal are able to implement to minimise wheel squeal as far as practicable or even eliminate all together on the rail loop.

Point sources which represent the stated L_{Amax} sound power level from rail movements (122 dB) were placed at a series of points in the model along the straight section of the rail spur nearest to noise sensitive receivers (wheel squeal is not relevant along this straight section). The highest predicted L_{Amax} noise level from any point along this section was assessed against the sleep disturbance screening criteria and results are presented in Section 5.5 of the Hume Coal Project NVA (EMM 2017). In summary, noise modelling demonstrated that L_{Amax} external noise levels associated with the site would be below the INP Application Notes sleep disturbance screening criteria (ie background plus 15 dB) at all residential assessment locations for all assessable weather conditions, with the exception of:

- assessment location 15 where a 1 dB exceedance is predicted during adverse weather conditions;
- assessment location 16 where a 3 dB exceedance is predicted during calm conditions and a 6 dB exceedance is predicted during adverse weather conditions; and
- assessment location 17 where a 2 dB exceedance is predicted during calm conditions and a 3 dB exceedance is predicted during adverse weather conditions.

The predicted external maximum noise levels during calm and adverse weather conditions would equate to an internal noise level of 36 dB, 38 to 41 dB and 42 to 43 dB for assessment locations 15, 16 and 17, respectively, based on a partially open window providing 10 dB of sound reduction. Therefore, although the INP screening criteria has been exceeded, the calculated internal noise levels are well below those that are likely to cause awakening reactions.

Further, two assessment locations (15 and 16) are entitled to voluntary mitigation upon request due to the operational noise impacts identified. The mitigation afforded to these assessment locations would provide an alternate means of ventilation and therefore allowing these occupants to leave windows closed when so desired, reducing internal maximum noise levels further to 26 dB and 28 to 31 dB, respectively.

iii Train bunching and horn noise

Trains will enter the rail loop at a speed of approximately 20 km/hr on the straight section of the rail loop which is nearest to surrounding noise sensitive receivers. The bunching of wagons as the train decelerates from a maximum of 20km/hr on the rail spur will be minimised by the electronically controlled pneumatic brakes. This type of braking is designed for this purpose. Furthermore, the rail loop will be constructed on purposely designed grades aimed at reducing bunching. If rail squeal is effectively managed on the loop, the maximum noise level associated with a train pass-by moving at a constant slow speed would be associated with the locomotive pass-by. The adopted sound power level of 122 dB, L_{Amax} for a locomotive is significantly higher than other potential maximum noise levels from rail activity (including rail wagon bunching if relevant given the technology proposed) and therefore appropriately represents potential sleep disturbance impacts.

Train horns will not be a normal part of operations on the loop or the rail spur. Horns are only used for safety purposes (eg if workers are on the track) and therefore not part of normal and assessable operational noise.

14.3.2 Operation of the rail line

Community, business, and special interest group submissions raised concern over the noise impact from the increasing train movements and the new rail route. Concerns raised related to the frequency of train movements and their operations 24 hours per day (and in particular during the night-time hours), the cumulative impacts of this increase with other trains using the line, the potential noise generated by the train wagons, the locomotives (noting C44 models are proposed), and the noise produced by the wheels as they move over the junction points and across the Southern Line from Berrima to Illawarra. Site specific concerns included impacts from increased train movements on the townships of Berrima, Medway, Moss Vale, Robertson (in particular the primary school), Glenquarry and other towns and villages across the route to Port Kembla.

Concerns were raised relating to train loading operations being skewed to the night time for rail access, and to avoid congestion across the North South line, thereby resulting in a greater noise impact.

Respondents submitted that the current railway line is already subject to high traffic in freight trains. The noise created by the trains idling, stopping and starting along the whole network was also raised, and whether a curfew could be imposed at Berrima and Moss Vale.

The assessment of network and non-network rail operations was completed in the NVA report for the Berrima Rail Project. The Berrima Rail Project is defined as a non-network rail line as it services a discrete number of users and is not used by the public and not part of the broader rail system. Hence, the noise aspects of its operations are treated separately and noise targets are stricter than for network rail lines. The network rail line in the vicinity of the project is the Main Southern Rail Line, and the assessment included a review of noise along this line, the Moss Vale to Unanderra line and the Illawarra line. This included assessment against government policy of 24 hour movements and cumulative impact with existing rail users. Rail wagon loading at the rail loop was included in the assessment of industrial noise levels and therefore assessed against the stricter Industrial Noise Policy (EPA 2000).

The number of trains from the Berrima Rail Project that were assumed to potentially operate at night provides for a conservative prediction of noise and assessment against criteria. The inputs into the Berrima Rail Project NVA were based on the maximum frequency of eight train movements in a day (ie four trips each way), as described in Table 4.4 of the Berrima Rail Project NVA and as reproduced below in Table 14.2.

Table 14.2 Rail traffic volumes adopted in noise model

Period	Existing users	Existing users + Berrima Rail Project
Night ¹	12 ²	16 ²

Notes: 1. Night: Monday–Saturday 10.00 pm to 7.00 am, on Sundays and public holidays 10.00 pm to 8.00 am.
2. Includes two 'light locomotive' movements (i.e. locomotive only movement for the purpose of shunting, maintenance or refuelling).

The inputs into the noise model accounted for noise generated by the locomotives and train wagons. The results of the noise model were compared with current noise guidelines, finding that network rail operations (ie on the Main Southern Rail Line) will satisfy appropriate noise criteria set by government. Operation of Hume Coal trains on the broader rail network is predicted to only cause a negligible or marginal increase in rail noise levels (refer to Sections 5.4.2 to 5.4.4 of the Berrima Rail Project NVA).

The assessment of non-network rail operations (ie on the Berrima Rail Line) showed noise criteria will largely be satisfied. There is one location at the eastern end of the Berrima Branch Line (location 28, refer to Figure 14.1) where a marginal (1 dB) exceedance of criteria is expected above the trigger level for voluntary mitigation rights (refer to Table 5.3 of the Berrima Rail Project NVA). Appropriate measures will be implemented to mitigate this residual noise level. Such measures may include acoustic treatment to the dwelling in line with government policy (ie the VLAMP). Noise from the rail maintenance facility will also impact only one location where a negligible 1dB over the PSNL is predicted for the less sensitive daytime period only (refer to Table 5.2 of the NVA). The likelihood of sleep disturbance is predicted to be minimal and consistent with current rail operations (refer to Section 5.5 of the NVA).

It is also relevant to note that scheduling of train paths is determined by track owner the Australian Rail Track Corporation (ARTC) not Hume Coal. Hence, a curfew at Berrima and Moss Vale is not an option availed to Hume Coal.

14.3.3 Sleep disturbance and health

i Sleep disturbance

1. EPA submission on assessment approach - The EPA recommends that possible sleep disturbance impacts from rail movements associated with the Berrima Rail Project are assessed in more detail using the application notes in the INP.

The EPA noted that the noise impact assessment for the Berrima Rail Project stated that the Rail Infrastructure Noise Guideline (RING) provides a L_{Amax} criterion of 80 dB for non-network rail lines. The EPA's concern is that the RING does not provide a L_{Amax} criterion for non-network rail lines, and the assessment should have instead used the approach in the application notes to the INP. Further, the predicted maximum noise levels from rail movements (up to L_{Amax} 56 dB) assume that curve noise would be effectively managed. The application notes require a detailed analysis where disturbance screening criterion are not met.

2. Community submissions - Some community submissions also raised concerns about the potential for sleep disturbance impacts as a result of train movements.

1. Assessment approach

The Berrima Rail Project NVA references all three government documents of relevance (refer to Section 3.5), being the INP application notes, the Road Noise Policy (RNP) and the Rail Infrastructure Noise Guideline (RING) for possible sleep disturbance impacts from rail movements.

The sleep disturbance screening criteria shown in Table 3.11 of the report are based on the INP application notes, consistent with the EPA's submission.

The additional reference below Table 3.11 in the NVA report to the 80 dB LAmax for new rail line developments was not applied to the rail spur assessment, but was noted for context only to highlight the disparity between two criteria values for essentially the same type of noise.

As reported in Section 5.5 of the Berrima Rail Project NVA report, internal noise levels up to LAmax 46 dB are predicted at locations 19 and 62 provided that rail squeal is effectively managed. Although this level is above the EPA's screening noise level it is below levels that are likely to cause awakening reactions according to information in the EPA's RNP document.

In terms of the INP application notes, the following further information is provided:

- how often high noise events will occur – up to two trains (although typically only one train per night) and hence up to four noise events per night at the predicted levels could occur;
- time of day (normally between 10pm and 7am) – scheduling at this stage cannot define exact train times and so it can only be assumed that events would occur anytime in this period (10pm to 7am); and
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods) – long term sampling data at locations BG-4 and BG-7 (as per NVA labelling) are considered representative of the baseline at locations 19 and 62 respectively. BG-7 is located in close proximity to assessment location 62. Noise from road traffic and existing industrial uses was noted at BG-7 as described in Section 2 of the NVA. Existing maximum noise levels were reported through attended monitoring by Pacific Environment Limited during noise logger deployments. The data at BG-4 shows existing baseline LAmax at night (10pm to 7am) vary between 40 dB to 60 dB predominantly (ie ignoring outliers), this includes natural as well as manmade sounds. Noise levels above 60 dB LAmax were common and recorded most nights. Similarly, at monitoring position BG-7 (nearby to assessment location 62) the LAmax noise levels range between 50 dB to 70 dB during the night. Noise levels above 60 dB LAmax were common and recorded every night. This provides additional context on the predicted 56dB LAmax noise level at up to four times per night from proposed rail movements.

2. Community

The community's submission on sleep disturbance from rail operations is largely addressed above. Further, proposed Hume Coal train events will not result in higher maximum noise level events compared to existing train movements generated by current users and for residences located along the existing rail spur.

ii Health

Some community submissions claimed that noise from trains will pose unacceptable health issues and that in the long term disturbed sleep patterns could lead to mental and emotional health issues. Concerns regarding potential health issues to students and staff at Robertson Primary School were also raised.

The noise assessment from proposed rail operations was completed in accordance with state government policy.

This includes an assessment of sleep disturbance, and hence has relevance to health. The assessment included network rail operations in the area of Robertson, where noise criteria are predicted to be satisfied.

The Robertson Primary School is approximately 100 m from the nearest rail track. The addition of Hume Coal trains on these sections of track is predicted to lead to a negligible (<0.5 dB) increase in total rail noise.

The nearest residences are approximately 20 m from the track. The addition of Hume Coal trains on these sections of track is predicted to lead to a negligible (<0.5 dB) increase in total average rail noise to all locations potentially affected and therefore be unlikely to increase the incidence of disturbed sleep patterns.

14.3.4 Vibration impacts

Multiple community concerns were raised about the vibration from hauling coal over the train line; some added this would be a concern over a 24 hour period each day.

The Hume Coal Project NVA report assessed vibration impacts. Data shows that ground induced vibration is predicted to satisfy human response criteria at residences based on the proposed plant and activities. This issue is discussed in detail in Section 5.6 and Table 5.4 of the NVA.

Vibration induced by rail operations is addressed in the Berrima Rail Project NVA report in Section 5.6.

Given the track on ballast configuration throughout the proposed rail spur and the separation distances, ground induced vibration is predicted to satisfy human response criteria at sensitive land uses (eg residences).

Appropriate vibration criteria are set in the EPA's guidelines (Assessing vibration: a technical guideline (DEC 2006)). Other guidance of relevance can be found in the publication *Development near rail corridors and busy roads – Interim Guideline* (DoP 2008b). Specifically, in relation to separation distances from development near rail corridors, the guideline shows a vibration assessment is not required if a residence is greater than 25 m from the track. The nearest privately owned residences to the new track are more than 200 m away.

14.3.5 Rail maintenance facility

- i. Operation - A number of concerns were raised in community submissions relating to the noise that would be generated by the rail maintenance facility, suggesting that 24 hour operations will be disruptive and noisy for local residents.
- ii. Construction - Some respondents raised concerns that the construction of the rail maintenance facility would also significantly contribute to noise pollution, requesting an outline of noise control measures during the construction and operation of the rail maintenance facility.
- iii. Location - One special interest group (Berrima Residents Association) asked the DPE to relocate the maintenance siding to the west side of the Hume Highway as relocating the facility would avoid noise impacts.

i Noise from the operations of the rail maintenance facility

The operation of the rail maintenance facility will meet the EPA criteria.

Sections 5.1 and 5.2 of the Berrima Rail Project NVA report provide the results of a noise assessment of the rail maintenance facility construction and operations which are compared to the EPA policy. The operational assessment shows that noise levels are predicted to be well below (satisfy) EPA criteria at all residences at all times during the day and night.

ii Noise from the construction of the rail maintenance facility

Construction of the rail maintenance facility will be managed in order to minimise disturbance for residents.

The construction assessment demonstrates that most activities will satisfy noise management levels at most locations. Any exceedances shown during out of hours activities will need to be specifically managed in accordance with government requirements, including adoption of all feasible and reasonable measures. For example, predicted exceedances at locations 28 and 29 will be limited to a total of 1 to 3 nights. It is also noted that these locations are at the eastern end of the Berrima Branch Line, and so the exceedances predicted there are not related to the maintenance facility, but upgrades to the existing Branch Line.

All final measures adopted will be described in the Construction Environment Management Plan. This will need to be approved by the DPE prior to construction commencing.

iii Relocation of rail maintenance facility

The rail maintenance facility has been situated after careful consideration of both operational and environmental requirements. As the noise impacts from the operation of the rail maintenance facility at this location will meet the PSNL for all of Berrima except for one residence, which would receive only a 1dB (negligible impact), relocation for noise impacts would be unfounded.

14.4 Noise impacts – Hume Coal Project

14.4.1 Construction impacts

A number of community, interest group and business submissions raised concerns over the assessment approach and outcomes of the construction phase assessment. Key issues raised were:

- i. Timing of construction and mining phases - were the construction activities and mining phase assessed cumulatively, noting that some coal extraction will commence during the construction phase of the project. Further, questions were raised about the noise criteria that were applied in the instance when these phases are occurring concurrently.
- ii. Hours of construction - what hours of operation/construction were assumed?
- iii. Assessment locations - some individual property owners raised specific concerns about construction impacts on their property not being assessed.
- iv. Berrima - concerns were also raised about the predicted exceedance of NMLs during construction and the potential impacts of construction noise on the township of Berrima.
- v. Road traffic noise - a couple of respondents also questioned whether road traffic noise during the construction phase has been considered.
- vi. Property acquisition - queries were raised about the situation where properties have been identified for acquisition during the operational phase; however would also experience noise levels in excess of the NML during the construction phase.
- vii. Impacts - the WSC submitted that the EIS downplays the noise impact the project will have on many residents particularly during the construction phase.

i Timing of construction and operations in the noise assessment

Both construction and operational noise were assessed independently. This is because all noise producing construction activities that form part of the major surface works would have ceased prior to mining operations commencing.

While there will be the need to construct underground drifts and the like (operations) during the surface construction phase, it is important to note that this will not contribute to any possible noise impacts, as they are underground.

Such underground works or related surface activities together with early operational activities (ie not full operations) will not result in any greater offsite noise levels than those presented in the assessment of full operations. During such a scenario, the stricter operational noise criteria will apply. This has been addressed in the construction noise and vibration assessment in so far as predictions of either construction or operation provided in the assessment produce the 'outer envelope' of potential impacts.

The construction assessment was prepared in accordance with NSW government requirements as described in the Interim Construction Noise Guideline (ICNG).

ii Hours of construction

The hours of construction are described in Section 4.3 of the NVA report and were assessed accordingly. Most construction activities will occur during standard hours. However, some works are proposed and required to occur during out of hours (refer to Section 5.7 of the NVA report). These out-of-hours works for the Hume Coal Project are related to the conveyor portal, personnel and material portal and ventilation shaft construction. Continuous construction of these elements is required to maintain a safe level of geotechnical stability which can be time dependant.

Also, some limited internal activity within the CPP building is proposed 24 hours, 7 days a week during the construction phase which is required due to the specialist nature of this equipment item and the need for a continuous construction methodology.

Predictions for proposed out of hours construction show that the noise management levels (NMLs) will overall largely be achieved. The assessment identified some marginal (up to 3dB) exceedances during limited activities that will be targeted for further mitigation during the development of the Construction Environmental Management Plan to achieve out of hours NMLs at all assessment locations.

iii Assessment locations

Construction (and general) noise will dissipate the further it travels from the source. Therefore the NVA first identified those residences that surround the project boundary. Their exact locations are shown in Figure 2.1 in the Hume Coal Project NVA (EMM 2017I) and Figure 14.1 in this report.

As described in the NVA report for the Hume Coal Project in Section 2.2, these assessment locations were initially identified using land ownership registrations, aerial photography and verification in the field where locations were visible from public roads.

The assessment locations identified are considered representative of all residential locations and catchments surrounding the site. Within the identified predicted zone of impacts it is unlikely that a residence has been missed, but nonetheless a noise result can be inferred from a near neighbour if this has occurred.

The results show that construction noise will only impact some of the properties immediately adjacent to the northern boundary for defined time periods and are predicted to exceed the lower level "noise affected" NML. A feasible and reasonable noise mitigation and management will be adopted as required by EPA policy. For the closest of the Medway Road residences for example (eg locations 12 to 15), the following is predicted as per Appendix D of the NVA (EMM 2017I):

- early works activities (standard hours only) are shown to either satisfy NMLs or exceed them by up to 14 dB, and at all times satisfy the highly noise affected NML of 75dB during standard hours.
- during construction of portals and portal access (standard hours only), noise levels are expected to largely satisfy NMLs.
- during CPP construction (standard hours only), noise levels up to 24 dB above standard hours NMLs are predicted, with the highly noise affected NML satisfied at all locations.
- during surface infrastructure construction (standard hours only), noise levels are predicted to satisfy NMLs or exceed them at times by up to 8 dB and satisfy the highly noise affected NML at all locations.
- during construction of the overland conveyor, predicted noise levels satisfy the NMLs.
- during construction of ventilation shaft access, predicted noise levels satisfy NMLs during the standard hours, with marginal 3 dB exceedances shown during the evening and night time for limited periods.

iv Predicted exceedances of NMLs and predictions in Berrima

The predicted noise levels presented in the EIS confirm that construction noise will not impact on the village of Berrima.

Appendix D of the Hume Coal Project NVA (EMM 2017I) report lists the results of construction noise predictions. This shows that construction noise at the locations representing the village of Berrima (eg 70 and 73) are well below and satisfy all government criteria.

v Road traffic noise

Road traffic noise during construction has been considered and assessed in accordance with government criteria as shown in Section 5.10.2 of the EIS NVA report. It was found that there would be no measurable change on most roads or a negligible increase due to the Hume Coal Project for the Old Hume Highway and Medway Road.

vi Acquisition and the construction phase

Where properties have been identified for acquisition due to operational noise impacts, these will likely be acquired or negotiations reached prior to construction commencing. It is noted however, that construction noise management levels (NMLs) are not mandatory and are only used to inform application of feasible and reasonable measures to reduce noise. In respect of operational noise, the state government's *Voluntary Land Acquisition and Mitigation Policy* (VLAMP, NSW Government 2014) seeks to balance acquisition and mitigation obligations for mining operators that provide appropriate protections for landholders, where impacts are identified. Voluntary land acquisition and mitigation rights in the VLAMP are assigned to privately owned dwellings based on the level of predicted noise above the project noise criteria, or the PSNL. The characterisation of the noise impacts are generally based around the human perception to changes in noise levels. For example, a change in noise level of 1 to 2 dB is typically indiscernible to the human ear. The characterisation of a residual noise impact of 0 to 2 dB above the PSNL is therefore considered negligible as per the VLAMP terms. The VLAMP defines an impact of 3-5 dBA above the PSNL and assuming the development would contribute more than 1 dB to the total industrial noise level to be moderate and warrant mitigation measures in the form of architectural treatment to a dwelling. The VLAMP defines an impact of greater than 5 dB above PSNL to be significant and that warrants mitigation and/or acquisition of the property.

vii Impacts during the construction phase

The WSC submitted that the EIS downplays the noise impact the project will have on many residents particularly during the construction phase.

The NVA (EMM 2017I) presented the predicted noise levels from the proposed construction and operation of the Hume Coal Project. As described earlier, the predictions are based on commercial software applications that adopt accepted algorithms and methods described in EPA policies and guidelines (eg INP and NPfI). EMM's specialists in this field and responsible for this work are highly trained and experienced in modelling and assessment work and are lead by a specialist with over 21 years of experience in this area.

The potential impacts during construction and operational phases of the proposed project are provided in the EIS and discussed in the context of appropriate and relevant government (EPA) policies and guidelines. There will be exceedances of non-mandatory criteria and management levels, and hence appropriate responses for mitigation have been provided consistent with government policies. The exceedances likely during construction whilst not insignificant are typical for large scale construction work and therefore not unexpected. Hence, feasible and reasonable mitigation and management measures will be adopted to minimise impacts as described in the NVA and will be detailed further in the construction noise and vibration management plan.

14.4.2 Operational impacts

i.	Level of impact - a number of community and special interest groups raised concerns and objections over potential negative impacts of noise (including exceedances of the PSNLs) to local residents, visitors, local businesses, the wildlife and the environment. Concerns raised included; 24 hour operations, potential negative impacts on tourists and their experience of the area subsequently impacting on the region's image; impacts on residents and the general amenity of the area which is currently 'peaceful and quiet', and potential impacts on local businesses such as tourism and agriculture.
ii.	Assessment locations - some individual property owners raised specific concerns about noise impacts on their property not being assessed, or not being adequately mitigated where exceedances are predicted.
iii.	Impacts of specific activities - many community submissions raised concerns about the noise impacts of specific activities and pieces of equipment including conveyor belts, bucket wheel loader, stockpile machines, loading of trains, bulldozers and trucks during the operations period, cranes, light vehicles coming to and from the site, crushing of the limestone and other rock from offsite.
iv.	Neighbouring villages - Concerns were raised over the potential noise impacts on the villages of Berrima, New Berrima, Medway, Moss Vale and surrounding villages. Respondents raised concerns that matters such as the impact of the prevailing winds, the proximity of the stockpiles and 24 hour operations to Berrima, New Berrima and Medway, were not considered in the EIS. Other site specific concerns included Medway Road and Oldbury Farm.
v.	Equestrian training centre - One submission raised concern over the potential impact of noise on the equestrian activities and events held in proximity to the project site, which is also a training centre for Australia's Olympic Equestrian Team.

i Level of impact

The Hume Coal Project and the Berrima Rail Project were assessed for potential noise impacts. The Hume Coal Project NVA followed strict guidelines, policies and standards as outlined in the response in Section 14.1 to demonstrate that the Hume Coal Project can be managed to achieve relevant government expectations as described in EPA policy. This includes satisfying noise criteria that maintain a level of amenity consistent with EPA policy.

The assessment considered all potential sources of noise, duration and time of use during operations of the mine and rail. The noise modelling adopted various operating and meteorological scenarios that may result in different levels of noise for locations surrounding the project boundary. As described in the NVA report for the Hume Coal Project in Section 2.2, assessment locations were initially identified using land ownership registrations, aerial photography and verification in the field where locations were visible from public roads. The assessment locations identified are considered representative of all residential locations and catchments surrounding the site. Within the identified predicted zone of impacts it is unlikely that a residence has been missed, but nonetheless a noise result can be inferred from a near neighbour if this has occurred. Hence, the benefit of any mitigation applied to achieve criteria at a near neighbour would also be afforded to all surrounding properties.

The results of the modelling showed that with the mitigation measures in place, the general amenity of the area will remain the same or otherwise satisfy EPA recommended amenity criteria, with only a few properties to the north of the project boundary predicted to be impacted to a level where they will be entitled to voluntary mitigation or acquisition. Further discussion on impacts potential impacts to tourism is provided in Chapter 23.

ii Assessment locations

Some individual property owners raised specific concerns about noise impacts on their property not being assessed, or not being adequately mitigated where exceedances are predicted.

Noise will generally dissipate the further it travels from the source. Therefore the NVA first identified those residences that surround the project boundary. Their exact locations are shown in Figure 14.1 (and in Figure 2.1 in the NVA).

The results show that noise levels above criteria are predicted for some of the properties immediately adjacent to the northern boundary and these will be entitled to voluntary mitigation measures or voluntary acquisition depending on the level of exceedance.

However, it is important to note that during operations noise levels will continue to be monitored, and if noise levels exceed the noise limits specified in the development consent at other properties, they will also be entitled to the appropriate mitigation or acquisition measures.

iii Noise impacts from specific activities

The plant, equipment and activities mentioned in the submissions have all been adequately included in the noise modelling and assessment of noise during operations to demonstrate concurrence with government criteria. The plant and equipment modelled is listed in Table 4.2 from NVA report, and reproduced below.

Table 14.3 Indicative operations equipment quantities and sound power levels

Item and location	Mitigated sound power level (Lw), dB LAeq(15-min)	Quantity			Adopted noise mitigation/management
		Day	Evening	Night	
Mining infrastructure area					
Ventilation fan	93 (total)	2	2	2	Fan attenuation
Compressors	77	5	5	5	Enclosed
Sewage treatment (pumps)	85	1	1	1	Enclosed
Fuel pump	89	1	1	1	
Workshop activity (eg hand and power tools)	103	1	1	1	Limited activities in the evening and night period
Vehicle wash-down / service area (pump/gerni)	90	1	1	1	
Load-haul-dump (LHD) truck	85	1	1	1	
Personnel transport	85	4	4	4	

Table 14.3 Indicative operations equipment quantities and sound power levels

Item and location	Mitigated sound power level (L _w), dB L _{Aeq} (15-min)	Quantity			Adopted noise mitigation/management
		Day	Evening	Night	
Tele handler	95	1	0	0	
Coal handling and preparation plant area					
D9 dozer	115	1	0	0	Noise attenuated
Loader	105	1	1	1	3.5m bund around rejects load hopper
Overland conveyor (per lineal meter)	65 (east side) 75 (west side)	1780m	1780m	1780m	Machined steel idlers and enclosed (roof and east side)
ROM stockpile (radial stacker/reclaimer)	104	1	1	1	Drives enclosed
Crushing station	106	1	1	1	Sheet metal enclosure
Tertiary screens	105	1	1	1	Sheet metal enclosure
CPP	94	1	1	1	Fully enclosed in metal clad building, variable voltage, variable frequency (VVVF) drives, concrete platforms for screens, increased steel work to stiffen structure
Product stacker	104	2	2	2	Drives enclosed
Product reclaimer	104	1	1	1	Drives enclosed
Rejects stacker	104	1	1	1	Drives enclosed
Reject plant (paste plant)	102	1	1	1	Fully enclosed in metal clad building
Product stockpile conveyors	75/m	770 m	770 m	770 m	Machined steel idlers
Enclosed conveyors	65/m	890 m	890 m	890 m	Machined steel idlers and full enclosure
All other conveyors	75/m	1000m	1000 m	1000m	Machined steel idlers
Conveyor drive small (<500 kW)	90	9	9	9	Sheet metal enclosure
Conveyor drive large (>500 kW)	100	7	7	7	Sheet metal enclosure
Water treatment plant	85	1	1	1	Sheet metal enclosure
Train load out					
Bin, feeder and train load out	103	1	1	1	Enclosed
Train load out conveyor (per lineal meter)	65	650 m	650 m	650 m	Machined steel idlers and full enclosure
Locomotives (idle to slow moving < 10km/h)	101	4	4	4	Latest generation locomotives

iv Neighbouring villages

The NVA included the prevailing winds, stockpiles and nature of operations and modelled them to show any impacts. The results show that with mitigation measures in place the townships of Medway, Berrima, Sutton Forest, Moss Vale, Bowral and Mittagong will not be impacted by noise from the project as defined by the NSW EPA noise policy.

The results show that noise will only impact some of the properties immediately adjacent to the northern boundary on Medway Rd and these will be entitled to voluntary mitigation measures or voluntary acquisition depending on the level of impact.

The property of Oldbury Farm will not be impacted by noise from the operations of the project as defined by the NSW EPA noise policy and based on predicted noise levels shown in Table 5.1 of the EIS NVA report for locations 58 and 59.

v Equestrian training centre

In relation to the submission concerning potential impacts on equestrian events and activities, it has been assessed that the location will be unaffected by noise. Further discussion on the co-existence of coal mining and other industries is provided in Chapter 20 (Economics) and Chapter 23 (Tourism).

14.4.3 Sleep disturbance and health

i Sleep disturbance

As per the Berrima Rail Project, the EPA recommends that possible sleep disturbance impacts from rail movements associated with the Hume Coal Project are assessed in more detail using the application notes in the INP. In particular, the EPA noted that the Hume Coal assessment concluded the predicted noise levels from the rail movements would exceed the sleep disturbance screening criteria (up to LA_{max} 53dB). It also concluded that up to two rail movements would occur in one night and that therefore a maximum noise event would only occur up to two times per night. The EPA notes that this is correct where a train's pass by is the event for which a maximum (LA_{max}) noise level occurs. However, for sources of noise such as wheel squeal, each wagon pass by can generate wheel squeal and therefore a high noise level. Consequently, there could be a maximum noise event associated with each locomotive or wagon pass by, and there could be up to about 40 maximum noise events per train movement in this case.

Potential impacts on sleep disturbance were also raised in many community submissions. Concerns related to noise waking up residents, blasting and subterranean noise impacts, and low frequency noise (LFN) keeping the community awake at night.

Response to EPA queries

The INP Application Notes (<http://www.epa.nsw.gov.au/noise/applicnotesindustnoise.htm>) state that where sleep disturbance screening criteria are exceeded, then additional analysis should be undertaken. This should consider factors such as:

- the extent to which the maximum noise level exceeds the background level;
- how often the events would occur;
- the time the events would occur (between the hours of 10pm to 7am); and
- whether there are times of the day when there is a clear change in the noise environment (such as during the early morning shoulder period).

The INP Application Notes also refer to the NSW Department of Climate Change and Water 2011, Road Noise Policy (RNP) for some guidance on sleep disturbance.

It is acknowledged that there are many factors that contribute to sleep disturbance. EMM does not claim that sleep disturbance will be avoided completely with internal maximum noise levels of less than 50 to 55 dB. Given the reference in the INP Application Notes to the RNP, the research summarised in the RNP is an appropriate reference to adopt for further analysis where INP sleep disturbance screening criteria are exceeded.

There will be a maximum of two trains and therefore up to four train movements per night. However, by virtue of the rail loop configuration, the predicted maximum noise levels at assessment locations 15, 16 and 17 from a rail pass by

event at approximately 20 km/h would occur once per train trip as the train enters the rail loop, noting the train travels on the loop in an anti-clockwise direction. Upon turning to negotiate the second half of the rail loop, the train is more removed from residences and will be travelling at a crawl speed less than 10 km/h, and will not register a L_{Amax} 'event' of the same magnitude to the sleep disturbance level when observed at residences.

Predicted internal maximum noise levels with windows open for the three assessment locations which exceed the INP sleep disturbance screening criteria are 36 dB, 38 to 41 dB and 42 to 43 dB (for locations 15, 16 and 17 respectively). The maximum noise level events are predicted to occur up to two times per night. With windows closed, these predicted internal maximum noise levels reduce to 26 dB, 28 to 31 dB and 32 to 33 dB (for locations 15, 16 and 17 respectively). A 'windows closed' scenario is very likely for assessment locations 15 and 16 given the mitigation rights afforded to these properties as a consequence of predicted average noise levels from proposed operations presented in the noise assessment.

Applying the conclusions on sleep disturbance in the NSW RNP, based on the frequency and level of predicted maximum noise, it is reasonable to conclude that these events are "unlikely to awaken people from sleep" for windows open and closed scenarios. Further, that these events are "not likely to affect the health and wellbeing significantly".

In addition to the above, given the release of the NPfI on 27 October 2017, replacing the INP, the current EPA sleep disturbance criteria therein are an $L_{Aeq,15minute}$ 40dB (or background plus 5dB, whichever is the greater) and L_{Amax} 52 dB (or background plus 15 dB, whichever is the greater) free field noise level. The revised NPfI approach has been adopted to align with international guidance on sleep disturbance provided by the World Health Organisation (WHO). All assessment locations not predicted to exceed acquisition criteria (as per the VLAMP) are predicted to satisfy the NPfI (and WHO) sleep disturbance criteria during calm conditions. During adverse weather, only location 17 is predicted to marginally exceed (by 1dB) the L_{Amax} criterion value of 52 dB. An exceedance of 1dB is not perceptible to the human ear and is described as negligible in the NPfI Table 4.1 'Significance of residual noise impacts' and in the VLAMP Table 1 'Characterisation of noise impacts and potential treatments'. Detailed design of the proposed rail loop barrier will be influential in the final noise levels at location 17 and could result in adherence to the non-mandatory NPfI sleep disturbance criteria.

Sleep disturbance impacts are therefore not considered a risk of the project.

Rail squeal is not a significant risk given the operational parameters of the rail loop and Hume Coal's commitment to best practice track/rail noise mitigation.

Basutu et al make recommendations that are based on a series of measurements of different train types conducted on a network rail line. Importantly, the paper acknowledges that train speed affects the level of curve gain. In its concluding statement, a recommendation to expand the current study to include measurements of train speed and rail roughness is provided.

Rail wheel squeal – some cause and a case study of freight-car wheel squeal reduction (Tickell et al) also acknowledges that train speed effects the level of wheel squeal. This paper reviews a case study, whereby a reduction in wheel squeal was achieved through reducing the train speed from 40 km/h to 20 km/h.

Based on these technical papers, EMM's view is, that the curve gain corrections recommended in Basutu et al do not directly apply to the rail loop given that:

- the train speed on the curved section of the rail track will be less than 10km/h;
- it is a private rail line, whereby Hume Coal can manage the train speed without impacting other users; and
- Hume Coal is committed to best practice rail/track noise mitigation including grinding, lubrication, and top-of-rail friction modifiers. Curve Squeal: Causes, Treatments and Results (Hanson et al) suggest that rail wheel squeal can be reduced significantly with track lubrication and top-of-rail friction modifiers. Measurements of track lubrication specifically demonstrated a greater than 90% reduction in wheel squeal. More recent discoveries have found that the ability for three piece bogies (or wagons) to negotiate tight curves have been a key factor to wheel squeal due to poor rotation of the centre plate and high levels of bogie (or wagon) warp. The paper by Hanson et al goes on to state that this can be mitigated by using cross bracing or steering arms to reduce the warping affect.

In summary, if wheel squeal is still found to be an issue at the slow train speeds proposed, there are a number of measures that Hume Coal are able to implement to minimise wheel squeal as far as practicable or even eliminate all together on the rail loop.

Response to community queries

Potential impacts on sleep disturbance were also raised in many community submissions. Concerns related to noise waking up residents, blasting and subterranean noise impacts, and low frequency noise keeping the community awake at night.

The issue raised regarding blasting and subterranean noise is addressed in the Section 14.4.4 of this document.

LFN has been assessed in accordance with EPA guidelines for both day and night and it can be concluded that potential increased impacts due to potential LFN are contained to properties identified as those already entitled to voluntary acquisition or mitigation due to operational noise. Hume Coal is committed to quantifying LFN during mine operations through regular compliance noise monitoring. If potential LFN impacts are identified by Hume Coal in accordance with the guidelines/ policy entitlements commensurate with the level of impacts would be offered.

ii Health

A number of community submissions raised concerns about potential health impacts related to noise impact including LFN, submitting it could potentially trigger frustration and anxiety.

The levels of LFN predicted from the project are shown to satisfy NPfI at all locations not identified for mitigation or acquisition.

LFN has been assessed in accordance with EPA guidelines for both day and night and it can be concluded that potential increased impacts due to potential LFN are contained to properties identified as those already entitled to voluntary acquisition or mitigation due to operational noise.

Hume Coal is committed to quantifying LFN during mine operations through regular compliance noise monitoring. If potential LFN impacts are identified by Hume Coal in accordance with the guidelines/ policy, entitlements commensurate with the level of impacts would be offered.

Section 5.4 of the Hume Coal Project NVA report (EMM 2017I) covers LFN in accordance with current government policy, being the recently released NPfI (EPA 2017). This policy provides the latest approach which the government endorses for assessment of LFN.

14.4.4 Blasting and vibration

- | | |
|------|---|
| i. | The Southern Highland Greens stated that one of the notable buildings missing from some assessments was Oldbury Farm, stating that in relation to noise this assumes subterranean noise will not be transmitted other than directly vertical, which it was claimed is a nonsense assumption. |
| ii. | Community respondents raised concerns over vibration and underground traffic, which it was claimed could cause damage to buildings, with buildings expected to 'shake and crack' as a result of underground traffic. Further details regarding vibration effects, related to both construction and operation phases of the project, were requested. |
| iii. | A number of community submissions also raised concerns about the stud farms that could be adversely affected by blasting from the project. |

i Transmission of noise vertically

As shown on Figure 25.1 of this report, Oldbury Farm is outside of the project area. Noise from underground operations does not travel vertically such that it can be heard at the surface via air borne transmission in the way it does with noise sources (plant and equipment) at the surface. What can occur is what is known as ground borne noise which comes from the transfer of ground vibration into audible noise induced by underground workings. Such vibration induces movement in structures, elements of structures or objects within a building (eg dwelling) which converts that vibration energy into audible noise.

The potential effects of vibration during mine operation were considered as part of the noise and vibration assessment for the Hume Coal Project (EMM 2017). This addressed the anticipated most significant source of vibration being from a tunnel boring machine during operations and typical construction plant/equipment.

Human response criteria are not expected to be breached at the distances expected between plant and residences (eg 300 m for construction activities and 110 m or greater during tunnel boring). Published literature and data support this position as shown in Section 5.8 of the Hume Coal Project NVA report.

Extremely small scale underground shot firing may be required for the underground drifts and ventilation shaft construction. Blasting related vibration (only applicable during construction) was addressed in Section 5.9 of the NVA report. It was shown that blast overpressure noise and ground vibration would satisfy appropriate criteria based on the small scale charge masses expected to be used.

ii Vibration

The notion that buildings will shake as a result of underground traffic assumes that vibration from mining operations underground will have effects at the surface. As explained in Section 11.3.8 of the Hume Coal Project EIS, relevant vibration damage criteria applicable to Australian conditions are established in BS 7385 Part 2-1993 *'Evaluation and measurement for vibration in buildings Part 2'*. Based on this guideline, a criterion of 7.5 mm/s was identified as a conservative criterion against which to assess the potential for vibration related affects from the project on residential buildings.

The proposed mine workings will typically be around 130 m (ranging from 70 m to 170 m) below the surface. Based on established published data cited in the noise assessment (refer to Section 5.8, Appendix I of the EIS), the peak particle velocity (PPV) vibration levels are significantly less than 0.1 mm/s for a tunnel boring machine operation at a distance of 100 m. This provides a reasonably close approximation of the type of vibration levels that could be expected from the type of mining equipment that will be used by the project. Therefore, based on the structural vibration screening criteria of 7.5 mm/s, vibration levels from proposed mining are expected to satisfy the strict guidelines relating to structures on any surface features.

As explained in (i), vibration from construction blasting is predicted to satisfy criteria for the management of vibration.

iii Equestrian facilities

Literature on impacts from small scale underground blasting on stud farms is relatively scarce or non-existent. However, it follows that by satisfying annoyance based criteria for humans, impacts on fauna should also be within appropriate values. The distances between proposed blast locations and known horse stud or equestrian properties are at least 700 m apart (ie the closest is the ROM portal to Candy Lodge on Coney Hatch Lane). At this distance, induced ground vibration from proposed blasting (based on a likely maximum instantaneous charge (MIC) of 8 kg for tunnel portal construction) would be close to perceptible thresholds for humans. At such levels (eg <0.2mm/s peak particle velocity), impacts on horses are therefore considered unlikely.

The other aspect to blasting is overpressure noise, which is airborne. This is not relevant to underground blasts, particularly given the relative magnitude of the blast MIC (ie 8kg). Given the distance between the blast location and the point the pressure wave releases to the surface, the overpressure noise magnitude will be much diminished. At the closest horse facility approximately 700 m from the closest proposed blast locations, a blast overpressure of 103 dB is predicted for an 8 kg MIC. This is well below the adopted 115 dB criterion for human annoyance and similarly is expected to be appropriate for fauna.

14.5 Management and monitoring – Berrima Rail Project

The EPA recommends that Hume Coal consider further mitigation measures to manage curve noise, bunching noise and rail noise more generally on the proposed rail link and loading loop. Measures suggested include: minimising the number of curves and maximising curve radius in the rail link; using best practice rolling stock including locomotives with the lowest practicable noise levels and steering, permanently-coupled multipack wagons; maintenance of the rail link and loading loop, including gauge face lubrication and top of rail friction modifiers; and technologies and practices that minimise unnecessary horn use and locomotive idling.

The following commitments and additional commentary is provided in Table 14.4 to address feasible and reasonable noise mitigation and management for rail operations.

Table 14.4 Noise mitigation measures – Berrima Rail Project

Commitment	Additional comments
Procurement of latest generation low noise emission AC locomotives with electronically controlled pneumatic brakes	Latest generation AC locomotives that will be procured by Hume Coal will be fitted as standard with electronically controlled pneumatic brakes. The brakes synchronously apply brake force to each wagon. This limits the potential for the brake force to be varied between wagons and therefore decelerating at different rates, limiting the bunching affect. Conversely this also applies to when trains accelerate where stretching of wagons is minimised.
Constructing a rail noise barrier to the north of the rail loop to attenuate noise levels from loading and rail loop activity	A 4m high noise barrier will be constructed at the rail loop. This was explained in Section 2.3.5 and shown in Figure 2.4 of the Berrima Rail Project EIS, noting again that the rail loop falls within the Berrima Rail Project scope; however, it was assessed in accordance with the INP along with the Hume Coal Project.
Gauge face lubrication and top of rail friction modifiers	Hume Coal is committed to implementing additional noise mitigation such as track lubrication, top-of-rail friction modifiers, if residual wheel squeal is experienced (considered unlikely at the proposed speeds). Hume Coal will adopt the use of automatic rail lubrication equipment in accordance with ASA Standard T HR TR 00111 ST Rail Lubrication and top of rail friction modifiers, where required. Implement measures to ensure the rail cross sectional profile is maintained in accordance with ETN-01-02 Rail Grinding Manual for Plain Track to ensure the correct wheel / rail contact position and hence to encourage proper rolling stock steering.
Unnecessary horn use and locomotive idle locations	A train driver policy will be developed to address and minimise horn use and locations where locomotives cannot idle, whenever possible.

Specific conditions of consent are proposed by Hume Coal, similar to those adopted on other major projects with rail operations, in relation to the management of rail squeal. These include:

- Locomotives that incorporate available best practice noise emission technologies. Prior to construction of the rail spur, Hume Coal will submit a report to the Secretary of DPE for consideration and approval that has been prepared in consultation with TfNSW and the NSW EPA that justifies the technology proposed and how it meets the objectives of best practice noise and emission technologies.
- Wagons that incorporate available best practice noise technologies including as a minimum, permanently coupled 'multi-pack' steering wagons using Electronically Controlled Pneumatic (ECP) braking with a wire based distributed power system (or better practice technology). Prior to the commencement of operations, Hume Coal will submit a report to the Secretary for consideration and approval that has been prepared in consultation with TfNSW and the EPA that justifies the technology proposed and how it meets the objectives of best practice noise technologies.
- Implementing additional noise mitigation such as track lubrication and top-of-rail friction modifiers, if residual wheel squeal is experienced. This will adopt the use of automatic rail lubrication equipment in accordance with ASA Standard T HR TR 00111 ST Rail Lubrication and top of rail friction modifiers, where required.
- Implement measures to ensure the rail cross sectional profile is maintained in accordance with ETN-01-02 Rail Grinding Manual for Plain Track to ensure the correct wheel / rail contact position and hence to encourage proper rolling stock steering.
- Hume Coal will install and maintain a rail noise monitoring system on the rail spur and loop at the commencement of operation to continuously monitor the noise from rail operations. The system will capture the noise from each individual train passby noise generation event, and include information to identify:
 - time and date of coal train passbys;
 - imagery or video to enable identification of the rolling stock during day and night;
 - $L_{Aeq,15hour}$ and $L_{Aeq,9hour}$ from rail operations; and
 - L_{AFmax} and SEL of individual train passbys, measured in accordance with ISO3095; or
 - other alternative information as agreed with, or required by, the Secretary.

The results from the noise monitoring system will be publicly accessible via a website maintained by Hume Coal. The noise results from each train will be available on the website within 24 hours of it passing the monitor, unless unforeseen circumstances (ie a system malfunction) have occurred. The $L_{Aeq, 15hour}$ and $L_{Aeq, 9hour}$ from each day will be available on the website within 24 hours of the period ending.

Prior to the commencement of operation, Hume Coal will also submit for the approval of the Secretary, justification supporting the appropriateness of the location for rail noise monitoring, including details of any alternate options considered and reasons for these being used. The rail noise monitoring system will not operate until the Secretary has approved the proposed monitoring location(s).

Hume Coal will provide an annual report to the Secretary with the results of the monitoring for a period of five years, or as otherwise agreed, from the commencement of operation.

More broadly with respect to rail alignment and the radii of track curves, the design cannot be materially changed due to land ownership, topographical and infrastructure constraints (e.g. the Berrima Road Deviation proposed by Wingecarribee Shire Council and the Berrima Cement Works). The designs have tried to achieve the largest curve radii possible within the identified constraints. The track section with the smallest curve radii (i.e. the new rail entry to the Cement Works) looks unlikely due to the local Council's plans to proceed with the Berrima Road Deviation.

14.6 Management and monitoring - Hume Coal Project

1. Monitoring and mitigation measures - a number of community and special interest group submissions requested more detail on the monitoring and mitigation measures proposed during construction and operation, submitting that the noise monitoring network should be confirmed prior to approval.
2. Claims were made that the noise and vibration assessment does not include discussion or explanation to support the conclusion that noise mitigation measures will satisfy the evening and night noise management levels.
3. Macquarie University also submitted that project approval should be delayed until all residences entitled to voluntary noise mitigation upon request (under the VLAMP) are resolved satisfactorily.

14.6.1 Monitoring and mitigation measures

Normal practice is for the regulatory body to apply specific conditions of approval in any development consent at the time of approval and not during the submission of the EIS. This often requires the development of a construction noise and vibration management plan and an operational noise and vibration management plan that details all mitigation, management and monitoring requirements. Such plans will be approved by the regulator (the DPE in this case) and include input through consultation with the NSW EPA and other relevant stakeholders.

14.6.2 Evening and night compliance

The EIS NVA report identified exceedances of derived evening and night time NMLs for limited works and activities that are unavoidable during these out-of-hours periods. Measures to mitigate such exceedances have been defined broadly in the EIS and will be refined and detailed in the overall construction noise and vibration management plan (CNVMP), which will be part of the broader construction environmental management plan (CEMP) for approval by the DPE. Achievement of NMLs at all locations and at all times would be the objective of the CNVMP, particularly during the more sensitive evening and night periods. However, this may not be achievable at some locations for limited activities and alternate measures will be considered where NMLs cannot be feasibly and reasonably achieved.

14.6.3 VLAMP and timing of project determination

The development consent would also normally require that mitigation upon request be a condition of approval. Many examples and precedents are available on the DPE's online major projects database which can be viewed by the public. It is also often common practice that proponent's negotiate with property owners identified as entitled to mitigation or acquisition in accordance with the VLAMP. This process has commenced in the case of the Hume Coal Project. Further, it would be inappropriate to finalise these negotiations with potentially affected residences prior to receiving project approval. If the project is approved, the development consent will outline conditions relating to his process, which will need to be met by Hume Coal.

15 Air quality

This section responds to submissions that raised matters relating to potential air quality impacts of the Hume Coal Project and Berrima Rail Project. Responses have been provided by Ramboll Environ, who prepared the technical assessment for both projects.

15.1 Adequacy of modelling approach

The EPA noted in their submission they did not identify any issues with the modelling undertaken in the air quality assessment that have the potential to alter the overall conclusions and outcomes of the assessment. Notwithstanding, they raised a few matters to be addressed, which are responded to in this section and in Section 15.2.

15.1.1 Hume Coal Project

The EPA noted that the annual average dust deposition was taken as the annual average for all dust monitors for the years 2012-2015, stating that adopting an ambient annual average which has been averaged over several years is not in accordance with the Approved Methods for Modelling and Assessment of Air Pollutants. Notwithstanding, the EPA acknowledges that taking 2013 annual average data predicts compliance for all pollutants.

The EPA comment regarding use of the "all data" average as background is noted; however it is also noted that the *Approved Methods for Modelling and Assessment of Air Pollutants* (Approved Methods) (EPA 2016) do not explicitly state that the use of multi-year averages for background is not approved. Nevertheless, if the maximum recorded dust deposition level for 2013 (1.8g/m²/month) was adopted, cumulative levels at all receptors would be lower than 2.0 g/m²/month for both construction and operations scenarios, which is well below the cumulative impact assessment criterion of 4.0 g/m²/month. Therefore, the conclusion relating to predicted compliance with cumulative dust deposition criteria at all receptors during both construction and operational phases of the Hume Coal Project remains unchanged.

A number of business groups, community and special interest group submissions raised questions about the adequacy of the air quality assessment approach. The key issues raised were:

- i. Adequacy of the assessment - a number of submissions raised concerns regarding the overall adequacy and accuracy of the air quality assessment, questioning the claim that the assessment is conservative, and requesting additional data validating the accuracy of the dispersion model predictions.
- ii. Background air quality data - the selection and suitability of the ambient air quality data used in the assessment was questioned and further justification requested. One respondent submitted that the use of 5-year average data is not considered to be appropriate, suggesting that the report should adopt local 2013 background data primarily, and discuss the sensitivity of the cumulative predictions to annual variability. The use of PM₁₀ monitoring data at Bargo, Camden and Monash was also questioned given the availability of local data sources. The Southern Highland Greens also questioned the use of dust monitors at the Boral Cement Works, stating that they only measure PM₁₀ and not PM_{2.5}.
- iii. Construction phase assessment – questions were raised as to why a qualitative rather than a quantitative assessment of construction impacts was undertaken. Concerns were raised that the assessment presents incremental impacts only.
- iv. Cumulative impacts: it was submitted that cumulative impacts at receptor locations have not been presented, with one respondent noting that it is a requirement of the Approved Methods that an Air Quality Impact Assessment (AQIA) presents predicted cumulative impacts at all receptors in a tabulated form (increment, background, cumulative). It was submitted that as this has not been provided, where an exceedance is predicted the source of the exceedance (ie background fluctuations or the project) cannot be determined.

i Adequacy of assessment

The scope and methodology of the air quality impact assessment was in accordance with the SEARs and the Approved Methods (EPA 2016). This included quantitatively modelling and assessing the project's predicted particulate matter and combustion emissions from a range of scenarios (construction and operations). Conservative assumptions were used to provide upper bound estimates of the project's impacts. Further, the region's air quality is well characterised from a network of monitoring stations operated by Hume Coal and independent bodies (such as NSW OEH).

In its submission the EPA stated that the air quality modelling was conducted generally in accordance with the approved methods and had no requirement to alter the scope or methodology. As such no further action is required.

ii Background air quality data

Background air quality was quantified through the combination of local air quality monitoring data, regional air quality monitoring data (presented in Section 5 of the air quality impact assessment report (Ramboll Environ 2017a) and modelling of local emissions sources (presented in Section 6 of the air quality impact assessment report).

Data recorded during the 2013 calendar year, concurrent with the input meteorological datasets, was the primary focus of the baseline quantification. It is acknowledged that a multi-year average was used for background for annual average total suspended particulates (TSP), PM₁₀, PM_{2.5} and dust deposition in the assessment of cumulative impacts. The difference between the five year average and 2013 average value for each pollutant was investigated and is presented below:

- TSP (Boral HVAS) – multi-year average = 37.6 µg/m³ and 2013 average = 45.2 µg/m³;
- PM₁₀ (Hume TEOM1) – multi-year average = 13.5 µg/m³ and 2013 average = 15.1 µg/m³; and
- PM_{2.5} (derived Hume TEOM) – multi-year average = 6.3 µg/m³ and 2013 average = 6.5 µg/m³.

The use of either the multi-year average or 2013 average concentration as background for each pollutant would not change the conclusion that all cumulative concentrations are below applicable air quality impact assessment criteria at all receptors.

PM₁₀ and PM_{2.5} data was sourced from regional NSW Government and ACT Government monitoring stations to supplement the local area monitoring data. Local monitoring data was the primary resource for quantifying ambient background concentrations. While it is acknowledged that the Boral Cement Works does not currently monitor ambient PM_{2.5} concentrations, the use of ambient TSP and PM₁₀ monitoring results obtained from Boral are of high value to the quantification of local air quality levels. Ambient PM_{2.5} concentrations were sourced from other reliable monitoring locations (Hume onsite data and regional NSW and ACT Government stations). Boral have advised they will be installing monitoring equipment for PM_{2.5} soon in response to a recent modification (Mod 9) to their development consent.

It is noted that the approach to cumulative background quantification (modelling of local sources combined with ambient monitoring datasets) was discussed with the NSW EPA air quality technical policy department prior to the commencement of the air quality impact assessment.

iii Construction phase assessment

Construction emissions were quantified and modelled for the Hume Coal Project, and are presented in Section 7 (emissions inventory) and Section 9 of the air quality impact assessment (Ramboll Environ 2017a). Predicted concentrations, including cumulative concentrations, are presented in Section 9. All predicted concentrations from the construction phase satisfy all applicable air quality impact assessment criteria at all surrounding receptors.

iv Cumulative impacts

Maximum cumulative annual average concentrations across all receptors and scenarios are presented in Section 9.1.4 of the Hume Coal Project air quality impact assessment report (Ramboll Environ 2017a). Maximum cumulative annual average concentrations are below applicable air quality impact assessment criteria at all locations.

For the assessment of cumulative 24-hour average concentrations, a statistical approach was adopted. The ten-highest impacted receptors were selected for detailed cumulative analysis on the basis that if cumulative compliance was predicted at this subset of receptors, cumulative compliance would also be achieved at all receptors, with a lesser impact predicted. This approach brings together all available measured concentrations to provide a detailed analysis of the likelihood of additional exceedance days, accounting for existing exceedances due to bushfires and dust storms. While this approach is not documented in the Approved Methods (EPA 2016); the approach is routinely implemented for air quality impact assessments in NSW and is accepted by the NSW EPA as a robust alternative to assessing cumulative impacts where large amounts of background data are available. As stated above, the air quality impact assessment has been reviewed for technical adequacy by the NSW EPA, with no issues raised relating to the methodology or modelling undertaken that would have the potential to alter the overall conclusions and outcomes of the assessment.

15.1.2 Berrima Rail Project

A number of community submissions questioned the adequacy of the air quality assessment for the Berrima Rail Project, and questioned the conservative nature of the assessment.

One in particular questioned the assessment of NO_x emissions from the Berrima Rail Project. The submission asked why the Tier 1+ standards for NO_x modelling were applied, why predicted maximum concentration of NO₂ (68.8 ug/m³) is below the background level of concentration (Bargo's 1 hr average of 94ug/m³), and raised concerns about the ozone limiting methodology used in the modelling stating that this is not the most conservative approach. The submission also asked about the effect of using unrestricted emission factors for locomotives on the predicted NO₂ concentrations. It was also submitted that the EIS downplays the already high NO₂ emissions in the area. The use of the data from the Bargo air quality monitoring station was also questioned.

Finally, the respondent asked why the following statement is conservative as opposed to necessary: "1-hour average concentrations were predicted based on the peak hourly rail movements occurring continuously throughout the 12 month dispersion modelling period." The 1 hour average concentration would not be affected if assumed to have continuously occurred during the 12 month period. However this value could be affected if the other emission sources, background and peak rail movements coincided within the same 1 hour period, which is the purpose of the modelling.

The NSW EPA did not identify any issues with the modelling undertaken in the air quality assessment for the Berrima Rail Project that have the potential to alter the overall conclusions and outcomes of the assessment. As was the case for the Hume Coal Project air quality impact assessment, the Berrima Rail Project air quality impact assessment was conducted in accordance with the Approved Methods (EPA 2016).

If the project is approved, Hume Coal will procure a dedicated fleet of locomotives for the transportation of product coal to market. The locomotives to be procured by Hume Coal would be compliant with Tier 0 at a minimum.

The quoted predicted maximum NO₂ concentration of 68.8ug/m³ relates to existing Berrima Branch rail line emissions only. It is not a cumulative concentration incorporating the ambient background data from Bargo.

The use of the ozone limiting methodology (OLM) for the air quality impact assessment is the second most conservative NO₂ conversion methodology prescribed within the Approved Methods. The most conservative approach assumes 100% of predicted NO_x converts directly to NO₂; however this approach returned cumulative exceedances when implemented. As per the guidance of the NSW EPA, if the 100% NO_x method returns exceedances, the OLM approach is the next most conservative method to implement. Therefore, the OLM approach was implemented for the air quality impact assessment. It is reiterated that the air quality impact assessment was reviewed for technical adequacy by the NSW EPA.

The air quality impact assessment does not downplay NO_x emission sources in the region. It is noted that the neighbouring NO_x emission sources were explicitly modelled (as detailed in Section 6 of the air quality impact assessment report) for pairing with project-related predictions and ambient background concentrations. Ambient concentrations were sourced from the Bargo air quality monitoring station. It is noted that the approach to cumulative background (ie modelling of local sources combined with ambient monitoring datasets) was discussed with the NSW EPA air quality technical policy department prior to the commencement of the air quality impact assessment.

The approach adopted of assuming a peak 1-hour emissions profile continuously throughout the 12-month modelling is conservative, as the approach combines maximum emissions potential with all possible meteorological conditions to predict maximum potential impacts. It is of course necessary to undertake such an approach for any air quality impact assessment; however this does not negate the fact that the approach, and subsequent predicted results, is conservative in nature.

15.2 Meteorological data

The NSW EPA recommended that Hume Coal clarify how the results from the two meteorological data sets (Hume Coal weather station and the Bureau of Meteorology (BOM) operated Moss Vale station) were incorporated into the cumulative 24 average PM₁₀ and PM_{2.5} assessment.

Numerous community and interest group submissions also questioned the meteorological data used, raising concerns about quoted prevailing wind directions and speed, asked why data was only presented for one Hume Coal weather station and for only one year (2013), and submitted that 'official' meteorological data should have been used in the assessment. Concerns were also raised about the use of data from only two weather stations, and the use of 'average' wind speeds.

Some specific questions were asked about the representation of weather data for Berrima. The Berrima Residents Association submitted that the wind speed and directions presented in the EIS are 'unrecognisable' to any Berrima resident, and that for most of the year (September to March) winds blow strongly to the north-east. They also submitted that Hume Coal's southern weather station is remote from the two populations centres (Berrima and New Berrima), which will be most impacted by noise and dust, and therefore the results of the assessment should be discounted. Another submission from the Southern Highlands Greens stated that prevailing winds are from the south and south-west, and that wind measurements were provided only on an average basis and not maximums (for which there would be greater environmental risk).

The way the two meteorological data sets were incorporated is described below.

- The construction and operational models were run twice, applying each dataset and corresponding emissions inventory (i.e. four model runs in total).
- For the cumulative 24-hour average impacts, the maximum predicted concentration on each day between the two model runs was selected to extract a single 365-day model prediction dataset for each of construction and operations.
- The cumulative frequency analysis was conducted for the 365 day model prediction dataset at each of the top ten highest receptors, as documented in Section 9.1.3 of the air quality impact assessment.

Significant meteorological data analysis was completed as part of the Hume Coal Project air quality impact assessment. Multiple years of real-time monitoring data from multiple local area stations was collated in order to obtain a comprehensive understanding of local meteorological conditions. The stations included two Hume Coal meteorological stations, two BOM stations and one weather station owned by Boral, as follows:

- Hume Coal Station number 1, which was installed in 2012 approximately 8.1 km south of the proposed surface infrastructure area location. Placement of this weather station was undertaken prior to the location of the surface infrastructure area being determined and the relevant properties acquired.
- Hume Coal station number 2, which was installed in 2015 in the vicinity of the proposed product coal stockpiling area;
- BOM automatic weather station (AWS) at Moss Vale, approximately 11.5 km east-southeast of the surface infrastructure area;
- BOM long-term climate station at Moss Vale (Hoskins Street), approximately 8.3 km southeast of the surface infrastructure area; and
- Boral-owned meteorological station at the Berrima Cement Works, approximately 4.5 km east-southeast of the surface infrastructure area.

The location of all meteorological monitoring stations is illustrated in Figure 4.2 of the air quality impact assessment report (Ramboll Environ 2017a).

At the time of dispersion modelling, the most complete period of monitoring data from the onsite monitoring station meeting the data capture requirements of the NSW EPA was 2013. Justification for the use of 2013 was provided through comparison of 2013 with wind data recorded between 2010 and 2014, illustrating that 2013 was a representative year for the local area with regards to wind speed and direction.

During the assessment process, a second meteorological station was installed by Hume Coal in the vicinity of the product stockpiles to the north of the Hume Coal Project area. Section 4.1 of the air quality impact assessment illustrates that similar wind profiles were recorded at the two onsite Hume stations, the Boral station and the BOM Moss Vale station for the period between October 2015 and July 2016. While this period was not complete and did not meet the requirements of the NSW EPA for dispersion modelling purposes, the analysis usefully demonstrates the similarity of recorded wind direction across the local area.

The dispersion modelling conducted for the air quality impact assessment incorporated continuous meteorological data from the BOM Moss Vale automatic weather station and onsite Hume Coal meteorological monitoring station. An entire 12 months of hourly observations from each station (24 months of modelling in total) were input into the dispersion model AERMOD in order to predict particulate matter emission dispersion from the proposed Hume Coal Project. This approach is beyond the requirements of the NSW EPA Approved Methods, which only require a single year of modelling from a single representative station to be completed.

The meteorological data used in the air quality impact assessment modelling was recorded in real-time at sub-hourly intervals, returning both average and peak gust conditions for each hour of recorded data. Dispersion models predict concentrations in hourly time steps, with variability in wind incorporated into the input dataset. Further, emission calculations accounted for peak gusts for each hour of the modelling period.

While varying claims of dominant wind directions were made by various submissions, the data analysis conducted for multiple meteorological monitoring resources in the region surrounding the Project area (owned by Hume Coal, Boral and the BOM) all identify that the dominant wind directions experienced throughout a given year are from the west (primarily between autumn and spring), north-easterly (primarily during summer) and to a lesser extent south-easterly (primarily between spring and autumn).

The completed meteorological analysis illustrates that despite the spatial distance between the various analysed stations, the recorded wind direction pattern is comparable between all sites. To account for the variation in recorded wind speeds between the datasets (wind speeds are routinely higher at the BOM Moss Vale site due to a more exposed setting), emission calculations and dispersion modelling was conducted using both the onsite Hume Coal and BOM Moss Vale 2013 datasets.

15.3 Air quality impacts – coal transport by rail

15.3.1 Coal dust emissions

Some community, business and special interest group submissions were raised concerns about the transportation of coal via trains, which they believe will cause dust and air pollution. Concerns were raised that persons and communities residing along the rail line will experience significant increases in impacts from coal dust and diesel emissions. Some questioned whether the train wagons will indeed be covered; some submitting that they doubt this will be the case as it may change once the project is approved.

One of the respondents questioned whether the coal will be watered down before being loaded onto train wagons, and what difference the covered coal wagons will make in terms of air pollution. Another claimed that the majority of the coal dust particulates originate not from uncovered coal wagons, but the coal dust that covers the entire wagon and undersides (via the hoppers underneath) during the loading and unloading process.

Respondents also raised concerns about the coal dust generated by passing trains and their potential hazardous impact on students and staff at Robertson Primary School and Berrima Primary School.

A submission from Macquarie University raised the Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain released in 2015 by the NSW Chief Scientist and Engineer, stating that this review concluded there was insufficient data about the amount and distribution of particulates in rail corridors to assess mitigation effectiveness, and that the composition of the dust, its sources, quantity, concentration, and pattern and distance of dispersal is not well understood. Therefore, the implications to human health from PM derived from rail transported coal cannot be characterised and the risks cannot be quantified.

A number of community submission also raised the Hunter Valley, claiming that the extent of air pollution there due to coal trains is well known.

The findings of the NSW Chief Scientist in the 2016 report *Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain* are acknowledged regarding existing uncertainty and data gaps relating to potential fugitive emissions from rail wagons. However, as per the NSW Chief Scientist report, reviewed reports identify that the loaded and unloaded surface of rail wagons accounts for approximately 80% of fugitive emissions. Therefore, the covering of rail wagons will mitigate the primary source of fugitive rail dust emissions. Hume Coal remain committed to the use of covers on the project coal wagons and anticipate that the requirement to do so will form part of any conditions of development consent for the project.

Modern “bat wing” design coal wagons have long hopper openings and minimal surfaces on which parasitic coal can accumulate, and their use will minimise the occurrence of wagon loading overspill and subsequent parasitic coal loading on wagons leaving the site, as will the use of a modern, automated train loading facility. Further, coal will be sprayed at conveyor transfer points prior to loading to reduce loose dust content.

The NSW Chief Scientist report recommends that control measures currently implemented by the coal industry are continued and encourages the implementation of new mitigation strategies. It is considered that through the implementation of covered rail wagons, a measure never before implemented in the Australian coal mining industry, the Hume Coal Project is indeed adopting the recommendations of the NSW Chief Scientist.

As the Hume Coal rail wagons will be covered, there will be minimal fugitive coal dust emissions released as trains move from the mine site to port. Fugitive coal dust impacts from Hume Coal wagons will therefore be negligible at all locations along the rail corridor, including at the Robertson Primary School and Berrima Primary School. Further, it is noted that the Berrima Primary School is a significant distance (at least 2.7 km) away from the Hume Coal Rail line.

15.3.2 Diesel emissions

A number of concerns were raised in submissions from the community and special interest groups relating to diesel emissions from trains and their effects on health and the environment. Many respondents submitted that diesel emissions in particular are a potential threat to human health, particularly the elderly and children, and some raised concerns over impacts specifically in Berrima, New Berrima, Bowral, Medway, Burradoo and Moss Vale.

Some respondents sought more information in regards to the C44 model of locomotives, including the diesel particulate 'signature' and their level of diesel emissions, loaded and unloaded. One of the respondents noted that the exhaust emissions will increase with the age of the locomotive, and another claimed that diesel locomotives burn poor quality fuel and generate 'huge' emissions. A community submission questioned the decision to use the C44ACi locomotive, claiming that they generate more emissions than older locomotives, the highest exhaust emissions of any available locomotive, and are not the latest generation of rail locomotives as stated in the EIS. This submission cited a study entitled Locomotive emissions project: Potential measures to reduce emissions from new and in-service locomotives in NSW and Australia industry presentation (ENVIRON 2012).

Hume Coal was also asked to explain the effect of using unrestricted emissions factors for the locomotives on the NO₂ concentrations at residences next to the Berrima Branch Line (receptors 26, 27, 28 and 29). A submission noted that the C44ACi locomotive is classified as per Tier 0 and does not comply with the Tier 1 requirement of NO_x emissions between 6.64 and 8.98 g/kW.hr.

Emissions of diesel combustion from mining operations and locomotives were quantified in the air quality impact assessment for the Hume Coal Project and Berrima Rail Project (Ramboll Environ 2017a and 2017b). Regarding diesel locomotives, combustion emissions were modelled for the Berrima Branch Line section of the rail line, as this represents the area with greatest potential for cumulative impacts with emissions from the Hume Coal Project at surrounding receptors. The predicted concentrations for all pollutants were well below applicable air quality impact assessment criteria at all sensitive receptor locations surrounding the Hume Coal Project.

The C44ACi locomotives represent the latest generation of locomotive available in Australia that fit NSW gauge and dynamic envelope requirements. At the time the air quality assessment report was prepared, advice received by Hume Coal was that the C44ACi locomotive would be Tier 1 compliant; however further clarification has identified that the locomotives are in fact Tier 0 compliant as identified in submissions to the EIS.

A 2016 NSW EPA-commissioned study, completed by ABMARC (2016), tested emissions from several locomotive engines currently in operation in NSW, including the C44ACi locomotive. The AMBARC cycle average emission factors for the C44ACi compared with the adopted locomotive emission factors are as follows:

- PM – 0.11 g/kWhr (ABMARC) versus 0.2 g/kWhr (adopted in the air quality impact assessment);
- NO_x – 12.1 g/kWhr (ABMARC) versus 6.7 g/kWhr (adopted in the air quality impact assessment); and
- VOC – 0.46 g/kWhr (ABMARC) as Total Hydrocarbon versus 0.29 g/kWhr (adopted in the air quality impact assessment).

From the above comparison, it can be seen that the locomotive emission factor adopted in the air quality impact assessment for Hume Coal trains for PM is higher than the recorded emission factor for the C44ACi; however is lower for NO_x and VOCs. To understand the implications of this difference in emission factors to the results of the air quality impact assessment, emissions were recalculated for NO_x from Hume Coal Project locomotive movements and resultant NO₂ concentrations predicted.

The increase in locomotive emission factor increases the maximum cumulative (Hume Coal Project + Neighbouring Emissions Sources + Ambient Background) NO₂ concentrations listed in Table 9.4 of the air quality impact assessment (Ramboll Environ 2017b) as follows:

- Maximum cumulative 1-hour average NO₂ concentration: 221.7 µg/m³ vs 201.7 µg/m³ in the air quality impact assessment.
- Maximum cumulative annual average NO₂ concentration: 25.3 µg/m³ vs 23.0 µg/m³ in the air quality impact assessment.

While the revised maximum concentrations predicted across all receptors through applying the higher NO_x emission rate are higher than the results presented in the air quality impact assessment, the concentrations remain below the applicable NSW EPA air quality assessment criteria. Existing sources of NO_x emissions in the surrounding environment remain the dominant contributor to local NO₂ impacts. Consequently, the use of a higher NO_x emission factor for the Hume Coal Project emission factors would not alter the conclusions of the air quality impact assessment. Due to the very low predicted concentrations of individual VOC species, the use of the above higher emission factor for VOCs would not change the conclusions of the air quality impact assessment.

Irrespective of the above, if the project is approved Hume Coal will procure a dedicated fleet of locomotives for the transportation of product coal to market, utilising the latest locomotive available on the market at the time of procurement with the highest emission standards available. Hume Coal will procure locomotives that are compliant with Tier 0 at a minimum, and likely a higher emission standard such as Tier 2 or UIC3A, depending on what is available on the market at the time.

15.3.3 Potential health impacts

An interest group respondent noted that the Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain recommended the need for a pilot study to establish with greater precision the health effects of localised air quality in rail corridors, and its likely impact on people living and working near the corridor. At this stage, the recommended pilot study has not been initiated and the respondent believes it would be highly relevant to the Berrima Rail Project.

The findings of the NSW Chief Scientist in the 2016 report *Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain* are acknowledged regarding existing uncertainty and data gaps relating to potential fugitive emissions from rail wagons. However, as stated above in Section 15.3.1 and as per the NSW Chief Scientist report, reviewed reports identify that the loaded and unloaded surface of rail wagons accounts for approximately 80% of fugitive emissions. Therefore, the covering of rail wagons will mitigate the primary source of fugitive rail dust emissions.

Further, the design of the wagon loading station and wagons will minimise the occurrence of wagon loading overspill and subsequent parasitic coal loading on wagons leaving site for Port Kembla.

15.4 Air quality impacts – construction phase (Hume Coal Project)

Concerns about dust generated during the construction phase were raised in a number of community and special interest group submissions. Submissions noted that vehicle movements on unpaved above ground surface areas during construction are one of the primary dust-generating activities that will occur during the construction of the project. The submission from Macquarie University claimed that the Hume Coal Project will generate higher impacts to air quality relative to the operational phase of the project due to a greater proportion of surface based material handling and truck transportation, and questions the effectiveness of the mitigation measures proposed.

Hume Coal was asked to assess the potential impacts from the construction phase at locations on the Hume Highway. The respondent noted that the short-term dust plumes generated by the project during the construction phase pose a significant and unquantifiable risk to vehicles along the Hume Highway.

The Macquarie University submission also notes that diesel combustion is predicted to account for the vast majority of PM in the PM_{2.5} fraction, noting that Hume Coal intends to mitigate potential underground exposures to diesel emissions by fitting diesel exhaust scrubbers and diesel particulate filters on all underground diesel equipment. The submission claims this measure is not a planned intervention for surface diesel machinery during either the construction or operational phases of the mine.

The impact of diesel trucks and the 'toxic pollution' during construction was also raised.

Maximum particulate matter impacts were predicted to be higher for the construction phase relative to the predicted impacts associated with the operation phase of the Project; however for both construction and operational phases the predicted impacts are well below applicable assessment criteria at all surrounding receptors, as explained in Section 9 of air quality impact assessment (Ramboll Environ 2017a). The reasons that the maximum predicted construction scenario impacts are higher relative to the maximum predicted operational scenario impacts for particulate matter are considered as follows:

- The modelled construction scenario assess a theoretical 24-hour activity footprint that assumes that all areas of construction are active concurrently. This 24-hour activity footprint is then repeated continuously throughout the model period (two separate 12 month periods of meteorological data).
- This conservative activity footprint involves a higher amount of surface-based activities relative to the operational scenario. There is therefore more surface based emission sources spread out across the project area during the construction scenario.

Calculated particulate matter emissions from the construction phase incorporated the application of particulate matter control measures detailed in Section 7.2.1 of the air quality impact assessment (Ramboll Environ, 2017a). Resultant predicted maximum concentrations from the construction phase are well below applicable assessment criterion at all surrounding receptors, indicating that the measures proposed are effective in the management of particulate matter emissions and impacts from the construction phase.

Impacts from the construction phase on the Hume Highway are presented in the air quality impact assessment (Figure 9.1, 9.2, A5-1, A5-2, A5-3, A5-4) as predicted concentration isopleth plots. By reviewing these figures where the predicted isopleth lines intersect the Hume Highway, it can be seen that the predicted concentrations and dust deposition levels are well below applicable assessment criteria for all assessed averaging periods.

Diesel exhaust scrubbers and diesel particulate filters are proposed for underground operations to manage impacts for both occupational health management (in the confined underground operational areas) and ambient air quality (post-release from ventilation outlets); however such measures are not proposed for surface based equipment. The results presented in the air quality impact assessment of diesel-combustion related pollutants (particulate matter, NO_x, and individual VOCs), are well below applicable impact assessment criteria at all sensitive receptor locations. All surface based equipment will be regularly serviced to maintain manufacturer's emission performance specifications.

15.5 Air quality impacts – operational phase (Hume Coal Project)

15.5.1 General air quality impacts

Numerous community submissions, special interest groups and business submissions raised concerns about the impact of dust and general air pollution as result of the project. Concerns were raised regarding potential impacts on residents, visitors, schools and businesses in Berrima, Moss Vale and surrounding villages, and subsequently the impact on amenity, quality of life, wildlife and the environment. Some respondents raised concerns about coal dust settling on roofs, vehicles, solar panels, domestic water tanks supplied by rain water from roofs, especially in the vicinity of Berrima, but also in Medway, New Berrima, Bowral, Burradoo, Moss Vale, Exeter and Sutton Forest (Oldbury Farm). Prevailing winds in the area are seen as the main contributor to the dispersion of coal dust. Some respondents claim that the impact on air quality is understated in the EIS, and that the area is well known for its clean air, equally enjoyed by residents and visitors that enjoy escaping to the area.

Some submissions mentioned concerns about specific operational activities that have the potential to generate dust; the processing and handling of coal using aboveground equipment such as conveyor belts, transfer stations, reclaimers, vehicles, CHPP, and load out facilities; as well as using aboveground stockpiles to store coal and rejects.

Concerns were also raised that dust emissions from the mine could pollute the local dams and water catchment.

Another respondent submitted that coal particulate pollution in Australia is increasing, and that the Hume Coal Project will add to this pollution.

As per Section 7 through to Section 9 of the Hume Coal Project air quality impact assessment, emissions from the construction and operation of the Hume Coal Project were quantified and input into the atmospheric dispersion model AERMOD to predict resultant air quality impacts across the surrounding region. The dispersion modelling was conducted in accordance with the Approved Methods (EPA 2016). The air quality impact assessment has been reviewed and accepted for technical adequacy by the NSW EPA.

As documented in Section 2.3 of the air quality impact assessment report, air quality impacts were predicted for a range of representative receptors surrounding the Project area, along with individual town receptors for Medway, Berrima, New Berrima, Bowral, Burradoo, Sutton Forest and Moss Vale. The results of the dispersion modelling presented in Section 9 of the air quality impact assessment report highlight that impacts from both the construction and operation of the Hume Coal Project would be well below applicable air quality impact assessment criteria at all surrounding receptors. Predicted coal dust deposition levels from the operational coal mine, illustrated in Figure A5.8 and A5.12, are very low beyond the boundary of the Project area and would not adversely impact upon neighbouring residences in the surrounding environment.

An analysis of proposed emission mitigation measures is documented in Section 7.3.3 of the air quality impact assessment report. This analysis, conducted in accordance with guidance from the NSW EPA, compares proposed measures against accepted coal industry best practice dust control measures for each significant emissions source at the Project, including stockpiles, conveyors and transfer points. The review identified that proposed mitigation and management measures for the Hume Coal Project are in accordance with or above accepted industry best practice dust control measures.

Cumulative impacts of the Hume Coal Project with existing ambient air quality levels, accounting for emissions from neighbouring emission sources and regional transportation of emissions, shows compliance with all applicable air quality impact assessment criteria at all surrounding locations.

A discussion on potential impacts on local dams and the water catchment relating to dust is provided in Section 22.7.4.

15.5.2 Odour

Some community members raised concerns about the odour emanating from stockpiles and diesel emissions. One questioned whether residents along Medway Road will be impacted by odour from the mine.

Analysis of emissions of odourous pollutants associated with diesel combustion was undertaken through the modelling of emissions of individual odourous volatile organic compounds ethylbenzene, toluene and xylenes. Predicted concentrations of these pollutants are presented in Section 9.2 of the air quality impact assessment report (Ramboll Environ 2017a). Concentrations of these pollutants are predicted to be significantly below the applicable air quality criteria at all neighbouring receptors, including those along Medway Road, indicating that odour impacts from diesel combustion will be avoided.

Odour from the underground operations of the Hume Coal Project was quantified in the air quality impact assessment (Section 7.5 and Section 9.3 of Ramboll Environ 2017a) through an assessment of potential odour emissions from the ventilation shafts, drawing on odour monitoring results obtained from other underground coal mining operations in NSW. The predicted 99th percentile 1-second (nose response) odour concentrations across all surrounding receptors were predicted to be below the conservative odour assessment criterion of 2 odour units (OU). Therefore, adverse odour impacts from project emissions are unlikely in the surrounding environment.

In relation to coal stockpiles, odour emissions are generally associated with spontaneous combustion (Cliff et al, 2014). As documented in Section 10.3 of the air quality impact assessment (Ramboll Environ 2017a), while the coal in the Hume Coal Project area has low potential for spontaneous combustion, Hume Coal propose a number of control measures to manage the risk of potential spontaneous combustion occurring, as appropriate:

- undertake a spontaneous combustion risk assessment for coal and rejects and develop and implement a Spontaneous Combustion Management Plan if deemed necessary;
- undertake continuous real-time monitoring of ventilation air for the presence of the products of combustion;
- seal mined-out panels progressively as the mine is worked; and

- stockpile management in accordance with good industry practice.

The potential for odour impacts associated with the Project is therefore considered very low.

15.5.3 Emissions from coal transport by road

Some community submissions mentioned that coal will be transported by trucks, thereby generating dust along the route.

Coal will not be transported by truck; rather it will be transported entirely by rail, as described in Chapter 2 of the Hume Coal Project EIS (EMM 2017a).

15.5.4 Coal seam gas

A community respondent noted that high coal seam gas volumes are present in the area, and would like to know how this will impact air quality.

Testing of the Wongawilli Seam has indicated that the seam gas content is very low, with a recorded carbon dioxide equivalent (CO₂-e) concentration of 0.00068 t CO₂-e/t of ROM coal. At these low levels, it becomes difficult to accurately test for gas content, with the measurement error being equivalent to about 70% of the average measured gas content. The composition of the seam gas is typically close to 100% CO₂. This is supported by the experience at the adjacent Berrima Colliery where a gas chromatograph test of the mine's return air found no measurable methane. Potential odour impacts from underground ventilation shaft emissions were quantified in the air quality impact assessment and were below applicable impact assessment criteria at all surrounding receptors.

15.5.5 Emissions to air from blasting

One community submission raised concerns about blasting, claiming it has the potential to create a large dust plume north over Berrima Village, as well as the associated health and safety issues.

The Project is an underground mining operation. There will be no surface blasting associated with the project during the operational phase to generate blast-related particulate matter emissions. Therefore, no blasting plume will occur to impact Berrima or any other area surrounding the project.

15.5.6 Potential air quality related impacts to agriculture

Some community respondents noted that air quality could impact agriculture and local farms, including stud farms. One of the main concerns was the subsequent impact via the consumption of local produce.

Plant life can be affected by the deposition of any kind of dust matter on the leaf surfaces beyond a certain level. Zia-Khan et al (2015) presented findings that plant photosynthesis reduced when leaves were dusted with 5 to 10 grams of dust per m² of leaf surface. Farmer (1993) provides a review of the effects of dust on plants, and identifies that deposition rates of approximately 6g/m²/month or greater for cement dust can reduce vegetative and plant reproductive growth. While cement dust differs to coal dust, these values could be used to analyse the potential impact of dust deposition levels from the Hume Coal Project on surrounding agriculture.

As illustrated in Figure A5.4, A5.8 and A5.12 of the air quality impact assessment (Ramboll Environ 2017a), predicted dust deposition levels from the Hume Coal Project are less than 1 g/m²/month at all locations beyond the project area boundary. Consequently, it is considered unlikely that emissions from the project would have any impact on the surrounding vegetation. Further, as shown on the above-mentioned figures, dust deposition as a result of the project will be concentrated around the surface infrastructure area, dissipating to low levels quickly with distance. Therefore, even within the project area, dust deposition levels will be less than 1 g/m²/month on privately owned land. This will also generally be the case for the Hume Coal owned properties of Evandale and Mereworth, such that agricultural activities there will not be dust affected.

Cargill (1999) identifies a recommended total dust level of less than 2,400µg/m³ for total dust (TSP) and less than 230µg/m³ for respirable dust (PM_{2.5}) is maintained within barns and stables for protection of equine health. Predicted concentrations of all particulate matter are significantly lower than these concentrations at any location beyond the project area boundary (less than 20 µg/m³ for 24-hour PM₁₀ and less than 2.5 µg/m³ for 24-hour PM₁₀). Consequently, it is considered that the Hume Coal Project would not adversely affect the health of horses or other livestock in the surrounding region.

15.5.7 Aboveground coal and reject stockpiles

Some community and special interest group submissions raised concerns about the dust and particulate matter generated by the aboveground stockpiles. Given the height, size and position (NNW) of coal and reject stockpiles and their vicinity to Berrima and the Hume Motorway, it was submitted that strong southerly and westerly winds which can last for days, are likely to convey coal dust particulates into Berrima, New Berrima, Moss Vale, Sutton Forest, Exeter, Mittagong, Bowral, Bundanoon and onto the Motorway. A few respondents claimed that complete control of wind erosion cannot be achieved in such situations.

A number of submissions also expressed concern in regards to the size of the rejects stockpile, which will be stored aboveground for 18 months, and the potential toxic materials that could be blown from the stockpile. One respondent noted that the stockpile could continue to grow substantially if the slurry operation is halted for any reason.

As discussed in Section 15.2, significant meteorological data analysis was completed as part of the air quality impact assessment for the Hume Coal Project. The input meteorology datasets that underpin the dispersion modelling account for all meteorological conditions on an hour by hour basis throughout the modelled period (2013 datasets collected by the Hume onsite station and BOM Moss Vale station). These datasets included sustained periods of elevated winds from the west and south as they occurred during 2013, with both hourly average and hourly maximum gusts accounted for in the modelling and emissions calculations. An example of sustained wind conditions in the input meteorology datasets is presented in Figure 15.1.

The data in Figure 15.1 presents a select period (26 September 2013 to 1 October 2013) from the 2013 BOM Moss Vale dataset used in the modelling and presents wind direction (direction blowing from), hourly average wind speed and hourly peak gust winds. The graph illustrates periods of sustained high wind speeds (gusts up to 95 km/hr) blowing for continuous hours from the west (between 250° and 290°). The conditions from this presented time period, along with the remainder of the 2013 dataset, were input to the dispersion modelling and emission calculations.

Therefore, it is considered that sustained periods of elevated winds have indeed been accounted for in the air quality impact assessment and predicted concentrations presented in the report. The results of the modelling, which account for sustained periods of elevated wind speeds and potential downwind transport of particulate matter emissions, demonstrate compliance with all applicable air quality impact assessment criteria at all sensitive receptors and town centres.

The emission calculations and dispersion modelling conducted incorporate a range of emission control technology. As detailed in Section 7.3.3 of the air quality impact assessment report, the proposed mitigation and management measures for the Hume Coal Project are in accordance with or above accepted industry best practice dust control measures. On the basis of the modelling results presented, the proposed measures are effective at managing emissions from the Hume Coal Project.

Emissions from the temporary rejects storage area will be controlled through the application of water sprays to maintain elevated surface moisture content and mitigate potential wind erosion emissions. The rejects will comprise of natural rock and stone materials (siltstones, mudstones, clay and coal particles) and will not contain toxic components.

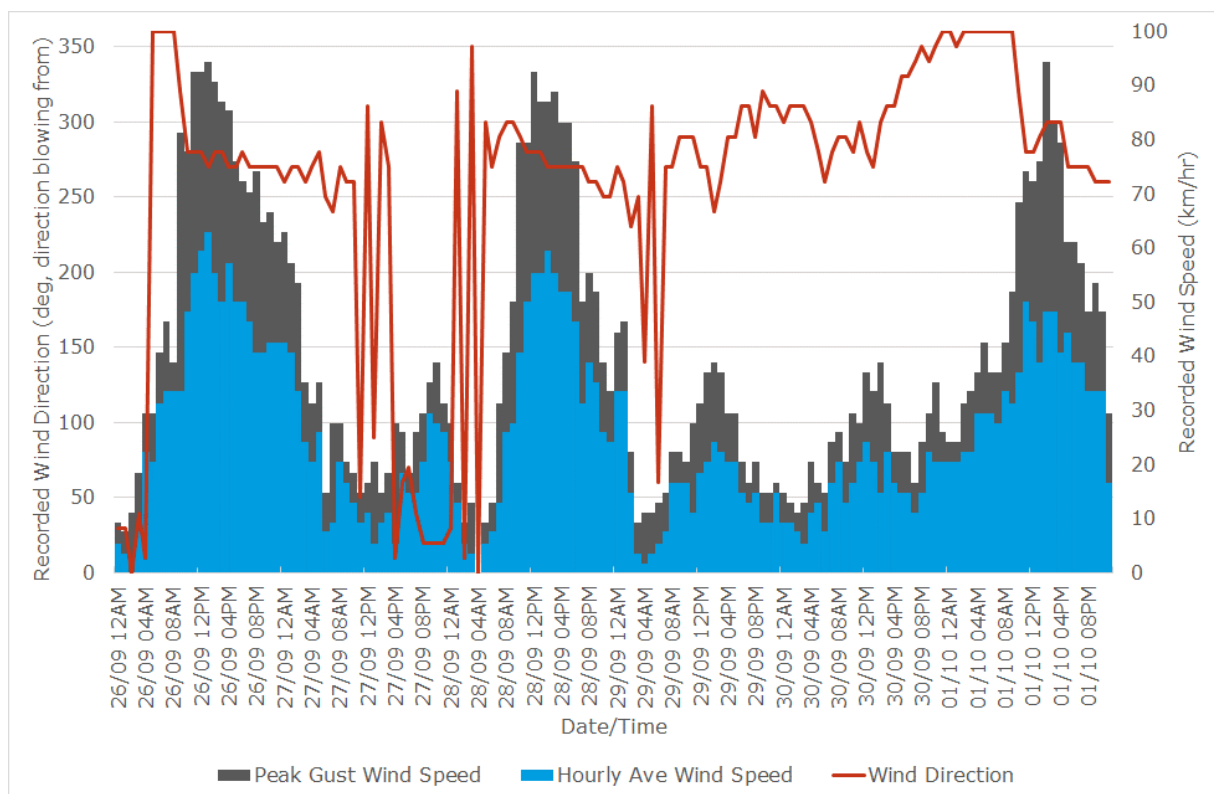


Figure 15.1 Example of hourly wind speed (average and peak gust) and direction from input meteorology file – BoM Moss Vale 26 September 2013 to 1 October 2013

15.5.8 Potential health impacts relating to air quality

A number of community submissions and special interest groups raised concerns about the health effects of coal dust and particulate matter on humans and animals. It was submitted that coal dust is referred to as a known carcinogen, with one submission noting that coal dust contains manganese, sulphates, cadmium, lead, pyrites, methyl mercury, silica, toxic isotopes and other contaminating chemicals.

Respondents also raised concerns relating to diesel emissions and their impact on health. One respondent stated that coal mining is the most significant non-road diesel emissions source in the Hunter Region of NSW, where industrial non-road diesel equipment at coal mines account of 95 % of total PM_{2.5} non-road diesel emissions.

The claim that coal dust is a known carcinogen is not accepted. According to the World Health Organisation International Agency for Research on Cancer (WHO IARC), coal dust cannot be classified as to its carcinogenicity to humans (IARC 1997, IARC 2017) and is currently listed as a Group 3 substance, being “*Not classifiable as to its carcinogenicity to humans*”. The recent National Institute for Occupational Safety and Health (NIOSH) meta study, which reviewed health studies for coal dust exposures published post 1995, supports IARC’s findings (NIOSH, 2011).

The air quality impact assessment report completed for the Hume Coal Project (Ramboll Environ 2017a) predicted concentrations of particulate matter (TSP, PM₁₀ and PM_{2.5}) and gaseous pollutants (NO₂ and individual VOCs) from diesel combustion emissions from across the local region surrounding the project area, with specific predictions made at the closest individual representative residential receptors and key town centres. Model predictions of pollutant concentrations for relevant averaging periods were compared with applicable NSW EPA impact assessment criteria (Section 9 of the air quality impact assessment report). The adopted assessment criteria, listed within the NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, are designed to maintain an ambient air quality that allows for adequate protection of human health and well-being.

Predicted concentrations, taking the existing ambient air quality into consideration for cumulative effects, are below applicable air quality assessment criteria at all surrounding receptors for both the construction and operational scenarios assessed. On the basis of the modelling conducted and predicted compliance with applicable assessment criteria, the Hume Coal Project will not adversely impact upon the surrounding air quality environment with respect to emissions of fugitive particulate matter or from diesel combustion. In addition, a Health Impact Assessment was conducted for the project by Dr David McKenzie and included in the Hume Coal Project EIS. This assessment found that the increased risk in the population due to the worst case annual average increased long-term exposure to PM_{2.5} and PM₁₀ as a result of the Hume Coal Project will be significantly less than 1 in 100,000. This level of increase is considered to be “sufficiently small and to be of no cause for concern”, as per the National Environmental Protection (Ambient Air Quality) Measure. Further, Dr McKenzie’s report concluded that exposures to daily increases of PM_{2.5} and PM₁₀ pose an insignificant risk.

15.5.9 Ventilation shafts

A number of community submissions asked for more information about where the exhaust stacks and ventilation shafts will be located, what parameters dictate the safe location of ventilation shafts from residents/communities, and the effect of ventilation shafts near local homes.

The location of the ventilation shaft outlets are marked in Figure 2.2 and Figure A3.2 of the air quality impact assessment report (Ramboll Environ 2017a), and shown in Figure 2.1 of this report (refer to Chapter 2). The proposal is for one upcast shaft which will draw air out of the mine, and two smaller downcast shafts as well as two access tunnels known as “drifts” will draw air into the mine. Emissions from underground mining operations were quantified through the conservative use of maximum recorded ventilation shaft monitoring data from similar underground coal mining operations in NSW. The predicted impacts from the upcast ventilation shaft outlet are illustrated in Figure 9.3, 9.4 and A5.5 to A5.12 of the Hume Coal Project air quality impact assessment report, with concentration isopleth contours located about the ventilation shaft outlet site. These figures show predicted concentrations are well below applicable impact assessment criteria and that the ventilation shaft emissions would not adversely impact on the surrounding environment. There are no emissions from the downcast shafts or the drifts during mine operations due to the fact these locations will be used for drawing air into the underground mine.

15.5.10 Hume Highway

RMS requested addition information relating to the impact of dust and grit on the concrete pavement of the Hume Highway.

The underground nature of the proposed mine and the best practice mitigation measures proposed means that the project will not be a significant source of dust. As described in the Hume Coal Project EIS and in the response above in Section 15.5.1, cumulative impacts of the Hume Coal Project with existing ambient air quality levels and emissions from neighbouring emission sources will be in compliance with all applicable air quality impact assessment criteria at all surrounding locations. Further, the proposed air quality mitigation and management measures committed to by Hume Coal are in accordance with or above accepted industry best practice dust control measures. It follows that no impact is expected on the concrete paving as a result of project-related dust.

Further, it is expected that the normal road pavement surface wear particles from traffic would be much more likely to cause damage to concrete road pavement slabs compared to any deposited dust particles from a mine, which by their nature having been airborne for a significant period would be of a much finer particle grading more comparable to clay or silt particles, and therefore much less likely to accumulate in any cracks or gaps between the concrete slabs in the road, to the extent that they could cause compression failures. There is no mention of this process (ie fine dust entering into cracks) as a recognised mechanism of road pavement failures in any of the concrete road pavement design guides which are used in Australia.

15.6 Monitoring, mitigation and management

15.6.1 Berrima Rail Project

The CFMEU submitted that covering coal wagons is beyond current industry practice and questioned whether it would cause complications with efficient management of coal rolling stock in the coal freight system or with other users and the port. The union has been of the view that dust issues with coal freight are adequately managed through watering and possibly the use of surfactants.

Some community submissions also questioned the effectiveness of covering the wagons, claiming that the majority of coal dust particulates originate not from uncovered coal wagons, but the coal dust that covers the entire wagon and undersides (via the hoppers underneath) during the loading and unloading process. One referred to a study by Warren Buffett of train transit coal loss, finding 6% loss even when covered.

Macquarie University submitted that conditions with respect to the management of dust and particulate emissions should acknowledge the findings of the *Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain* in terms of the health implications, existing knowledge gaps and the current 'inadequacies' in quantifying the extent to which coal handling and transport contributes to dust and particulates in the rail corridor. It was also suggested that conditions of consent should acknowledge the possible influence of known sources of dust in rail corridors from handling and transport of coal from the mine to port (the surface of loaded wagons, leakage from doors of loaded wagons, parasitic load, residual coal in empty wagons, emissions from diesel locomotives, dust originating from soil within the corridor or from elsewhere, re-entrainment of spilled coal or other dust in the rail corridor, including through, turbulence caused by passing trains.)

It is acknowledged that the implementation of covers to coal rail wagons is an industry first for Australian coal mining operations; however covered wagons are routinely used for other bulk goods such as wheat. The wagons will be configured to bottom-dump at the unloading point, so the covers will only need to be opened for loading operations at the mine site. Hume Coal will work with Port Kembla Coal Terminal to ensure the use of wagon covers does not present any technical issues regarding unloading wagons.

The findings of the NSW Chief Scientist in the 2016 report *Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain* are acknowledged regarding existing uncertainty and data gaps relating to potential fugitive emissions from rail wagons. As per the NSW Chief Scientist report, reviewed reports identify that the loaded and unloaded surface of rail wagons accounts for approximately 80% of fugitive emissions. Therefore, the covering of rail wagons will mitigate the primary source of fugitive rail dust emissions.

Further, the design of the wagon loading station and wagons to be used by the Hume Coal Project will minimise the occurrence of parasitic coal loading on wagons leaving site for Port Kembla.

The NSW Chief Scientist report (2016) recommends that control measures currently implemented by the coal industry are continued and encourages the implementation of new mitigation strategies. It is considered that through the implementation of covered rail wagons, a measure never before implemented in the Australian coal mining industry, the Hume Coal Project is indeed adopting recommendations of the NSW Chief Scientist.

The claim that 6% of coal could be lost during train transit is spurious and unfounded. This would amount to 180 tonnes of coal per train trip, which is equivalent to losing two full coal wagons, which does not occur in practice.

15.6.2 Hume Coal Project construction phase

One submission from a business respondent noted that section 10 of the Air Quality Impact Assessment Report does not present recommendations for control of particulates associated with construction.

Particulate matter control measures for the construction phase of the project are listed in Section 7.2.1 of the air quality impact assessment report, and state that particulate matter emissions would largely be controlled by the application of water. Earthworks such as embankments and cuttings will be revegetated as soon as possible following completion of work using methods like hydromulching.

A construction dust management plan will be developed prior to the commencement of the construction phase of the Hume Coal Project. The following measures will be implemented to mitigate the potential impacts during construction activities:

- regular site inspections will be carried out, and records of inspections maintained. This includes recording any exceptional incidents that cause dust and/or air emissions, either on or off site, and the action taken to resolve the situation;
- record all dust and air quality complaints, as per the site complaints procedure, identifying cause(s) and appropriate measures taken to reduce emissions;
- a maximum speed limit of 20 km/h will be imposed on all internal roads and work areas;
- proper maintenance and tuning of all equipment engines will be undertaken;
- an adequate water supply will be provided at all times for effective dust/particulate matter suppression/mitigation; and
- drop heights will be minimised from loading or handling equipment.

15.6.3 Hume Coal Project operational phase – mitigation measures

A number of community and special interest group submissions made comment on, or queried the proposed mitigation measures for the three coal stockpiles during the operations phase of the project. It was suggested that the EIS provides no details of mitigation measures proposed to prevent particulates and 'toxic materials' from the stockpiles causing air pollution and contamination. It was submitted that if the stockpiles of coal and rejects are not controlled with water sprays or applied with impermeable films, wind is likely to blow dust towards Berrima. Some submissions also raised concerns that Hume Coal has not yet decided on the final mitigation measures it will employ to most effectively limit TSP, PM₁₀ and PM_{2.5} from the coal and product stockpiles.

A few of the submissions made mention of the strong winds in the area, which will necessitate large volumes of water to damp down the coal dust. Respondents queried the calculations related to the amount of water to be used in the management of the stockpiles. It was noted that the efficiency of water sprays is between 50% to 80% (EIS, page 328), and that a control of 50% does not subdue the impact of dust emissions on people, animals and properties. Furthermore, the use of veneering (second mitigation scenario) on product stockpiles was questioned, claiming that the additional removal of material on the stockpile would disrupt the containment and control that might be generated through veneering technologies. Macquarie University also requested that watering and veneering of stockpiles be included as a condition on the EPL.

Another community respondent suggested Hume Coal should consider a full covered conveyor construction, as well as a waterproofed, dust proofed and covered silo storage for granulated products.

Quoted emission reduction factors were adopted from accepted publically available emissions estimation literature. Quantification of emissions and subsequent modelling incorporated the quoted emission reduction factors, with model predictions well below applicable assessment criteria at all surrounding receptors for all pollutants.

As per Section 7.3 of the air quality impact assessment report, two operational scenarios were developed for assessment. One scenario applied only water sprays to the product stockpiles, while the second scenario applied veneering and water sprays. Both options were quantified and assessed as the decision had not been made at the time of modelling regarding final stockpile mitigation measures. For the veneering and watering scenario, it was assumed that a nominal 20% of the stockpile area was actively disturbed and only controlled by watering, while the remaining 80% was controlled by veneering. While predicted to be lower for the watering and veneering scenario, it is noted that the predicted impacts under both watering only and veneering watering scenarios are well below applicable impact assessment criteria at all surrounding receptor locations.

As stated in Table 7.8 of the air quality impact assessment, with the exception of stockpile stacking and reclaim conveyors, all conveyors will be fitted with either a side wall or side wall and roof. All transfer points will be fully enclosed. These measures are consistent with the accepted best practice in the NSW coal mining industry.

15.6.4 Hume Coal Project operational phase – monitoring

Concerns were raised about whether Hume Coal would monitor air quality and dust impacts during the life of the project, ensuring that any increases in particulate matter and dust generated by the project is kept below the regulatory criteria. It was requested that the EPL include 'rigorous' conditions to ensure long-term assessment of TSP, PM₁₀ and PM_{2.5}, suggesting that this needs to be undertaken using a monitoring network that has been independently assessed as being 'fit for purpose' for the assessment of mine-related dust impacts. The submission from Macquarie University also suggested the EPL conditions should retain appropriate adaptive management measures, including an annual review to ensure it remains fit for purpose, and that monitoring is to be undertaken on the eastern boundary of the project area.

Specific requests were made that a dust monitoring program be conducted at Robertson Primary School to quantify existing dust and diesel emissions levels at the school.

A community submission also questioned why NO₂/NO_x monitoring is not planned during construction or operation, particularly when final modelling NO concentrations are close to 246 µg/m³.

Section 10.4 of the air quality impact assessment documents anticipated future air quality monitoring for the Hume Coal Project. Existing PM₁₀, PM_{2.5}, dust deposition and meteorological monitoring equipment will form the basis of the monitoring network.

If the project is approved, the final air quality monitoring network would be selected in accordance with the requirements of the NSW EPA, with regards to the number of stations, pollutants to be recorded and duration of air quality monitoring. In the event that existing equipment requires relocation, the results of the dispersion modelling, location of neighbouring receptors and layout of surface operations will be used to identify appropriate alternative monitoring locations. Final site selection will be made in accordance with applicable Australian Standards and NSW EPA requirements. Air quality monitoring requirements will be documented in the Environment Protection Licence for the project issued by the NSW EPA.

As described in Section 15.3.1, because the Hume Coal rail wagons will be covered, there will be minimal fugitive coal dust emissions released as trains move from the mine site to Port Kembla. Fugitive coal dust impacts from Hume Coal wagons will therefore be negligible at all locations along the rail corridor, including at the Robertson Primary School.

In relation to NO₂/NO_x levels, the claim that final modelling NO concentrations are close to 246 µg/m³ is incorrect. 246 µg/m³ is the *criterion* (1-hour) against which NO₂ levels are assessed against. As reported in Section 9.2 of the Hume Coal Project air quality impact assessment, the maximum predicted concentration of NO₂ (1-hour) at the nearest privately owned residence is 16.7 µg/m³, well below the accepted criterion. Given the very low levels predicted of NO_x/NO₂, no monitoring is considered necessary.

16 Mine design and geology

This chapter responds to submissions relating to the mine design adopted for the project, geological exploration and the geological environment, and the predicted impacts relating to subsidence.

Submissions in support of the Hume Coal Project raised the point that the mine design is a 'low impact' design. As explained in the EIS (EMM 2017a), this is due to a number of factors, including the underground nature of the mine and the non-caving mine design.

Notably, the NSW Division of Resources and Geoscience (DRG) stated in their submission that a review of available coal quality information suggests the proposed product quality, market split and yield is achievable. The DRG considers that a total of approximately 40 Mt of product (saleable) coal from the Hume Coal Project is feasible, and verified that the project will provide approximately 50 Mt of ROM coal. Further, the DRG Strategic Resource Assessment and Advice Unit considers the proposed mine plan for underground operations will 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. The DRG also noted that Hume Coal has considered a large variety of underground mining techniques and mine plans for the project.

16.1 Bulkhead design

A number of community submissions raised concerns regarding the proposed use of large monolithic water-retaining plugs (bulkhead seals) to seal off the mining panels as the mine progresses, allowing water pressure to build up in the voids of the sealed-off parts of the mine. Concerns relate primarily to the safety of mine workers and risks associated with the potential failure of bulkhead seals. Other concerns relate to the ability to cater for variations in geological conditions in the design of the monolithic plugs, and the ability to successfully integrate the construction activities associated with these seals with other day-to-day mining operations.

The EPA also raised questions about the bulkheads, submitting that the composition and design of the bulkheads are not detailed in the EIS. Further, the EPA noted that cracking and dilation of strata is expected to occur up to two to three metres above drivages due to subsidence. The drivages and roadways also appear to be located in the lower band of the coal seam at the base and roof. These conditions do not appear to conform to UK guideline recommendations for the installation of bulkhead seals.

WSC reference Berrima Colliery and the comments made about the effectiveness of bulkhead sealing of groundwater in its closure plan, urging a precautionary approach for the Hume Coal Project.

16.1.1 The use of bulkheads and safety concerns

Operating coal mines routinely store or impound water, especially in goafs or old workings. Proper management techniques serve to adequately mitigate the risks associated with impounding water underground, such as in circumstances where seam dip and the presence of substantial solid coal barrier pillars act to separate the hazard (the water) from the active workings.

Furthermore, and without attempting to minimise the serious issue of potential inrush hazards, mines often operate next to abandoned coal mines in adjacent leases that are filled with water, using appropriate management techniques. Many of these techniques are detailed in legislation and standards, such as *Mine Design Guideline 1024 - Guideline for Inrush Hazard Management* (MDG1024).

Safety management aspects of mine developments such as inrush hazard management and other mining hazards are dealt with via the use of appropriate management strategies and risk management plans post-project approval.

Operational management plans such as this are required, by law, to be developed in consultation with the workforce. The consultation and safety role for workers is developed under the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 (WHSMP(R)) Part 4, in addition to section 49(f) of the *Work Health and Safety Act 2011* (WHS Act). The mine operator must consult with workers on matters specific to the mine. These include the development, implementation and review of the Safety Management System (SMS), and parts of it, such as risk assessments for certain plans.

The mine operator must also implement a safety role for workers that, drawing on their relevant experience working at the mine, enables them to contribute to:

- identifying Principal Mining Hazards (PMHs);
- providing input on the appropriate risk control measures for PMHs and principal control plans; and
- providing input on the PMH management plans and their review.

The SMS should set out how this safety role for workers will be achieved at the mine in practice.

This may involve the mine operator considering how to give all workers the opportunity to contribute, given factors such as the different types of work undertaken at the mine, how to involve contractors and their workers, etc.

Additionally, the WHSMP(R) clause 120 sets out the safety role for workers in relation to principal mining hazards.

The operator of a mine must implement a safety role for the workers at the mine that enables them to contribute to:

- (a) the identification under clause 23 of principal mining hazards that are relevant to the work that the workers are or will be carrying out, and
- (b) the consideration of control measures for risks associated with principal mining hazards at the mine or petroleum site, and
- (c) the consideration of control measures for risks to be managed under principal control plans, and
- (d) the conduct of a review under clause 25.

Clause 121 of the regulations state:

Duty to consult with workers:

For the purposes of section 49 (f) of the WHS Act, the mine operator of a mine or petroleum site must consult with workers at the mine or petroleum site in relation to the following:

- (a) the development, implementation and review of the safety management system for the mine,
- (b) conducting risk assessments for principal hazard management plans,
- (c) conducting risk assessments for principal control plans,
- (d) preparing, testing and reviewing the emergency plan for the mine,
- (e) the implementation of the workers' safety role under clause 120,
- (f) developing and implementing strategies to protect persons at the mine from any risk to health and safety arising from the following:

- (i) the consumption of alcohol or use of drugs by any person,
- (ii) worker fatigue.

Section 47 of the WHS Act requires Persons Conducting a Business or Undertaking (PCBU) (including a mine operator) to consult with workers likely to be affected by a health and safety matter, so far as is reasonably practicable.

WHS Act Section 49 provides that consultation under this Division is required in relation to the following health and safety matters:

- (a) when identifying hazards and assessing risks to health and safety arising from the work carried out or to be carried out by the business or undertaking,
- (b) when making decisions about ways to eliminate or minimise those risks,
- (c) when making decisions about the adequacy of facilities for the welfare of workers,
- (d) when proposing changes that may affect the health or safety of workers,
- (e) when making decisions about the procedures for: (i) consulting with workers, or (ii) resolving work health or safety issues at the workplace, or (iii) monitoring the health of workers, or (iv) monitoring the conditions at any workplace under the management or control of the person conducting the business or undertaking, or (v) providing information and training for workers, or (f) when carrying out any other activity prescribed by the regulations for the purposes of this section.

If there are Health and Safety Representatives at the workplace, the mine operator has a duty as a PCBU to involve them in consultation on health and safety matters.

It is therefore highly inappropriate to develop operational safety management plans, particularly those relating to principal hazards, prior to employing the operational workforce.

Many mines are now routinely installing bulkheads to control and manage water, and international standards and guidelines exist for their site selection, design and installation, developed by organisations such as the National Institute for Occupational Safety and Health (NIOSH) in the United States of America (US), and the UK Health and Safety Executive (HSE) in the United Kingdom.

i Current industry practice

There are numerous examples of operating mines storing water in goaf areas and old workings, such as Ulan No 3 Colliery, where water is allowed to accumulate up to the contour of the lowest point in the next mining panel. At the old Elouera Colliery (now Wongawilli Colliery), the main pumps are located at the edge of a large volume of water impounded in longwall goafs. At Beltana, water was allowed to accumulate in old goafs and sometimes required accelerated pumping prior to holing the next longwall installation road. The old longwall goaves at Clarence Colliery are partially filled with water, and the recent partial extraction panels are partially flooded following mining. The list is by no means exhaustive.

An example of an operating mine using bulkheads to manage water is Oaky No 1 mine in central Queensland, where a set of bulkheads were installed in 2011-2012 to allow for the storage of water in goaves, and to provide for mitigation against underground mine inflows during high rainfall events. Mutton et al., (2012) describes the situation at the mine:

"The mine workings have over its life been getting deeper and as such the older working areas are outbye of the current workings and at a higher Relative Level (RL) meaning that if water was to build up in these areas and a (ventilation) seal failed the potential to block or flood some areas of the mine outbye of the working faces exists. The original strategy was to prevent water accumulation by pumping water out of the sealed areas via borehole pumps. Mechanical failure of these pumps and surface environmental restrictions on discharging water from the site has led to a review of the mine's water management strategy. Part of this strategy is to increase the underground (water) storage areas, provide longer periods to be able to discharge water from these areas."

It is understood that Ulan No 3 mine also recently installed bulkheads along a line of chain pillars between two longwall panels in order to provide for increased underground water storage and mitigation of potential flooding. This series of bulkheads provides the hydraulic containment of five adjacent longwall goaves, a key difference being that the containment is provided by a row of chain pillars with a solid width of around 20-30 m, as opposed to the proposed 50 m wide solid pillars proposed for Hume Coal.

Other mines understood to have installed bulkheads recently includes Austar coal mine in the Newcastle coalfields, Ulan West underground mine in the western coalfields, Tahmoor Colliery in the southern coalfields and Narrabri Coal.

A number of contracting companies that are either based-in, or have a presence in NSW offer the construction of coal mine bulkhead seals in their product range, including Aquacrete, Minova, Heintzmann, Strata Linings and Cellcrete.

Notably, most of the bulkheads currently installed in the industry are an afterthought, and the bulkheads need to be engineered around an existing site to solve a problem that has come to light, whereas at the Hume Coal Project, steps can be taken to incorporate future bulkhead sites into tactical mine site planning. This might involve taking measures like:

- implementing controls over mining dimensions at bulkhead sites (for example, mining at reduced roadway dimensions in order to limit the cross sectional area of the bulkhead; or profiling the roadway to create a gentle taper);
- mining to a more favourable working section for bulkhead design (if appropriate);
- increased frequency of geological mapping at bulkhead sites, in order to identify any geological structures prior to stonedusting, and to modify mine plans/site locations accordingly;
- install increased levels of support at bulkhead sites on development;
- install borescope holes and extensometers on development; and
- install different styles of support at bulkhead sites on development (e.g. corrosion-protected bolts (galvanised or epoxy-coated), or fibreglass rib support, if future rib trimming is likely).

The actual measures that are implemented during mining will depend on site-specific assessments. Further discussion on the proposed use and design of the bulkheads at Hume Coal is provided below.

ii Proposed practice at Hume Coal

The mining and sealing sequence for the workings proposed by Hume Coal, the time taken for panels to fill with water, combined with the likely head profile over time in the sealed workings mean that plunge mining operations will not normally occur (if ever) directly adjacent to sealed and pressurised workings. Notwithstanding, appropriately sized barrier pillars will be in place, and no mining will occur within designated “inrush control zones”, as provided for in the relevant NSW coal mining legislation (ie the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and the Work Health and Safety (WHS) (Mines and Petroleum Sites) Regulation 2014), as well as in the NSW Department of Primary Industry (DPI) document *Guideline for Inrush Hazard Management* (MDG 1024) (NSW DPI 2007).

The WHS (Mines and Petroleum Sites) Regulation 2014 provides for a 50 m separation of solid strata between an active mining face and mine workings that potentially contain water or any other material that can flow resulting in an inrush. This 50 m wide area is called an “inrush control zone”. Mining within an inrush control zone requires a risk assessment to be conducted and appropriate safety measures put in place. It also requires a special notification to the mine safety regulator. Hume Coal’s proposal does not involve mining within an inrush control zone as a result of proximity to old mine workings. The project design maintains 50 m wide solid barrier pillars between each panel, between the ends of each panel, and any subsequent main roadways.

The accuracy of mandatory underground mine surveys, which are undertaken at all coal mines by a registered mine surveyor on an ongoing basis, make it unrealistic to suggest that the location of the mine workings could ever be so inaccurate to cause a 50 m solid coal barrier to be inadvertently breached through mining activities. Physical equipment constraints like cable, hose and conveyor belt lengths mean that an unplanned deviation of this magnitude is not a credible risk scenario.

Hume Coal intends to operate on a similar basis to other mines already using bulkheads and/or coal barrier pillars to store water, as described in Section 16.1.1i, and has carefully considered the inrush risks of doing so to design the mine accordingly. The following key controls apply to the proposed impoundment of water in sealed workings at the Hume Coal Project:

1. The location of the workings will be reliably surveyed and recorded, allowing the mine operator to be confident of the precise location of the workings once access is no longer available.
2. The majority of the panels are oriented down-apparent-dip from the main headings, such that if a catastrophic failure were to occur at a bulkhead site, the volume of water that could be released is minimised. This is further detailed below in section iii.
3. Each panel is separated from the adjacent panels by a 50 m solid coal barrier pillar as provided for in MDG 1024 and the WHS (Mines and Petroleum Sites) Regulation 2014.
4. The sequence of mining is such that the active panels are adjacent to panels that are either also being mined, or just commenced the process of filling up, which is estimated to take one to three years following the sealing of the panel.
5. The bulkheads will be designed to an appropriately high factor of safety (nominally four). The number of individual bulkhead sites is minimised by accessing each panel via only three headings. The bulkheads themselves are proposed to be monolithic in design, and slightly tapered, which adds to the overall robustness of the design.
6. The area of the mine which is flatly-lying will be mined last, meaning that the panels are not likely to be filled with water prior to the mining operations ceasing altogether, let alone under a significant amount of pressure.

iii Catastrophic failure and bulkhead design

The catastrophic failure of bulkheads constructed as monolithic plugs is not considered to be a credible scenario due to the inherent nature of the design concept proposed by Hume Coal, assuming the bulkheads are installed with proper care and diligence using established and routinely practiced quality assurance processes, and that the design concept is verified and finalised following an inspection of each site by a suitably qualified engineer.

A monolithic plug consists of a long plug of cement or grout, or another engineered material that fully occupies the host mine heading. These remain in place through two primary mechanisms – self-weight, and interface shear strength between the sides, roof and floor of the mine heading and the plug. A tertiary mechanism is also proposed for the plugs to be constructed for Hume Coal, which is a slight taper (or wedge-shape) opening in the direction of the sealed off part of the mine. This means that the pressure on the plug will act to jam it more tightly into the tapered sides of the heading.

The bulkheads will be sited, designed, constructed and monitored generally in accordance with international standards, and will be designed to high factors of safety (nominally four). As a rule of thumb, this results in the length of the plugs being approximately 1/10 of the maximum possible head (eg a plug designed for 100 m of head would be about 10 m long, and should withstand 400 m of head (given the 4x safety factor).

The construction of the bulkheads will include assessment of the surrounding strata and may include pre-treatment of the surrounding strata with a curtain of microfine grout or similar material to reduce the potential for leakage through the rock around each bulkhead. This pre-treatment will be employed on a needs-basis following an assessment of each installation site, and would typically involve drilling a ring of grout holes around the perimeter of each roadway, followed by grouting with microfine cement which is designed to penetrate any cracks or small fissures present in the rock.

The bulkheads will be constructed from a low-shrinkage material, and may also be interface-grouted following construction to ensure no gaps exist between the plug and the rock.

The majority of the panels in the mine are oriented so that the mine workings slope away downhill from the main headings, further mitigating the risk of bulkhead failure, and meaning that the majority of the water contained in each panel will remain contained in the panel even if the bulkheads were to be temporarily depressurised.

Bulkhead sites will be included in the mine's inspection system and monitored according to a trigger action response plan (TARP). The trigger levels and the responses set out in the TARP will be determined by a risk assessment. If unacceptably high levels of leakage become apparent (as set under the TARP), the panel may be temporarily depressurised and remedial grouting can be employed.

Over the long term (post-mining) the bulkheads will become redundant when the mine workings fill completely with water, and the pressure on either side of the seals equalises.

A concept design for the bulkheads is discussed in the Hume Coal Project EIS (EMM 2017a) and a copy of the concept report has been provided to the mining expert engaged by DPE to assess this aspect. In accordance with the international guidelines, it is not appropriate to undertake a detailed design for the bulkheads until a site inspection has been undertaken. The design for each bulkhead will take the characteristics of each site into account. The materials used in their construction will depend on the final design and the company selects (via a tender process) to install them, as each of the companies listed above uses their own proprietary products.

iv Mine design and seam dip

Hume Coal has utilised the natural dip of the seam to design as much of the mine as possible so that bulkheads are installed at the top of the panels, greatly limiting the volume of water that could be released by a catastrophic plug failure. Regardless, concern over the potential for a large sudden uncontrolled release of water is far less relevant to the proposed 'tapered plug' style of bulkhead design that has been proposed, than it is for other potential designs (such as plate bulkheads or slab-style structures) simply due to the structural mechanics and potential failure modes involved.

v Potential secondary controls on release of water

If the roadway is relatively flat-lying but still gently dipping away from the bulkhead site or flat, then any release of water subsequent to the initial depressurisation of the void (if it is pressurised) would be able to be held back by a simple appropriately designed weir, since the head on this water will only be a maximum of the height of the weir, following any initial depressurisation. This principle is shown diagrammatically below in Figure 16.1. Prior to failure, the pressure would be balanced on either side of the weir, due to the fact that the structure is open at the top. During failure, any pressure difference would be relieved through the opening across the top of the weir, ensuring that any dynamic forces acting on the weir are limited to the force of water flowing over its top. Given the relatively incompressible nature of water, and the likely possible failure mechanisms of a tapered plug design, the volume flow rate over the top of the structure should be relatively low; meaning the dynamic loads on this structure should be low in comparison to the forces acting on the bulkhead. When the water in the area above the top of the weir is drained, the head acting on it will be limited to the height of the weir. Such a wall or weir would only need to be built two thirds of the height of the roadway to be effective in limiting the potential volume that could be released under the circumstances described above.

The initial void depressurisation should involve a fairly low volume of water given the relatively incompressible nature of water.

Whether or not such structures are used at the bulkhead sites will depend on a site-specific risk assessment for each location. In any case, the catastrophic and sudden failure of a tapered plug design as Hume has proposed is not a credible scenario, if appropriate and widely-adopted management measures are used during their design, installation and ongoing monitoring.

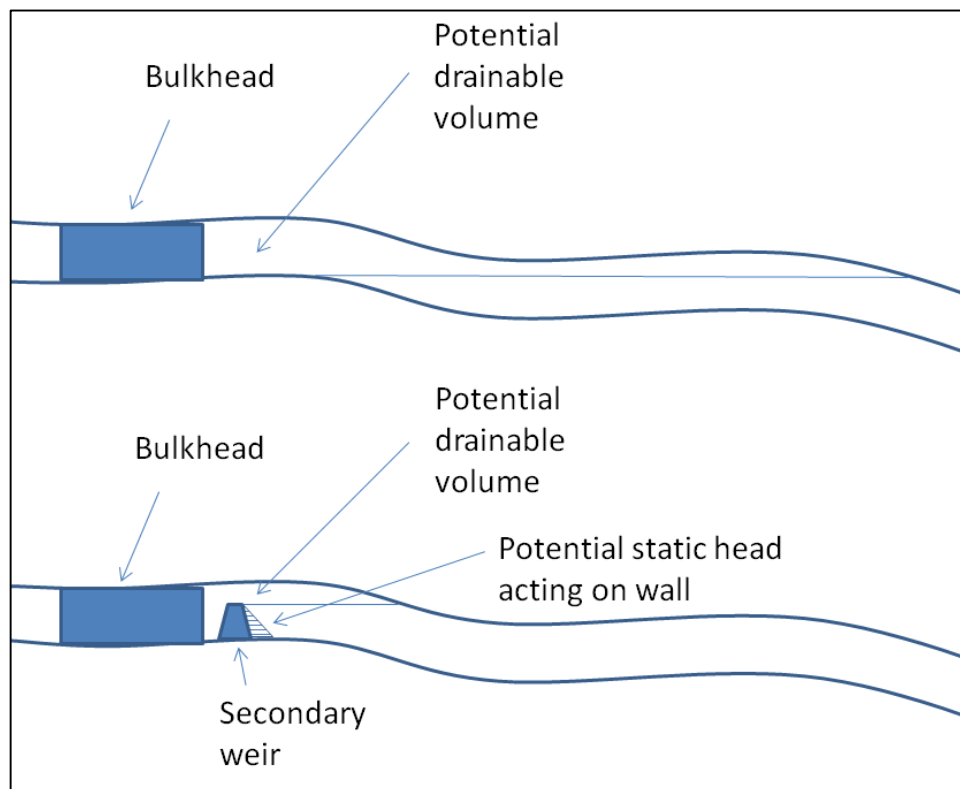


Figure 16.1 Concept to limit potential drainable volume from flat or shallow dipping panels

A more credible failure scenario for a tapered plug design is a piping failure around the seal. Such a failure will provide a warning through increasing seepage rates and allow a controlled depressurisation of the sealed void, and grouting or remediation of the leakage site.

The opportunities for such a failure mechanism to develop are greatly limited by the fact that the seam has no significant thick puggy clay bands and no discernible quantities of fireclay or seatearth.

In general, these issues are able to be managed very effectively through standard risk management techniques that are used at coal mines and mentioned earlier.

16.1.2 Ability to meet the UK guidelines

The EPA asserts that cracking and dilation of strata is expected to occur up to two to three metres above drivages due to subsidence, and that the conditions do not appear to conform to UK guideline recommendations for the installation of bulkhead seals. This is not the case.

There is no relationship between subsidence and the assumed height of desaturation in the groundwater modelling report, from which this statement is derived. It is true that strata delamination occurs in the immediate roof of coal mine roadways, however, this is usually limited to the roof bolting horizon, and is a common feature to all coal mines – with the possible exception of those with massive sandstone or conglomerate roofs. Roof bolts seek to close these delaminations via pre-tensioning each bolt to around 10 tonnes (or much more in the case of strand or cable-style bolts), however the roof bolts themselves can form a flow path for groundwater desaturation.

The UK Health and Safety Executive guidelines²⁸ (the UK guidelines) are specifically designed for bulkhead installation into existing and old coal mine workings, which might have had years of strata decay, delamination and convergence. UK coal mines typically are very deep, and have weak surrounding strata comprising mudstones and shales which often necessitate passive roof and rib support, such as steel sets and lagging or other types of standing support. By contrast, the Hume proposal is relatively shallow, and geotechnical testing and experience at the neighbouring Berrima Colliery suggests the mine will have competent surrounding strata that will not require routine passive support. There is nothing in the UK guidelines which suggests that conditions at the Hume Coal Project, which will be in relatively new and purpose-built roadways, are inappropriate for bulkhead installation, when the context of the UK guideline is fully understood. The EPA acknowledged in their submission that they were not qualified to comment on this matter.

In relation to the matter raised by the EPA, the UK HSE guideline states:

"The ground should be stable and the strata fracture incidence low. Mines should avoid building plugs:

- *in fault zones;*
- *where there are dykes or other igneous features;*
- *where there are any other geological features that may give rise to leakage paths for water;*
- *where mineral extraction might cause ground stresses to vary significantly (interaction); and*
- *in highly stressed zones, such as in pillar areas or close to large mine openings such as junctions."*

These points principally relate to abnormal geological conditions. . Each potential bulkhead location will be inspected to ensure it is suitable for bulkhead installation. If it is determined by appropriately qualified professionals that it is necessary to avoid or mitigate a feature listed above, the site location will be varied or an appropriate mitigation will be implemented.

Furthermore, the guidelines go on to provide potential mitigation measures should one or more of the site selection criteria be unable to be met. For example the guideline states:

25. Even in relatively strong rock, some preparation will be necessary to improve the condition of the strata. The nature and extent of strata and roadway treatments will depend on the characteristics of the strata in the vicinity of the proposed plug and on the condition of the host roadway.

27. This will include:

- Removing, where possible, lagging or cladding from the periphery of the roadway through the watertight plug site and carefully removing any broken rock;
- Excavating the periphery of the roadway to key in the front and rear shutters;
- Preparing one or more high points (domes) in the roof for the breather tube(s);
- Removing all plant and equipment, including rail track, pipes and cables;
- Thoroughly cleaning the roadway floor to remove all loose material, mud etc;

and may also include:

- **Reinforcing the roadway** over the length of the plug, and where necessary on either side of it, by rock bolting and/or cable bolting and removing some or all of the free standing supports;

²⁸ <http://www.hse.gov.uk/mining/circulars/waterplu.htm>

- **Setting additional support** in the host roadway either side of the watertight plug, such as concrete or steel supports or sprayed concrete lining; and
- **Treating the exposed rock faces** in the host roadway on either side of the plug **with low permeability and/or strength enhancing materials**.

28. Where all of the **lagging** cannot be removed safely, a longer plug may be needed to compensate for the likely effect of the lagging on the contact between the plug and the rock in that area.

29. **The assessment of ground conditions will also help determine whether or not there is a need to set additional support in the host roadway** on either side of the plug to resist the additional load developed by the increasing hydraulic head.

30. In the **many of the weaker rocks that characterise most stratified deposits in the UK the host roadway will need stiffening**; for example, using substantial steel or concrete supports or a sprayed concrete lining. Designers should specify at the outset whether or not the roadway requires additional support, and should set out clearly the reasons for their conclusions.

31. **Where additional roadway support is necessary**, it should extend for a distance equivalent to at least 2.5% of the design head on either side of the plug. For example, for a plug with a 400m design head in a roadway that requires additional support, this should extend for at least 10m (2.5% x 400m) on either side of the plug.

and

60. Alternatively, where **treatment of roof falls or grouting of the strata is required** either side of the plug, the back and front sections can be constructed, grouted and sealed in turn prior to infilling between them.

(bold added)

The fact that the UK guideline suggests that lagging or cladding may need to be removed from the bulkhead site implies that the guideline contemplates installing bulkheads in roadways where passive support was necessary. Passive support is installed without any pre-tensioning or pre-loading applied to it, or to the surrounding rock, and requires a reasonable amount of ground convergence in order to provide any effective resistance to further movement. Roadways in which passive support have been installed are therefore likely to have experienced reasonably high levels of convergence, with fracturing and delamination of surrounding strata being likely. That the guideline goes on to suggest additional potential roadway support, reinforcement and strength-enhancing treatments suggests that it considers installation of bulkheads can be appropriate in roadways where stability is an ongoing concern providing certain preparatory measures are taken.

As discussed above, the composition and final design of the bulkheads is a matter to be settled during mining operations, once the bulkhead sites can be inspected, and a contracting company is selected to supply and install the bulkheads. Most of the companies that provide bulkhead installation use proprietary materials in their construction. The proposed use of bulkheads has no pollution-related implications (see section 16.1.4) and is outside of the remit of the EPA.

16.1.3 Likely pressure profile

Virtual piezometers have been used in the groundwater model developed for the project (refer to Chapter 9) to determine the likely pressures in sealed mine voids. This work has shown that some parts of the mine are likely to experience a higher pressure accumulation in mine voids during operations than other areas. The highest amount of pressure recovery in the mine voids typically reached about 60-70 m prior to the flooding of the entire workings at the end of mine life.

Any material pressure accumulation in sealed mine voids lags the active panel by about two to three panels. Should the mine wish to delay the pressurisation of any particular void for a period of time, or to temporarily depressurise a void (for example, to undertake remedial grouting) in a controlled manner, this could be accomplished via the use of a suitably designed valve assembly and bulkhead penetration.

16.1.4 No similarity to Berrima

The proposed sealing of mine panels by Hume Coal is a very different proposition to the sealing of mine adits that was considered by Berrima Colliery. As discussed in Chapter 8 and illustrated in Figure 8.2, adits at Berrima Colliery are driven more or less horizontally into the coal seam where it outcrops in the bank of the Wingecarribee River. These adits are typically beneath natural cliff lines. The mine workings are in some cases about 150 years old, and parts of them are inaccessible. The proximity to the surface and the condition of these workings in some places along the river bank is unknown. Future erosion events or cliff falls into the river pose a risk of exposing old workings and damaging the integrity of any bulkhead seals installed into adits, or exposing the mine workings directly. The bulkheads would need to be effective at retaining water in the mine workings in perpetuity to limit the risk of a future catastrophic sudden release into the Wingecarribee River.

By contrast, the Hume Coal Project will access the coal seam via inclined tunnels (or “drifts”) from the surface. The bulkheads will be installed underground, not at the surface. They will only perform an active function for the duration of the mine’s life, following which time the drifts will be sealed, and the remainder of the mine workings will naturally fill up with water. This process will result in an equalisation of the pressure across the underground bulkhead seals.

There is therefore no long-term potential for the mine workings to release mine water to surface waterways due to the fact that the mine is accessed via drifts, and these drifts are in the form of inclined tunnels down into the ground, rather than horizontal adits off a river bank as is the case at Berrima Colliery. Furthermore, the bulkheads become functionally redundant following mine closure.

16.2 Pillar stability

- i. NSW DPI raised questions about pillar stability in their submission. They contend it is known from historical mining areas elsewhere in the state that pillar collapse can occur at an undefined time after the first workings have ceased, leading to irregular and unpredictable ground surface settlement. They also contend that the impact of such settlement above the proposed Hume Coal Project workings will ultimately be dependent on the integrity of the bulkhead seals and the coal rejects emplaced in the panels to provide both lateral and vertical stability to the intervening coal pillars.
- ii. DPI also submit that it is not clear whether the reduced density of the emplaced reject material between the coal pillars, in conjunction with the re-established hydraulic pressure in each sealed panel, will provide support adequate to maintain ground stability in the long-term. DPI therefore recommended additional independent expert analysis be undertaken into the likelihood of pillar failure in the future, potentially leading to impacts on the water supply to nearby users as a result of localised aquifer damage over the long-term.
- iii. One community submission claimed that the potential for irreversible environmental damage to aquifers is high.
- iv. Special interest group submissions also raised concerns about long term pillar stability. One claimed that the data that substantiates pillar strength determinations is derived from inadequate sources (eg broken and fractured rock). The selective use of data makes the pillar modelling suspect. Abnormal values have been used. There is a lack of data (limited number of results) with regard to pillar strength.

16.2.1 Suitability of EIS assessment

The issue of pillar stability has been comprehensively addressed in the Hume Coal Project EIS in the subsidence assessment undertaken by MineAdvice (Volume 7, Appendix L) which included a report on pillar stability as an appendix. Hume Coal utilised an established and appropriate empirical design methodology called ARMPS-HWM (Analysis of Retreat Mining Pillar Stability software for Highwall Mining) to undertake the initial design for the EIS. ARMPS-HWM was developed by NIOSH in the US, and is based on a database incorporating over 3000 individual web pillars, including many of similar geometries to those proposed by Hume Coal.

Empirical design methodologies are directly tied to real-world observations and hence they can be incredibly powerful when correctly applied with skill and diligence within the limitations of their relevant database. The use of empirical design methods is supported by Gale and Hebblewhite (2005), which is mirrored in the NSW Trade & Investment (Mine Safety) Code of Practice *Strata Control in Underground Coal Mines* (2015), whereby “experiential, numerical, empirical-mechanistic and hybrid” are listed as being “applicable methodologies” for the design of similar types of pillars.

ARMPS-HWM is judged by MineAdvice to be “mechanistic” given that it incorporates more than simply the loading and stability state of the web pillar in formulating suitable layout designs.

16.2.2 Pillar stability linkage to bulkheads and reject backfill

Contrary to the assumptions by DPI in their submission, there is no dependence on the long-term integrity of the bulkhead seals, or the reject emplacement in the assessment of pillar stability. The pillars have been assessed for their stability without any potential positive influence that may result from the emplacement of reject or the filling of the mine voids with water behind bulkhead seals.

These factors may provide additional stability to the system, but this is not relied upon in the assessment, and in the case of the reject emplacement is not quantified. This is very clear in a number of places in the Hume Coal Project EIS. For example, on page 127 of Volume 1, the EIS states “the system is designed to be long-term stable with or without backfill and hydrostatic pressure”, and later on page 362 “the design has been assessed without any assumed stability benefit related to these factors.”

Furthermore, bulkheads will become redundant once the mine is rehabilitated, since the workings will naturally flood and the pressures across these seals will equalise once mine inflows cease. This is expected to occur a short time (less than five years) after the mine is sealed. Therefore, they will not contribute to long-term stability after mine closure.

16.2.3 Numerical modelling

Subsequent to the submission of the Hume Coal Project EIS, DPE engaged Galvin and Associates to provide comment on the underground mining aspects of the project. As a result of this review, and as described in Chapter 4 (see section 4.2), Hume Coal brought forward numerical modelling work that was originally planned to be undertaken in the pre-production planning phase of the project, in order to provide a supplementary assessment to the work already contained in the EIS of mine pillar stability and potential subsidence outcomes.

i Numerical modelling study purpose

The purpose of the numerical modelling study was to address the points set out variously in the Galvin and Associates review by:

- Undertaking a parameter sensitivity analysis for overburden properties and depth of cover;
- determining relative distribution of pillar loads in three dimensions (3D) over a series of panels;

- gaining insight into the global stability behaviour of the pillar-overburden system; and
- providing a complement to the empirical design methodology.

On the final bullet point above, Galvin (2016) states that *"empirical and classical analytical pillar strength prediction techniques, supported by field measurements, are important for calibrating numerical models and for validating their outcomes."* This suggests that the numerical modelling outcome should not be materially different from the empirical models, if the empirical method and the numerical model are both used within the limits of the empirical evidence.

This is supported by Esterhuizen (2014) who states that *"numerical models need to be grounded in reality which can only be achieved through calibration and validation against empirical evidence"* and that in some cases, if carefully applied, numerical modelling can be used *"to extend the empirical evidence"*.

Hume Coal has only used the ARMPS-HWM method within its database limits. Therefore, Hume Coal have not sought to extend the empirical evidence, but rather, to gain insight into the system geomechanics, and in particular, any stability advantages in 3D that may be inherent in the proposed layout design, as compared to the two-dimensional (2D) assessment using ARMPS-HWM. The ARMPS-HWM database provides the evidence for the mechanistic behaviour of systems of pillars with similar geometries and safety factor combinations to those proposed by Hume Coal.

The main technical attribute of LaModel over ARMPS-HWM is that key overburden characteristics (ie Young's Modulus, E and unit thickness, t) can be included and varied to provide further insight as to the mechanics of the intended pillar "system" via parameter sensitivity analysis.

ARMPS-HWM allowed the "geometry" of web pillar areas between intra-panel barriers to be designed by restricting the width between barriers (W) to depth (H) ratio (W/H) to ≤ 0.71 , with LaModel allowing the varying influence of overburden lithology to be evaluated in both 2D and 3D. It is noted that the potential further contribution in this regard of the Hawkesbury Sandstone unit was fully recognised as part of the Hume Coal Project EIS, but not quantified due to the restricted W/H ratio between barriers being the primary layout control.

Both the 2D and 3D models have been conducted as part of a sensitivity study on the influence of the nature of the overburden on pillar loading distributions, recognising that due to overburden variability it will not be possible in reality to define actual pillar loading distributions at any given location within the mine. The objective of the modelling is to ensure that the stability of the proposed system incorporating web pillars and surrounding "barrier pillars" remains valid for a credible range of overburden conditions as defined by both laboratory testing data (in the case of E) and back-analysed values for t using known surface subsidence behaviour at Berrima Colliery as the back-analysis guide. This has resulted in a range of both E and t being conservatively applied in various combinations within the models, as justified by multiple observations.

As expected, the results for both the 2D and 3D models confirm that pillar load distributions for any given cover depth vary as a direct function of the assumed overburden parameters. For the stiffest assumed overburden conditions (ie high E and t), loads on the web pillars are reduced and those on the surrounding wider barrier pillars correspondingly increase. Conversely, even for the worst case scenario of minimum cover depth (80 m), both the 2D and 3D models show that the pillars behave as a system over the range of credible overburden parameters based on back-analysis and de-ratings for conservatism.

Further, the modelling also confirms Hume Coal's on-going position that the 2D ARMPS-HWM analyses, as used to design the web and intra-panel barrier pillars as part of the EIS, provided conservative design outcomes in terms of the stability of the narrow web pillars in isolation and the additional protection offered by the surrounding barrier pillars. This is as a direct result of the decision to significantly restrict the distances between intra-panel barriers according to ARMPS-HWM layout design rules.

ii Modelling process and scope

As discussed earlier in Chapter 4, the modelling process and scope achieved the objectives outlined above in Section 16.2.3i over five stages of work:

- confirm the validity of using the “coal wizard” modelling tool to characterise pillars;
- back-analysis of subsidence observations at the adjacent Berrima Colliery to obtain key overburden model parameters;
- parameter sensitivity in 2 dimensions (2D);
- parameter sensitivity in 3 dimensions (3D); and
- scenario analysis.

The 2D and 3D numerical modelling was undertaken using LaModel, which incorporates the Mark-Bieniawski pillar strength equations and associated stress gradient. This was to make the modelling outcomes directly comparable with those from ARMPS-HWM; the primary pillar design methodology used for the project in sizing the key coal pillars (webs and intra-panel barriers) within the proposed mine layout.

The scenario analysis involved the artificial “removal” of web pillars in order to simulate unrealistic worst-case pillar yielding (ie totally failed pillars with zero physical volume, infinite post-peak modulus and zero residual strength). In reality, a likely scenario would be that part of a pillar could begin to yield, but then would shed its excess load onto surrounding pillars. The modelled scenario conservatively assumes total failure and complete yield of the removed pillars, and also assumes their remnants don't occupy any volume in the panel thereby offering zero support to the overburden.

A detailed description of the modelling process, the history and pedigree of the modelling software and technique, and the underlying assumptions are contained in Heasley (2018). Interpretation of the results of the modelling is contained in MineAdvice (2018). Both reports are provided in Appendix 7.

iii Pillar characterisation using the “coal wizard” tool

An exercise was conducted to confirm the validity of using the “coal wizard” model tool to characterise the pillars according to Mark-Bieniawski pillar strength formula. This involved comparing results from pillars characterised using this modelling tool to pillars characterised manually, according to pillar stress-strain curves based on observational data prepared independently by MineAdvice. The results were virtually identical.

The outcome of this brief comparison was that the coal wizard was chosen to be used in subsequent models because:

1. the difference in output was insignificant;
2. the coal wizard can automatically generate yield zones and safety factor calculations in LaModel; and
3. the Mark-Bieniawski coal model has been verified and calibrated with the very large databases associated with ALPS (Analysis of Longwall Pillar Stability software) and ARMPS.

A more detailed explanation is provided in Heasley (2018) provided in Appendix 7.

iv Back analysis to Berrima Colliery

The second stage of the scope of work involved a back analysis of the subsidence observations at Berrima Colliery from three full-extraction panel subsidence monitoring survey cross lines, in order to determine reasonable values for the overburden parameter, “t” (or lamination thickness).

When combined with the overburden parameter “E” (Elastic Modulus), these two parameters effectively represent the stiffness of the overburden, with stiffer overburden meaning that the barriers carry a higher share of the load, and conversely, the web pillars carry less.

The elastic modulus of the overburden can be characterised using laboratory testing results from bore-core rock samples, with three values being chosen based on the high, low and average of the range of tested values. The back analysis was therefore conducted to determine reasonable values for the lamination thickness, t. As alluded to in Heasley (2018), when this approach is used, scaling of laboratory values of E to account for rock mass scale effects is not necessary since these effects are taken into account by the back analysed lamination thickness term (t), since these parameters are directly multiplicative in the model.

The results of the back analysis demonstrated that a model lamination thickness (t) of some 185 m was required in order to obtain a surface subsidence value of about 10 mm at an elastic modulus of 16.5 GPa.

Lamination thicknesses were chosen for the ensuing parameter sensitivity study of 20 m and 40 m so that the modelling results were sufficiently conservative, and to allow an assessment of mine stability at conservatively much lower levels of overburden stiffness than the observational data would suggest are present in the area.

v 2D and 3D parameter sensitivity analysis

The third and fourth stages of the modelling scope of work involved undertaking parameter sensitivity studies to understand the impact on mine stability of varying the overburden stiffness across three representative mining depths (80 m, 120 m, and 160 m). The 2D and 3D parameter sensitivity analyses support each other, with the 3D results showing additional load being distributed away from web pillars compared to the 2D analysis, as expected. This occurs primarily at the inbye one third to half of these pillars, where the combination of inter and intra panel barrier pillars forms an unbroken “U” shape and system stiffness is at its greatest.

The results of the parameter sensitivity study demonstrate a number of key points:

1. As expected, the overburden and pillar geometry is the key design control, with geology (overburden stiffness) taking a secondary role. This is shown by the fact that in the 2D modelling, a halving or doubling of overburden stiffness leads to typically less than 2-3% change in average web pillar safety factor.
2. The design outcomes in LaModel generally exhibit higher safety factors on web pillars than the original ARMPS-HWM design criteria.

The ARMPS-HWM safety factors are assumed to be averages for whole pillars, and are not able to be compared on a completely like-for-like basis along a pillar cross section like the outputs of the 3D model. It is notable though that in order for any part of a web pillar to experience a lower safety factor from the original ARMPS-HWM design criteria, the overburden stiffness needed to be de-rated almost an order of magnitude from the back analysed stiffness from subsidence observations at Berrima Colliery.

The scenario analysis was undertaken in order to understand the impact on global mine stability of localised pillar instability. Two purely hypothetical scenarios were analysed: the removal of the centre web pillar from the model; and the removal of all web pillars between a pair of intrapanel barrier pillars. These pillars were removed from the models in order to remove any stabilising influence on the pillar system that these pillars have. The results of the scenario analysis are the most important model runs from the point of view of both the assessment of global pillar stability, and validation of the original environmental impact assessment as being a “credible worst-case”.

The simulations undertaken for the scenario analysis represent purely hypothetical situations designed to test the integrity of the design, rather than representing any scenario that might happen. There is no plan to remove any pillars in the mine design.

A total of four 3D model runs were undertaken for the scenario analysis:

1. 80 m depth, one web pillar removed;
2. 80 m depth, seven consecutive web pillars removed (one entire set of webs between two intra-panel barrier pillars);
3. 160 m depth, one web pillar removed; and
4. 160 m depth, five consecutive web pillars removed (one entire set of webs between two intra-panel barrier pillars).

The key results of this modelling (provided in Table 16.1 below) demonstrate that even under the unreal assumption that an entire set of web pillars are removed from the pillar system, the surface subsidence and residual stability of the remaining pillars are generally in accordance with the original assessment presented in the Hume Coal Project EIS (ie imperceptible surface subsidence and long-term stable pillars).

Table 16.1 Key results from the 3D numerical modelling scenario analysis

Case	Peak subsidence	Interpanel barrier pillar safety factor	Chain pillar safety factor
80 m depth, one web pillar removed	3.6 mm	5.5	4.9
80 m depth, seven web pillar removed	23.5 mm	2.9	3.3
160 m depth, one web pillar removed	5.1 mm	4.1	2.5
160 m depth, five web pillar removed	16.4 mm	2.7	1.9

The minimum chain pillar safety factor (adjacent to a removed set of web pillars) is 1.9, indicating that the chain pillar would remain stable even under the hypothetical scenario that all the adjacent web pillars were removed and didn't bear any residual load; a situation that unrealistic.

However, it is important to note that the results presented in Table 16.1 do not take into account the potential for compression of coal roof and floor (where it exists), or the effect of depressurisation of the coal seam which are not taken into account in LaModel. Combined, these two effects may add about 5-10 mm of settlement.

Even in the case where all web pillars are removed, peak subsidence remains in the same order of magnitude as natural ground movements due to changes in moisture content, even in sandstone-derived soils, which have been shown to move via the use of sophisticated fixed GPS monitoring devices by as much as 20 to 30 mm independent of mining activity, in places in the Southern Coalfield.

The scenario analysis where all web pillars are removed is purely hypothetical for two reasons:

1. Even if the web pillars yielded entirely (which is highly unrealistic for the reasons below), the remnants would bear some load of the overlying overburden; and
2. The likelihood of these web pillars entirely yielding is not credible, given that there is significant stress relief on webs adjacent to both intra and inter-panel barriers. This is apparent in Figure 16.2, where the higher stress areas are shown by light orange colouring and the lower stress areas are denoted by red, purple and blue shading. This phenomenon of stress relief adjacent to barrier pillars has previously been described by Perry et al (2015) in a similar numerical modelling analysis of ARMPS-HWM designs, as leading to overly-conservative design outcomes for these pillars. For example, even in the case where one web is removed entirely from the centre of the panel at 80 m depth, the outer web pillars still have safety factors of 1.8.

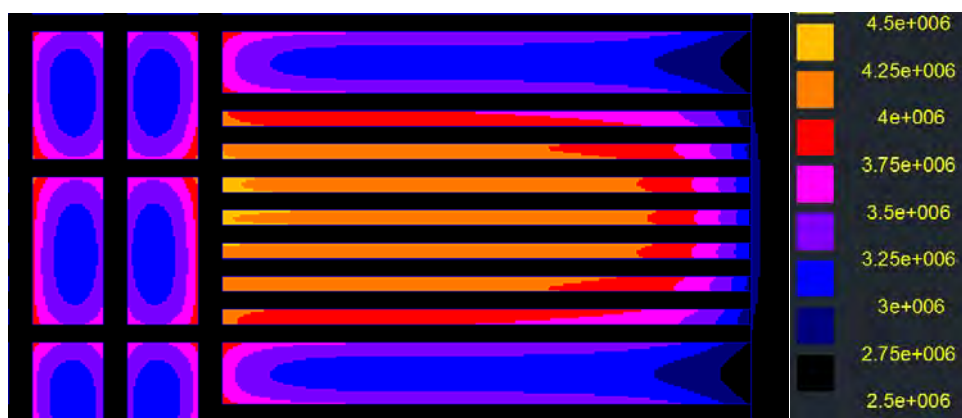


Figure 16.2 Pillar stress at 80m depth of cover, $E = 16.5\text{GPa}$, $t = 20\text{m}$ (scale in Pa)

The implications of the two points above are that even in the event that some parts of certain web pillars did yield, other parts of the web pillars are significantly shielded by the adjacent barrier pillars and therefore extremely unlikely to fail. The likelihood then of obtaining the barrier pillar or chain pillar safety factors modelled by removing all of the web pillars is therefore hypothetical, being based on scenarios that have been designed to test the integrity of the design with respect to the mine's global stability, rather than representing any eventuality that is assessed to be potentially likely.

16.2.4 Potential for damage to the overlying Hawkesbury Sandstone

The only mechanism by which a claim of irreversible environmental damage to aquifers could hold true would be if widespread, global pillar failures were to occur resulting in enhanced hydraulic conductivities of the overlying groundwater system rock; and the mine were designed in such a way that it would be self-draining in perpetuity. Two independent design methodologies have now demonstrated that a global pillar collapse is not a credible scenario: the original empirical design method described in the Hume Coal Project EIS, and the 3D numerical modelling that has been undertaken for the RTS (Heasley 2018). The mine will not be self-draining, and the remaining voids will fill with water once mining ceases and pumps are turned off.

Movements in overburden strata associated with the project are predicted to be significantly lower than would be required to enhance the hydraulic properties of the rock, and rock movements in the overburden are predicted to be elastic, even under the assumption of localised yielding of coal pillars. The mine is designed in such a manner that when the drift and shaft entries are sealed at the end of the mine life, the remaining void spaces in the mine workings will fill with water.

The mine is designed so that it is not freely-draining, unlike many mines that have been developed using adits off escarpments (like many Illawarra coal mines) or river valleys (such as Berrima Colliery). Once the mine has been sealed (or indeed each panel has been sealed) and the workings are fully saturated, the overall stability of the individual pillars becomes irrelevant, since any minor localised enhancement of the storage or connectivity of the groundwater system will not result in any increase to drainage from the mine.

16.2.5 Use of rock strength data in pillar design

Contrary to the assertions of the submitter, contemporary coal pillar design practice provides no opportunity to apply coal strengths determined from testing small diamond drilling borehole core samples to entire pillars, and Hume Coal has not done so. It is not even recommended practice to vary from the strength indices that have been empirically-derived from case histories involving entire pillars. Hume Coal has not used any coal strengths derived from bore core samples in any pillar stability calculations.

Core samples are not representative of the overall rock mass at the size and scale present in a coal pillar for core sample strength test results to be useful or meaningful to the designer. In this respect, Hume Coal agrees with the submitter, however claims that such data have been used in pillar design calculations are incorrect.

Coal pillar design is typically undertaken based on formulae that were derived from empirical studies, which generally attempt to define a discriminate equation between datasets of stable and unstable entire coal pillars; that is real case histories from coal mines. In this manner, the design equations take full account of scale, fracturing and geometrical effects present in coal pillar rock masses. Even numerical modelling must be calibrated against the pillar strengths determined from full-scale failed and stable pillar case histories, to properly account for the influence of geometry and scale on rock mass properties.

As stated by Mark (2007)²⁹:

The “classic” approach [to coal pillar design] was to test the uniaxial compressive strength (UCS) of small specimens in the laboratory, and then apply a “size effect” reduction factor to obtain an estimate of the in situ strength. **This approach was thoroughly discredited by a comprehensive study, involving 4000 individual UCS test results from over 60 coal seams, which found that there was no correlation between the laboratory UCS and actual pillar strength** (Mark and Barton, 1996). It seems that laboratory tests actually measure the degree of cleating in the specimen, but that cleat density has little relationship to pillar strength. Mark and Barton’s study also confirmed that the design formulas were far more successful in predicting performance when a uniform strength of 900 psi was employed. Studies conducted in South Africa and Australia have also found that a uniform coal strength worked reasonably well in pillar design formulas (Galvin et al., 1999).

Coal pillar designs are undertaken at sufficiently conservative factors of safety to account for natural rock mass strength variations.

The coal pillar design and pillar stability is explored in detail in the pillar stability assessment contained in the EIS, and this is supported by the 2D and 3D numerical modelling work subsequently undertaken.

²⁹ <https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/teoic.pdf>

16.3 Mining system

A number of general objections from the community and special interest groups to the Hume Coal Project raised concerns about the mining system. A number of submissions raised concerns about the innovative nature of the mining system, declaring it experimental and/or risky. One claimed the proposed method is untested or a simple derivation of longwall mining.

WSC claim that the mining method is largely new and untested. The EPA submitted there are uncertainties around the practicality of 'innovations' in the mine design and operation. The EPA also contend that the environmental risk associated with innovative mine design does not appear to be fully accounted for in the EIS.

Hume Coal does not propose to use the longwall mining method.

The Hume Coal Project EIS (section 2.3.1) characterises the mining system in the following way:

To eliminate and/or minimise impacts on surface features and water resources, the mine will use a non-caving mining method based on proven geotechnical design principles, leaving coal pillars in place. These will provide long-term support to the overlying rock strata. Using only first workings, there will be negligible surface subsidence, so overlying aquifers and surface features will be protected. The mine will install bulkheads to seal each panel immediately after extraction and backfilling. This means that groundwater in each panel can begin to recover once a bulkhead is installed. These bulkheads will result in a shorter recovery time for groundwater levels than in conventional underground mines.

Similar mining systems have been used at various locations around the world, including the United States of America and Australia. The innovative aspects of the project involve the manner in which proven techniques and equipment are combined to form a new mining system, as described below.

- Proven pillar design techniques from highwall mining (the ARMPS-HWM system developed by the National Institute for Occupational Safety and Health (NIOSH) in the USA) have been adapted and conservative factors included in its application to the project (such as the maximum distance between barrier pillars of 60 m). This is discussed in detail in subsidence assessment (refer to Appendix L).
- Proven mining plant and equipment from highwall mining and traditional underground coal mining will be used, such as remotely operated continuous miners (used in highwall mines all over the world), and flexible conveyors, which are currently used in Australia at Clarence Colliery and Ulan West and in other locations around the world.
- A bulkhead design concept has been included in the project using methods outlined in multiple design standards such as the publications: The design and construction of water impounding plugs in working mines by the UK Health and Safety Executive (HSE 2015); and Guidelines for permitting, construction, and monitoring of retention bulkheads in underground coal mines by NIOSH (Harteis et al. 2008).
- Proven plant and equipment designs for the underground reject emplacement, such as positive displacement piston pumps (used routinely in high-rise construction projects for concrete pumping), wear resistant pipe (used routinely in slurry pumping applications), and commercially available crushers and screens. The use of mine backfill has been used for years in underground metalliferous mines, and its application to underground coal mining has been carried out elsewhere in the world including in Germany and China.
- Proven, off the shelf designs for covered wagon hoppers which are commercially available at a number of manufacturers globally. Currently, most grain wagons operating in NSW have similar covered hoppers and have done so for decades. In NSW, coal wagons have been converted to grain wagons with the addition of pneumatic top doors, and vice versa.

The adaptation for use in the project of the techniques and equipment discussed above requires a typical level of engineering design for a modern underground mining project. Every mining project requires its own 'bespoke' tailoring of otherwise proven engineering solutions to meet its specific circumstances.

Hume Coal does not believe that there are any aspects of the proposed mining system that present undue environmental or mine safety risks due to innovation, since the plant and systems of work are largely proven and the innovations that are proposed represent incremental innovations and are inherently conservative.

The word *innovative* is not synonymous with unproven or incautious or perfunctory. Many innovations can be extremely conservative in nature; for example, where an innovation involves incremental, as opposed to step-change. Incremental innovations build on existing designs and the pre-existing knowledge base, and are typically low risk.

Many aspects of the Hume Coal Project design are innovatively conservative; for instance, the mine geometry with regard to the intrapanel barrier pillar spacing. Under the proposed design, the spacing between these barrier pillars is maintained at no more than 60 m, despite the empirical design methodology potentially allowing a larger spacing. Maintaining this spacing is a form of innovation that allows the mining equipment, chain pillar design and methods of work to be standardised across the mine.

Another example of an environmentally cautious approach is the use of bulkheads, in combination with a compartmentalised mine design, with panels oriented down apparent dip. This allows the mine to progressively seal the mine workings when mining is completed in a compartmentalised panel, limiting the footprint of the mine that requires de-watering. It is also cautious from a mine safety point of view since it limits the accessible parts of the mine and therein limits the risks associated with inadvertent access by the workforce and the potential for various other risks associated with old mine workings. The construction of monolithic plug-like seals to retain water in coal mines is not new and is not itself an innovation. These structures are built routinely in mines in Australia and around the world.

Many of the innovative aspects of the project involve the atypical combination of otherwise proven methods, plant and equipment. This represents an incremental innovation, since the individual elements are themselves proven in different combinations or uses.

The site that provides the best analogue to the Hume Coal proposal in terms of the overall mining plant and equipment, geology, pillar design and pillar design assessment, and level of subsidence impacts is Clarence Colliery, near Lithgow, NSW.

16.4 Mine safety

A few submissions from the community and special interest groups raised concerns related to mine safety. Some of these submissions are non-specific; others raise the following concerns:

1. Strata failure: Some submissions infer that the presence of Hawkesbury Sandstone in the overburden is a safety issue, although they are not specific about why they believe this to be the case. Another claims that “the use of high wall mining methods with remote controlled continuous mining equipment, adjacent to sealed and flooded mined out panels, in an environment of unresolved faults and volcanic intrusion, should raise safety concerns with the authorities involved”.
2. Inrush: Numerous submissions raise safety concerns due to potential water ingress. Claims were also made that returning water to mine voids represents a serious safety risk citing the Gretley disaster and alleging the risk cannot be fully mitigated.
3. Explosion: One submission claims that the orientation of mine entries away from the freeway “just in case” there was a problem (ie explosion), whilst unlikely to impact the freeway, does not give great deal of comfort over the use of new technologies.
4. Reject emplacement: one interest group submission states that Safe Work Australia, in their *Code of Practice for Inrush and Inundation Hazard Management*, identify hydraulic and paste-filling operations as a hazard, and the Airly Colliery near Lithgow rejected reject emplacement in mined voids on the grounds of cost and safety.

16.4.1 Risks from strata failure

In terms of the risk to personnel arising from strata failure, the use of remotely operated equipment is of a benefit to the safety of personnel, since people will not be directly exposed to these hazards at the mine face during normal mining operations. Strata failure will be managed via the use of the principal hazard management plan covering ground or strata failure. The requirement for this plan is developed under Clause 24 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 and the matters must be considered in developing the control measures to manage the risks of ground or strata failure are provided in Schedule 1 of the regulation. This includes the potential for failure of roof and sides, as well as the potential for failure of pillars.

Detailed discussion on the issue of pillar stability is provided in Section 16.2. The presence of the Hawkesbury Sandstone represents a benefit to mine stability in the context of the mining system that is proposed. If the mine was developing large unsupported goaf areas (such as those formed by a longwall), the potential for wind blast and periodic loadings would have needed to be assessed, however these hazards are not relevant to the proposed mining method, which does not result in large unsupported goaf areas.

The development of the web pillars is further covered by Clause 33 of the Work Health and Safety (Mines) Regulation 2014 which sets out the notification requirements for “high risk activities” to the mine safety regulator. Schedule 3 of the Work Health and Safety (Mines) Regulation 2014 lists the activities considered to be “high risk”, and this includes the “formation of non-conforming pillars”.

In this clause, “conforming pillar” means a pillar, the shortest horizontal dimension of which is no less than: (a) one tenth of the thickness of the cover (to the surface), or (b) 10 m, if the thickness of the cover is less than 100 m. The formation of a pillar, other than a conforming pillar, is identified as a high risk activity.

All of the web pillars to be formed at the Hume Coal Project would be classified as “non-conforming”. The waiting period for the activity (mining, to form non-conforming pillars), following notification is 7 days. The information and documents that must be provided in relation to the activity are as follows: (a) engineering drawings of the activity endorsed by the individual nominated to exercise the statutory function of mining engineering manager at the mine, and (b) a geotechnical report on the activity, in addition to the standard information required by clause 33 for a high risk activity notification, which includes a risk assessment.

These notifications and management plans are matters that will be addressed if development consent is granted. The development of principal hazard management plans and the associated legal requirements for workforce consultation are covered earlier in this chapter.

16.4.2 Risks from inrush

With the exception of the risk of bulkhead failure, which is discussed earlier, the risks of inrush of water or slurry can be divided into two distinct categories:

- inrush due to an inadvertent reduction in width of a barrier, leading to a physical breach; and
- inrush of water along a geological structure.

Of these two broad categories of inrush hazard, the first category is likely to result in more severe consequences, with a large number of examples worldwide where fatalities have resulted from the sudden flooding of an active mine. To the extent that can be determined via the available literature, all examples of inrushes along geological structures which have resulted in serious incidents have been associated with accidental or inappropriate reduction in barrier width. This is discussed in further detail below.

In the case of the Hume Coal Project, this type of inrush is extremely unlikely, to the extent of not representing a credible risk scenario. This is due to a number of reasons:

1. Most of the case histories where an inadvertent reduction in barrier width has occurred involve incidents where the active mine intersected historical workings or adjacent mine workings for which a precise location was not known. By contrast, all of the workings at the Hume Coal Project will be surveyed by qualified mine surveyors using modern survey techniques and/or inertial navigation systems as mining occurs, and recorded on the mine's survey plan. Such systems have been demonstrated to be able to run with extremely high accuracies, and will provide a high level of confidence of the location of all mine workings. For example, field trials have demonstrated inertial navigation systems having real-world precision of 100 mm over a 380 m plunge, with newer systems providing even better accuracy. The plunge lengths proposed by Hume Coal are 120 m. Furthermore, the length of plunges will be physically limited by the lengths of the continuous haulage systems, cable and hose lengths and other physical constraints. There is no credible circumstance where one or more plunges could be in error so much as to result into a breach into an adjacent panel.
2. A second, contributing factor to many of these case histories is that the designated barrier width was insufficient to allow an adequate factor of safety against collapse due to overburden loading or failure due to hydraulic head. The barriers at Hume Coal have been designed to provide 50 m of solid coal between adjacent panels. This is based on the requirements of NSW mine design guidelines. Specifically, MDG1024 calls for *“establishing and maintaining a solid coal barrier of at least 50 m between the workplace and the assessed worst case position [of adjacent mine workings]”*. The use of a 50 m barrier is conservative. This width of barrier has an extremely high factor of safety for all depth ranges within the Hume Coal Project mine footprint and, with a width to height ratio of 14:1 these barrier pillars would be considered to be “practically indestructible”.

3. There are various methods of calculating barrier pillar width for inrush control from around the world, and using typical parameters for the Hume Coal Project, these alternative methodologies result in narrower barrier widths than the proposed 50 m width that is indirectly derived from NSW legislation, and defined within MDG 1024. The barrier pillar widths recommended by the various international methodologies at 130 m of pressure head and 3.5 m mining height are shown in Table 16.2. Both result in narrower barrier widths than the 50m barrier pillars proposed for the Hume Coal Project.

Table 16.2 Recommended barrier pillar width according to international methodologies

Country	Formula	Recommended barrier pillar width
USA	Ashley Formula	33.1 m
UK	King and Whittaker	26.7 m

Inflow of water along a geological structure is a more likely risk scenario than an inadvertent holing of adjacent mine workings; however, this risk will be carefully managed in accordance with NSW legislative requirements, which include a requirement for the mine to develop and implement principal hazard management plans³⁰, including one specifically for inrush risk. The inflow rates associated with this type of event tend to be manageable, where barrier pillar widths remain at appropriate widths. The workforce consultation requirements associated with the development of such hazard management plans are discussed earlier in this chapter.

Small scale faults and dykes are very common features in underground coal mines, and these features are added to the mine's survey plans as they are encountered. When these features are mapped, their thickness and orientations are recorded. Since these features tend to be linear, their projections are generally easy to factor into planning for subsequent adjacent mine panels.

Presently there is no known evidence to suggest an altered or locally-varying hydraulic conductivity field around potential faults within the proposed Hume Coal mining footprint. However, evidence does exist to support the notion that an altered conductivity field exists around two potential geological structures to the south of the mining footprint. These structures are interpreted to be in the form of subvertical flow barriers, with potential for enhanced lateral hydraulic conductivities immediately adjacent to the structures. These structures run approximately parallel to the southern boundary of the mine footprint and any reasonable extrapolation of their lateral extent does not intersect the proposed mine workings, inferring that they will not impact on the proposed mine workings.

Ultimately, the geological and hydrogeological characterisation of faulting within the mining footprint will improve with the benefit of underground mapping and other potential techniques such as the proving of structures using in-seam drilling.

This improved knowledge may necessitate variations to the conceptual mine plan, such as leaving blocks of coal behind as barriers to flow between mapped and inferred faults and mine voids, should it be determined that the faults are likely to act as flow conduits.

³⁰ http://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0009/691614/principal-hazard-management-plan-guide.pdf

Other circumstances may require mitigation measures to be adopted, such as the pre-grouting of faults or other potential flow conduits such as paleochannels (if their intersection with mine workings is inevitable), or leaving wider barriers in place. These are operational decisions that will be made by mine management in accordance with the relevant risk assessment and hazard management processes in place at the time, in accordance with legislated workforce consultation requirements.

Inrush hazards will be managed via the use of the principal hazard management plan covering inrush. The requirement for this plan is developed under Clause 24 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 and the matters that must be considered in developing the control measures to manage the risks of inrush are provided in Schedule 1 of the regulation. These management plans are matters that will be addressed if development consent is granted. The development of principal hazard management plans and the associated legal requirements for workforce consultation are covered earlier in this chapter.

16.4.3 Literature review

A review of available literature including Gui and Lin (2017)³¹, Vutukuri and Singh (1995)³² and Moebs and Sames (1989)³³ suggests that inrush incidents involving geological features have occurred in the past, with the majority involving an inrush along a fault intersecting old workings or some other water-bearing feature. Where these events posed serious safety incidents (including fatalities) the barrier width was also clearly inadequate, with some barriers being so narrow that they failed structurally. Certain case histories, including a number from Taiwan and China, involve very steeply dipping and geologically complex seams, with stored water immediately above, or above-and-adjacent to the active workings.

The cases where inadequate barriers were involved appear to be almost exclusively the cases with higher inflow rates and fatalities. A further group of these case histories involve connections of relatively deep mine workings to overlying karst aquifers via faults. Karst rocks, being soluble in water, often contain networks of caverns and open voids; a situation that is specific to that particular geology and not credible in Hawkesbury Sandstone.

Vutukuri and Singh (1995) describe an earlier analysis by Job in 1987 which characterised inrushes in British collieries between 1851 and 1970. During this period, "contact with abandoned old workings" accounted for 162 cases, whilst "strata water entering working" accounted for two cases.

Moebs and Sames (1989) provide an analysis of inrush incidents in the US between 1883 and 1985. During this period, about half the recorded inrush incidents occurred due to very shallow mine workings intercepting unconsolidated, saturated surface sediments ("sand, gravel or clay deposits") whilst the remaining half "resulted from inadvertent penetration of a coal barrier". A key factor in the incidents at shallow mines that have inadvertently intercepted unconsolidated sediments is that the sediments themselves can flow into the workings when saturated with water. This is an important distinction when compared to mining below a saturated but competent rock mass.

As discussed earlier, the inadvertent holing through into old workings is not a credible inrush scenario for the Hume Coal Project, and the proposed workings are not shallow enough to intersect unconsolidated surface sediments. This type of strata failure is known as a "sinkhole". Sinkholes attributable to coal mining have not been known to occur above mines at depths greater than 50 m in Australia (Canbulat et al., 2017).

³¹ <http://wpt.iwaponline.com/content/12/2/444>

³² https://www.researchgate.net/publication/226701718_Mine_inundation-case_histories,

³³ https://stacks.cdc.gov/view/cdc/10577/cdc_10577_DS1.pdf

One case history was identified in Moebs and Sames (1989) involving the movement of water from an adjacent mine through the roof strata along a suspected paleo-channel. This is a credible potential scenario that needs to be considered when developing the inrush management plan. This event did not result in a “catastrophic” inrush, with manageable inflow rates of around 15 L/s. This event was correctly defined as “leakage across a barrier pillar”. The width of the barrier in this case was thought to be 140 m, but the barrier integrity was only proven to a depth of 50 ft (15 m) by drilling. Given the era and location of the adjacent mine workings, there is a reasonable likelihood that the old mine workings may have been significantly closer than intended.

16.4.4 Explosion risk

All coal mines must consider the risk of explosion due to the liberation of explosive gases (predominantly methane gas) during mining, and the presence of coal dust in the mine workings. Coal dust is explosive when stirred up into air, similar to other fine combustible materials such as wheat flour or sawdust.

Explosion is one of the principal mining hazards described in the Work Health and Safety (WHS) (Mines and Petroleum Sites) Regulation 2014, and the regulation requires a management plan to be developed for each underground coal mine.

The methane gas content of the coal seam that has been measured in borehole samples at the Hume Project, and in mine ventilation air at the adjacent Berrima Colliery, is extremely low. This means that the explosion risk due to methane gas is reduced when compared to typical underground coal mines. This risk must still be managed however, since methane gas or other explosive gases may still be present in pockets of the mine.

The risk of coal dust explosion is also therefore lowered, since coal dust explosions are typically initiated by a methane gas explosion; however, this risk will also need to be managed at the mine, via the use of underground explosion barriers and explosion-suppressing limestone dust that is applied to the inside of the mine workings.

The orientation of the mine entries is part of the management of explosion risk. The fact that this risk has been considered in the design provides no more of an indication of the likelihood of an explosion than the presence of a life jacket under the seat of a passenger aeroplane is an indication of the risk of ditching at sea. (Since the introduction of passenger jet airliner services in 1958, only four occurrences have clearly met the criteria for a ditching event involving a passenger jet³⁵, yet all passenger aircraft are fitted with lifejackets).

16.4.5 Underground reject emplacement

There is little doubt that the surface emplacement of coal reject would be cheaper and less burdensome on the project from a risk management point of view; however, in 2014 Hume Coal was advised by the Department of Planning to design the mine to include underground reject emplacement rather than surface emplacement facilities.

The risks associated with underground emplacement are not unmanageable and the costs have been taken into account in the project's cost model. Further responses to submissions regarding underground reject emplacement are provided in Chapter 11.

³⁵ <http://www.airsafe.com/events/ditch.htm>

16.5 Resource recovery

1. Respondents questioned the mine viability drawing a causative relationship between a mine's extraction ratio and mine viability. Others noted the low recovery rate and claimed that other mines on the South Coast have argued that mining a high proportion of the resource is essential to their economic viability.
2. It was also claimed that the inclusion of a secondary thermal coal product is contrary to earlier public statements by Hume Coal and makes the mine uneconomic.
3. Claims were also made that the mine will extract a low quality coal. In particular, 45% of the product mix will be thermal coal, which is a 'second rate' coal.

16.5.1 Amount of resource to be recovered

The coal recovery rate is a function of the mine design. The design attempts to strike the correct balance between protecting environmental values and resource utilisation by ensuring that there is sufficient coal left in place in the form of pillars to maintain overlying ground/strata stability, reducing surface subsidence to negligible levels and minimising disturbance to the groundwater system.

Like any business, the viability of a coal mine is determined by the costs and revenues of the mine. Revenues are driven by the type of coal and its quality, and the number of tonnes of each type of coal produced. Costs are driven by the type and amount of labour, the type and numbers of equipment used, the amount of consumables used and the mine's overheads. Hume Coal's financial models are built from first-principles on this basis.

The economic viability of a mine is not a function of resource recovery. There is no place for resource recovery as a driver of costs or revenues in the project's financial model. Resource recovery is perhaps a third-order consideration which is only very loosely related to the rate of production, and therefore only weakly related annual tonnages.

There are many examples of longwall mines with far higher resource recovery rates compared to that of the Hume Coal Project that have proven uneconomic during economic downturns, just as there are numerous examples of bord and pillar operations producing thermal coal which continued to operate at positive cash margins even during the lowest point in the price cycle.

Mines that produce metallurgical coal receive higher prices than mines producing thermal or steaming coal, with benchmark metallurgical coal typically receiving about an 80% premium to benchmark thermal coal. The Hume Coal Project will produce about 55% metallurgical coal and about 45% thermal coal on average, giving the project a revenue advantage over mines that only produce thermal coal.

In the case of the Hume Coal Project there are many factors that are favourable from a cost perspective, including the low cover depths, lack of methane gas, favourable geotechnical conditions, favourable seam thickness, and lack of legacy infrastructure to name a few. The ability to employ a residential operational workforce also represents a material cost advantage when compared to mines with drive-in-drive-out or fly-in-fly-out workforces; the typical labour cost differential being between 15-30% on the basis of accommodation and travel costs alone.

Claims that reducing the percentage of resource recovered will increase the overall mine footprint are not correct. The mine footprint has been set by a number of hard and soft constraints, combined with an element of judgement of the mine designer. These constraints include things like the exploration lease boundary, depth of cover, coal quality and seam thickness.

16.5.2 Product mix

Hume Coal has stated that the mine would produce a primary coking coal product as well as a secondary thermal coal product in public information dating back to at least 2012, and possibly prior to this. Examples of these documents are available on the Hume Coal's website.

The two-product sales mix has always been taken into account in the economic evaluation of the project.

16.5.3 Coal quality

The quality of the coal has been determined by extensive testing and is taken into account by the economic modelling.

Bore cores from exploration drilling across the mining footprint, including bores drilled by Hume Coal as well as historical bores have been tested by accredited laboratories to determine the coal quality, product split and potential product yields.

The laboratory-determined yields have then been converted to practical yields (ie those achievable in a coal preparation plant) with the aid of LIMN modelling, which is a software package specifically designed for this purpose. The mine scheduling software has then taken into account these practical yields, as they vary over the mining footprint, in order to determine the annual saleable product tonnages, via the software program. These tonnages then form the basis for the economic modelling of the mine, including (for example) for the calculation of annual royalties.

The economic modelling has taken into account the quality of the product coal in calculating the mine's revenues, royalties and other economic benefits. Hume Coal engaged a coal marketing expert to determine appropriate price premia/discounts compared to benchmark coals, based on the specific, laboratory-determined characteristics of the coal to be produced, and has applied these premia/discounts to the benchmark price forecasts in order to determine the mine's revenue estimates.

It is also notable that the DPE Division of Resources and Geoscience noted in their submission on the project that their review of available coal quality information suggests the proposed product quality, market split and yield is achievable.

16.6 Exploration and Geology

A range of submissions from the community and special interest groups focussed on matters relating to exploration and geology. These submissions included the following assertions:

1. Exploration data - There is insufficient coverage of borehole exploration data to provide confidence in the resource estimate, geological characterisation, groundwater model and the overall mine plan. There is no certified estimate of the coal reserves, and insufficient exploration data is provided to the public in the EIS;
2. Earthquake potential - The area is due for a major earthquake. A349 lies within the seismicity zone once known as the Robertson-Moss Vale seismic belt. Even a minor earthquake might cause pillar and roof collapse, and could damage bores and aquifers.
3. Geological structures –
 - i. Neither the mine design nor the EIS takes into account the geological structures present. Geological structures and stresses can impact mine design. The assumptions used for geology are simplistic and dangerous. Whereas the geology is unique/complex, faulting and intrusions have been underestimated and difficult to detect in fractured core. It was further asserted that the extent of geological structures at Dendrobium mine has forced significant changes to mine layout and problems during mining. Yet this mine is in an area with far fewer geological discontinuities than the Hume Coal lease.

ii.	Hawkesbury Sandstone has numerous geological structures. How are workings going to be 'modified appropriately' if structure is unexpectedly intersected, and what are the long term geological risks?
iii.	Geological structures can lead to far field impacts on groundwater. Faults can act as conduits for water flow, and if the mine intersects a geological structure it will rapidly flood. The mining method adjacent to flooded workings should raise safety concerns.
iv.	Using high risk experimental 'high wall' mining techniques in an underground situation with 'difficult' geological conditions is concerning.
4.	The experience of mining the Illawarra Coal measures on the South Coast is not transferable to the Southern Highlands
5.	Hume Coal plan to mine relatively close to the surface (80 m to 180 m underground), right under an approximately 100 m thick, highly productive and badly fractured Hawkesbury sandstone layer which holds large volumes of water.

16.6.1 Coverage of exploration data

The coverage of geological information over the proposed mining footprint provides a high degree of understanding of the geological setting within A349. The coverage of geological information is sufficient to support the development of the mine plan.

Additional data is not required to progress the Mining Lease and Development Applications. There are in excess of 350 holes drilled over the Authorisation which provide ample evidence and data to support the development application for A349, including the lateral extent and thickness of the seam, the composition and thickness of the rock above and below the seam, and the quality of the coal. Additional exploration and geological data may be sought in certain areas during the life of the mine to support detailed production planning and make operational decisions; however this data is not required for a development consent application.

Reports for both coal resources and coal reserves have been prepared by 'Competent Persons' to Joint Ore Reserves Committee (JORC) requirements; however the reports remain confidential and proprietary information to the company. These reports are not required to be presented in the environmental impact statement and were not requested in the SEARS.

The majority of the proposed mining footprint is covered by a coal reserve (indicating a high level of confidence that the coal is able to be economically mined), and the entire mining footprint is covered by a coal resource.

One submission called for regional seismic surveys to be tied in to the geological model. While site-specific, purposefully-designed surface seismic surveys could be helpful in identifying geological structures in the A349 area and may be used to aid pre-production planning, regional seismic surveys would not improve geological interpretation within A349. Regional seismic surveys are usually undertaken at very high levels, typically basin-wide (or at least very extensive), and rather than focussing on a specific horizon (such as a coal seam) they usually have targets that are generalised. Regional seismic data lacks the detail that would be required to improve definition of the Wongawilli Seam or other geological horizons beyond what is currently available from borehole data and other points of observation (eg outcrop mapping) that have been used by Hume Coal.

Two areas of detailed, purposefully-designed 2D surface seismic have already been undertaken by Hume Coal within A349, and these surveys have proven useful for mine design. The work was undertaken by a leader in the field of seismic acquisition (Velseis), who also undertook the processing and interpretation for this work. The work was helpful in confirming geological structure but the interpretation of the geology of A349 does not rely solely on this seismic information or the borehole data. Several magnetic surveys have been completed across A349 (both airborne and ground-based) as well as airborne LiDAR, photography, gravity and radiometric surveys. Whilst these surveys remain confidential, some of the details of the seismic and magnetic surveys and their interpretation have been openly discussed and presented by Hume Coal in public at symposia, conferences and AusIMM meetings.

In addition, surface mapping has been undertaken to identify and map the surface expression of potential faults, dykes, diatremes and other features.

16.6.2 Earthquake potential

The Newcastle earthquake occurred in 1989 and was classed as a moderate earthquake, at 5.6 on the Richter scale. It left 13 people dead, and resulted in \$1.5 billion (1991 dollars) in damage³⁶. Many parts of Newcastle and surrounds having extremely shallow historical mine workings; in some cases less than 10 m deep.

Perry (1990) provides a description of the earthquake and subsequent investigations. These investigations revealed that “no damage to [operating] coal mines was reported” as a result of the earthquake, and according to Dr. Kevin McCue, who was at the Australian Bureau of Mineral Resources at the time, there was no convincing evidence of long term settlement resulting from the earthquake. In addition, he found no correlation between underground mine locations and heavily damaged areas, nor any evidence of earthquake-induced mine subsidence. This is significant, given the shallow depth of some of the historical mine workings in the area.

“N-waves” (or Rayleigh waves) travel along the Earth’s surface and are the type of waves primarily responsible for earthquake damage. The energy in these waves decays rapidly with depth, reaching a small fraction of their surface intensity at 100 m depth. In the case of Newcastle, this is extremely relevant given the shallow nature of the mine workings. By comparison, the mine workings at Hume Coal will typically be around 130 m (ranging 70 m to 170 m) below the surface. Any earthquake energy with the potential to damage coal pillars in the mine would be attenuated by the depth below the surface.

An analysis was conducted for Solid Energy in New Zealand into the potential impact of a magnitude 8 earthquake on the Spring Creek underground coal mine (Marchant et. al. 2004). A literature review was conducted as part of that study and included the following:

Dowding and Rozen summarised the damage to various underground mines from about 70 observations of earthquake damage in mines worldwide. They used an empirical formula to estimate the peak ground acceleration from the earthquake magnitude and the distance from the epicentre. A strong correlation between damage and increasing ground acceleration was found, with only minor damage occurring when the peak ground acceleration is below 0.5g, where g is the acceleration due to gravity. Sharma and Judd added new observations to those used by Dowding and Rozen (about 150 observations in total) and found that damage decreases with increasing depth of the mine workings, related to the fact that Rayleigh waves decay with depth.

Geoscience Australia provides web-based earthquake hazard mapping based on the peak ground acceleration from earthquakes with an annual exceedance probability of 1 in 500. For the Hume Coal Project area, this mapping provides a peak ground acceleration of approximately 0.0575g³⁷, or about ten times lower than the level at which “only minor damage” would occur.

³⁶ Minfact 21, March 1995, Minerals Council New South Wales

³⁷ <http://www.ga.gov.au/darwin-view/hazards.shtml>

This finding is consistent with the evidence from the Newcastle earthquake.

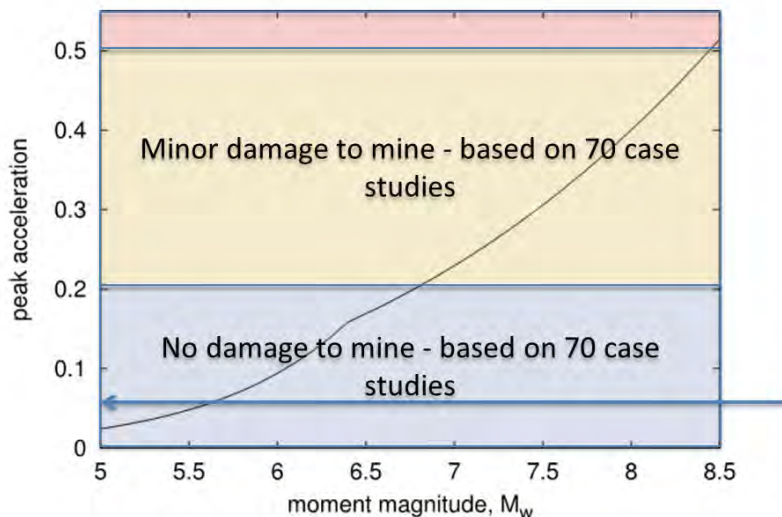


Figure 1. The peak ground acceleration, scaled by g , versus moment magnitude M_w , for $T = 0.2s$ and $r = 40km$.

Figure 16.3 Geoscience Australia Earthquake Hazard ranking for the Southern Highlands (adapted from Marchant and Weir 2004)

Given the empirical evidence from a range of case studies around the world, including the Newcastle earthquake in 1989, it is reasonable to conclude that the mine workings would suffer no damage and there would be no resulting surface settlement or damage to surface structures caused by the mine as a result of an earthquake of the magnitude contemplated by the Geoscience Australia hazard mapping.

16.6.3 Geological structures

i Mine design and geological structures

There are expected to be several geological structures present within the mining area of A349. An interpretation has been made about these geological structures, and the mine plan has taken these geological structures into account. Several areas associated with geological structures will not be mined. The comment that the mine plan takes no account of geological anomalies is incorrect. The footprint of the mine plan takes into account every known geological structure, as well as those that are inferred with high confidence, including diatremes and faults, and these areas are shown as being unmined in the concept plans that form the basis for the EIS.

There will be additional unknown geological structures intersected during underground mining development. This situation cannot be avoided in underground coal mining, and is commonplace across the industry. There is nothing to suggest that the geology at the project is unusually complex.

The systems of work and management systems at underground coal mines are specifically set up to cater for this type of occurrence, and use methods like Trigger Action Response Plans (TARPs), geological mapping and mine surveys, and strata hazard management plans to deal with these occurrences. Small faults and dykes are commonly mined through with no disruption or deterioration to conditions.

The proposed mining system is ideally equipped to deal with unknown geology. The initial development of chain pillars, combined with mining in prior adjacent panels, will allow high confidence geological hazard plans to be developed prior to commencing to form up web pillars, and allow plans to be varied accordingly. Additional structure encountered during mining of plunges would be subject to a TARP, with the ultimate response being to withdraw the mining machinery and proceed to the next plunge. Successive plunges can be shortened, or skipped entirely, if necessary to ensure mine safety and environmental outcomes are achieved.

An assertion was made in the submissions that the Hume Coal Project area has far more geological discontinuity than Dendrobium mine. Hume Coal's Exploration Manager has spent 21 years working for Illawarra Coal and frequently visited, inspected, mapped underground workings and assessed geological structures in all of Illawarra Coal's Wongawilli Seam mines; Kemira, Nebo, Dendrobium and Wongawilli Collieries. It is his opinion after working at Hume Coal for four years that Hume Coal would have a comparable number of geological structures as Dendrobium or any of the mines noted above. A comparison of the known geological structures in and around Dendrobium Mine as shown on the Southern Coalfield Regional Geology Map with Hume Coal's Geological Structures as shown in the EIS indicates that the number of geological structures present is comparable in frequency.

In terms of workload remaining to improve the geological understanding, this should be considered at different scales. On a broad scale, Hume Coal has a clear and well defined overall geological understanding of the Wongawilli Seam and the overlying strata (the Hawkesbury Sandstone and the Wianamatta Shales), the quality of the coal, and geological structures. Pre-production drilling to define and delineate fault structures, including orientation and precise definition of faulting (throw, dip, and nature), will be considered post project approval.

ii Hawkesbury sandstone

Jointing, fracturing and faulting are geological features varying in their intensity and impact across the A349 area. They are common geological structures in the Hawkesbury Sandstone (HBSS), but are restricted in both their horizontal and vertical extent by nature. The sandstone in the HBSS was originally deposited as sands and silts in a major braided river system. As the sands were compressed and cemented over time they formed rock. Joints typically formed as part of this diagenesis process, as part of shrinking from sediments to stone; whereas fractures tend to form from deformation forces (eg compressional stresses impacting on the strata). The HBSS is about 100 m thick throughout the A349 area, consisting of numerous beds of variable thickness and joints which are often restricted vertically within the same bed. Fracturing is a lot less common than jointing and would generally extend further than joints. Their influence is not expected to have a significant impact upon underground operations. Faulting in A349 is less prevalent than jointing or fracturing, but would tend to be more extensive in both length and height. The mine plan has been designed to take into account these geological structures.

iii Geological structures and groundwater

The geological structures identified at the Wongawilli Seam level are also likely to extend into the HBSS. It is also likely that some structures present in the HBSS and/or the Wianamatta Shales will not extend into the Wongawilli Seam (such as jointing and fracturing). It is possible that geological structures could act as conduits to facilitate increased water flow into the Wongawilli Seam. Where this occurs, a marginal increase in water inflow into the workings could be expected. This will be managed by the water management system of the mine.

The groundwater model developed for the Hume Coal Project has been calibrated to the inflows experienced in the same geological conditions at Berrima Colliery, and incorporates the results from well pumping tests undertaken above the proposed mining footprint. These both provide an estimate of the hydraulic properties of the rock mass, which takes into account fracturing and other geological features.

The groundwater model also takes into account the pre-mining hydraulic heads present across the mine footprint, as well as the progressive depressurisation that occurs ahead of mining within the coal seam. The calibrated groundwater model suggests that the inflows to the mine will be manageable, and well within typical quantities handled by coal mines.

The issue of groundwater inflows to the active parts of the mine from sealed panels is addressed earlier in Section 16.1.1.

The proposed mining technique is also addressed earlier in Section 16.3. The impacts of the proposed mining method on the overlying groundwater system are no different to any other non-caving pillar design. The ground movements predicted by the geotechnical 3D numerical modelling are well within the elastic range for the overburden, indicating that no new fractures or flow paths will be opened up in the overlying rock.

16.6.4 Previous experience of mining the Illawarra coal measures

The seam proposed to be mined at Hume Coal is the Wongawilli Seam. This is the same coal seam that has been mined in the Illawarra (and also the Southern Highlands at the adjacent Berrima Colliery) for over 150 years. Mining experience that would be transferable from the mining the Illawarra coal measures in the South Coast to the Hume Coal Project in the Southern Highlands includes: ventilation design, safety measures, inrush planning, coal quality, mining techniques, mining machinery, supporting methodologies (roof, rib behaviours), services (electrical, water, air etc), conveyors belts, coal transport, pillar design, subsidence assessments, and assessment of geological structures. An exhaustive list would be very extensive.

Further, Berrima Colliery, which is immediately to the north of the project area, used the “Wongawilli” method of bord and pillar mining for many years. This method was developed at Wongawilli Colliery on the South Coast.

16.7 Coal seam gas

A community submission questioned whether allowing coal mining in the area would then lead to coal seam gas extraction.

There is no potential for the extraction of economic quantities of coal seam gas in the area as there is practically no coal seam gas present.

Hume Coal has measured the gas levels in all of the coal seams present in A349 and also within the Hawkesbury Sandstone. Section 2.5.3 of the EIS (gas drainage) provides summary details of the gas contents and composition. The volume of gas is exceptionally low and nearly 100% of what is present is carbon dioxide (CO₂).

Further, Hume Coal does not hold any form of tenure that would allow the exploitation of coal seam gas, if it did exist.

16.8 Subsidence

In their submission Subsidence Advisory NSW state they have no objection to the Hume Coal Project, provided the DPE ensures the mine operator is required to adhere to the maximum vertical surface subsidence predictions as outlined in the Hume Coal Project EIS as part of the conditions of approval. They noted that the predicted worse case subsidence movements are well within those outlined within AS2870 ‘residential slabs and footings’. Therefore, Subsidence Advisory NSW considers that the predicted subsidence would not result in noticeable damage to surface infrastructure.

Community submissions in support of the project also noted the low impact nature of the mine design and the very low predicted levels of surface subsidence, which translates to negligible subsidence impacts on man-made and natural structures.

Other submissions relating to subsidence are discussed below.

Mining method and confidence in predictions: The DRG references the 'untested' nature of the proposed mining method, recommending that subsidence predictions and effects be a consideration of the independent expert advice sought [by DPE] in relation to the proposed first workings mining system. Principally, DRG requested that the construction and placement of fill, and claims in the EIS that near zero subsidence would result from this mining system, be addressed in the advice.

Subsidence impacts on surface features: DPI – Agriculture submitted that potential impacts from subsidence may impact on agricultural operations or infrastructure, stating that the subsidence management plan should include the management of subsidence impacts to rural landholdings, including impacts to infrastructure and any impacts to agricultural operations.

A number of community submissions also raised the issue of subsidence risk. Others raised concerns about houses being affected by subsidence due to undermining. Some submissions claimed that subsidence would destroy or threaten buildings in the townships of Exeter, Berrima and Sutton Forest and another submission claimed that three houses to the north of the mine could be affected by subsidence. Claims were also made that subsidence would cause risks to the Hume Highway. Two submissions raised the issue of cracking of stream beds and surface connective cracking, and impacts on groundwater. One submission claimed sink holes will open up beneath roads and the Main Southern Railway line. Other submissions cited subsidence risks or subsidence impacts more generally.

The Hume Coal Project EIS (EMM 2017a) addressed the issue of mine-induced subsidence in the subsidence assessment report provided in Appendix L, including an assessment of the potential impacts on built and natural features. This addresses all of the submissions claiming that the proposal represents a subsidence risk to streams, surface connective cracking, buildings and houses, agricultural operations, and the Hume Highway.

Since the EIS was written, Hume Coal commissioned 3D numerical modelling of the proposed mine workings, which was undertaken by an expert in the field from the University of West Virginia in order to provide another complementary assessment of pillar stability and subsidence using a different, independent methodology (as described above in section 16.2.3). The modelling provides confirmation of the magnitude of vertical subsidence assessed in the EIS, even in the improbable scenario that an entire series of web pillars is "removed" from the mine layout. That is, the predicted maximum level of subsidence associated with the project is so low that subsidence related impacts on surface features will be imperceptible. Further, with maximum surface settlement across the project area predicted to be less than 20 mm (and significantly less in many areas), the potential for significant three-dimensional horizontal shear effects to occur as a direct result of mining subsidence is also negligible.

Notably, in reality these pillars will not be removed, and even in a failed state would continue to provide some level of support to the overburden, making the assessment unrealistically conservative.

The findings of the EIS therefore remain in relation to potential impacts on surface features raised in the submissions such as buildings, houses, and the Hume Highway. Where mining induced ground tilt is expected to be less than 5 mm/m, it is unlikely that remedial work will be required on any buildings or built features. The maximum predicted tilt for the project is significantly lower at 0.26 mm/m. Further, given that no discernible differential vertical subsidence is predicted, there is negligible potential for damage to one and two-storey buildings. The mine plan for the project has specifically taken into account the presence of the Hume Highway transecting the project area, with the extent of mine workings under the highway limited to intermittent crossings to provide first working access headings, with negligible subsidence. The Main Southern Railway is well outside the project area, and as discussed in Section 14.4.2 of the Hume Coal Project EIS, the angle of draw associated with the mine is 0°. There will be no subsidence related impacts to the railway as a result of the project.

Further, no cracking of stream beds is predicted to occur. As stated in section 14.4.3 of the EIS, given the negligible to imperceptible subsidence impacts predicted for the project, none of the typical potential subsidence impacts on surface water resources in the project area are predicted to occur, such as ponding, realignment of drainage lines and stream bed cracking.

The potential for impacts to agricultural activities as a result of subsidence from a mining proposal relate to surface cracking and groundwater drawdown. For the Hume Coal Project, there will be no perceptible impacts on the surface as a result of subsidence, and therefore no impacts from cracking to agricultural activities. In relation to groundwater, as described in detail in Chapter 9, all bores that have the potential to be impacted by mine-related drawdown have been identified. In accordance with the NSW Aquifer Interference Policy, make good measures have been identified for bores that are predicted to be impacted by a project related drawdown of 2 m or more. The implementation of these measures will effectively mitigate the risk of impact to bores that are relied upon by agricultural activities in the area.

Notwithstanding all of the above, it is anticipated that the preparation of an extraction plan will be a condition of the development consent if the Hume Coal Project is approved. Extraction plans describe how subsidence impacts will be managed to meet the requirements of the development consent, and are assessed by the relevant government agencies, such as the DRG, who then provide advice to the DPE as to the adequacy of the plan. Approved extraction plans must then be implemented by the proponent as a requirement of both the development consent and the mining lease. Accordingly, Hume Coal will prepare an extraction plan which will outline detailed measures for monitoring and managing subsidence. Further discussion on this point is provided in Section 16.10.

16.9 Surface infrastructure

A number of community submissions raised questions regarding the location of surface infrastructure as follows:

1. Site selection and suitability - Submissions commented on the appropriateness of the selected surface infrastructure site. Some claimed that the surface infrastructure is too close to Berrima, whilst others noted the industrial nature of the area around Moss Vale and the fact that the site selection makes good use of existing nearby industrial infrastructure such as the existing rail underpass in the Hume Highway.
2. Others asked what parameters dictate the location of the ventilation shafts in relation to safe distances from residential and communities.

The site selection criteria for the surface infrastructure and the alternative options considered are detailed in the Hume Coal Project EIS (EMM 2017a).

The proposed ventilation shafts are not in the vicinity of residences, with the closest privately owned residence being about 1.3 km from the proposed upcast shaft. No noise, dust or odour impacts are predicted at any third-party residence due to the ventilation shafts.

Responses to submissions that raised concerns about the suitability of the site for the Hume Coal Project and Berrima Rail Project are provided in Chapter 6 (Legislation and Approvals).

16.10 Monitoring and post approval management plan requirements

NSW DPI submitted that a specific management plan for progressively monitoring the behaviour of the pillars, the integrity of the bulkhead seals and the coal reject emplacement from the commencement of mining will be required to demonstrate that the supports appropriately protect groundwater resources in the region. DPI contend that the appropriate management plans should include ongoing measurement and monitoring of take volumes, water quality, piezometric and potentiometric levels, periodic groundwater model refinement and scheduled reporting arrangements.

OEH request that a subsidence monitoring program be put in place for mining specifically in the vicinity of faults.

16.10.1 Management plan for the behaviour of pillars and integrity of the bulkhead seals

The workforce consultation that is required by law during the development of principal hazard management plans (detailed earlier in this chapter) precludes their development prior to employing the workforce. The integrity of the bulkhead seals and the behaviour of the pillars will be the subject of very detailed management measures in two principle hazard management plans, covering inrush and strata failure, as well as other site-specific management plans that will be determined via risk assessment. Both of these principal hazard management plans are required by law. It is concerning that DPI is not familiar with the laws that their department is responsible for enforcing.

16.10.2 Groundwater monitoring and model refinement

As described in the Revised Water Assessment report (EMM 2018a, refer to Appendix 2), Hume Coal has an extensive baseline hydrological and hydrogeological monitoring network in place. This network was established in consultation with DPI Water and data has been gathered progressively since 2011.

Data will continue to be collected from this network throughout the life of the mine. Expansion of the network may be considered once the project starts construction and then operation, and as suggested by DPI may be expanded to include aspects such as:

- water metering and recording of pumped volumes to/ from mine water dams, sediment basins, the primary water dam, underground sump and the void; and
- monitoring the quality of water in the underground sump and the rate and quality of water pumped into sealed voids.

The results of water monitoring will be reported in the Annual Review, which will be submitted to relevant government agencies. The preparation an Annual Review is a standard condition of coal mining development consents.

Regular verification and recalibration (if/as required) of the groundwater model will also be undertaken. The groundwater model predictions will be validated by installing custom-designed groundwater monitoring sites at key selected virtual piezometers used in the model. Model verification and reporting will be undertaken considered annually, with recalibration undertaken as required (ie, if verification demonstrates model is performing accurately, then there will be no need for model recalibration).

16.10.3 Subsidence monitoring

i Background

The proposed mining sequence involves mining progressing in a westerly direction prior to then commencing to mine in a southerly direction from the “pit bottom” area to the west of the Hume Highway. The proposed mining sequence will result in about five years of baseline subsidence monitoring of mining being gathered prior to any mining activities under the Hume Highway.

The subsidence assessment in the Hume Coal Project EIS predicted that the “credible worst case” vertical movements that could occur as a result of mining are about 20 mm of vertical movement. This represents vertical movement that could occur directly above areas of web pillar panels. Notably, no web pillar panels are proposed to be mined directly beneath private dwellings or the Hume Highway.

As described in Section 16.2.3, the numerical modelling conducted subsequent to the submission of the EIS confirmed that the assessed settlement of 20 mm is a “worst-case”, and is associated with total removal of the web pillars between two intrapanel barrier pillars. In reality, the web pillars will be left in place, which results in between 3 mm and 5 mm of surface settlement directly above the web pillar panels in the model. At these levels of movement, the influence of mining will not be able to be readily distinguished from natural ground movements, if at all. For context, 20 mm of vertical movement was considered to be the limit of survey accuracy until the advent of sophisticated GPS surveying equipment. Therefore, 20 mm has historically been considered “zero” subsidence, being lower than the achievable survey accuracy. Certain subsidence engineering parameters such as the “angle of draw” are still calculated based on the location along the subsidence cross-section of 20 mm of vertical movement.

The use of a 3D numerical model allows the results to be interrogated to understand the likely extent of the subsidence profile, albeit that using traditional subsidence definitions (i.e. >20 mm of vertical movement), the “extent” of the profile at the Hume Coal Project does not exist, except under the purely hypothetical scenario where all web pillars were artificially removed from the model in order to test the robustness of the design. In this hypothetical case, a small area in the centre of the panel at the shallowest cover depth exhibited about 24 mm of vertical movement. The results show that even under this unrealistic hypothetical scenario, where all of the support offered by the web pillars in one part of the mine has been removed, vertical subsidence has reverted to only 2 mm of vertical settlement, within about 25 m laterally of the panel over solid coal. The proposed design typically maintains about 50 m of solid coal laterally from the Hume Highway carriageway to the vertical projection of the nearest web pillars.

Under the base-case scenario where the web pillars remain in support of the overburden, the level of surface settlement is around 0.2 mm within 50 m laterally of the workings. Fixed real-time GPS position sensors are among the most accurate survey techniques currently available, and these devices have a stated precision of around 5 mm, meaning that levels of 0-2 mm of vertical movement are well below the limits of their accuracy, and are likely to be indistinguishable from background measurement noise.

The results of the numerical modelling quoted above do not include the potential effects of hydraulic depressurisation of the coal seam, which could contribute another few millimetres of settlement to the numerical modelling outputs. This depressurisation effect is likely to possess a very shallow gradient in subsidence terms, and therefore have minimal impact on strains. It is unlikely a traditional subsidence survey would be able to detect this effect; however the GPS units (which are not measuring movements relative to a nearby survey benchmark), may be able to detect these movements.

ii Subsidence monitoring

The issue associated with such low levels of surface movement is the ability to differentiate them from potentially much larger levels of monitoring survey “noise” in the form of natural background movements and survey error. This survey noise could result in surface movements of up to 50 mm due to the combination of moisture changes in clay-based soils and survey error. When the predicted movements are in the order of 5 mm (excluding depressurisation), it is almost impossible to determine what proportion of the measured surface movement constitutes a mining-related phenomenon and what constitutes natural movements and survey error.

Therefore, it is important for Hume Coal to build an understanding of the typical levels of background surface movement over a number of seasons and a range of climatic conditions, so that when mining does commence natural movement is not incorrectly categorised as a mining-related impact.

Hume Coal has commenced to purchase and install a number of real-time fixed GPS 3D monitoring devices (GNSS), which will be installed in locations that will allow natural background movements to be measured at relatively high accuracies for a number of years prior to the commencement of mining.

As stated above, these devices are able to measure 3D position to a quoted precision of 5 mm, which should be sufficient to develop a baseline of natural movements, but may still struggle to detect or differentiate mining-related settlements from survey error under normal mining conditions.

iii Proposed initial monitoring program

An initial subsidence monitoring program for the period prior to mining commencing, and the first five years of operations is presented in Table 16.3.

The main goals of this monitoring will be to provide a dataset of background movements and survey error, and to establish that the levels of mining-related subsidence are within the predicted magnitudes of surface settlement in the Hume Coal EIS. It may not be possible to distinguish these mining-related movements from survey error and background movements, depending on the site’s soil and other characteristics.

The subsidence monitoring program will be confirmed post-approval and documented in a subsidence management plan, which will be developed in consultation with DPE and relevant government agencies such as RMS.

Table 16.3 Proposed subsidence monitoring program - pre-mining and up to year 5

Phase	Location	Proposed monitoring	Likely survey precision	Proposed monitoring frequency	Purpose of monitoring
Pre-mining	Bridge abutments (Wells Ck, Medway Rivulet).	Prisms/survey	10 mm	Annual, approx. 2 to 3 surveys before mining commences	Establish a baseline of natural movements and survey error.
Pre-mining	Hume Coal properties.	Real-time GPS (GNSS)	5 mm	Real-time	Establish a base line of natural movements and survey error.
Initial mining to the west	Hume Coal properties.	Real-time GPS (GNSS)	5mm	Real-time	Understand time-dependent nature of surface settlements in relation to mining.
Initial mining to the west	Hume Coal properties, road easements, State Forest.	Survey cross lines	10-15 mm	Monthly during first 12 months of mining, then 6 monthly, subject to data review	Verify subsidence predictions.

Table 16.3 **Proposed subsidence monitoring program - pre-mining and up to year 5**

Phase	Location	Proposed monitoring	Likely survey precision	Proposed monitoring frequency	Purpose of monitoring
Initial mining to the west	Selected Aboriginal cultural heritage sites (described in the EIS).	Visual inspection	N/A	Pre and post-mining	Condition monitoring
12 months prior to mining under Hume Highway	Bridges (Wells Ck, Medway Rivulet). Siting is subject to GPS requirements for clear sky.	Real-time GPS (GNSS)	5 mm	Real-time	Establish a base line of natural movements and survey error, cross-check manual surveys.
During mining under Hume Highway	Bridges (Wells Ck, Medway Rivulet). Siting is subject to GPS requirements for clear sky.	Real-time GPS (GNSS)	5 mm	Real-time	Trigger for increased frequency of manual subsidence measurements and inspections of bridges. Trigger levels to be determined in consultation with RMS.
During mining under Hume Highway	Bridge abutments	Prisms/survey	10 mm	annual	Confirm GPS results

17 Traffic and transport

17.1 Introduction

This chapter responds to matters raised in the submissions relating to traffic and transport.

In relation to the Berrima Rail Project, the RMS noted in their submission that this project is not proposing any works on the state road network or works that would have an adverse impact on the network. RMS stated that; having reviewed the information provided it does not object to the Berrima Rail Project in principle, subject to the project's compliance with requirements detailed in the EIS and associated technical appendices.

The RMS provided a number of comments on the Hume Coal Project, which are responded to in this chapter. RMS noted that the mine has been designed such that there will be no mining under the highway except for the development of headings to access coal reserves on each side of the highway. Based on this and additional information provided in the EIS, RMS is satisfied that settlement likely to damage the Hume Highway is not expected and therefore raised no objections to the project with regard to undermining or de-stabilisation of the Hume Highway, provided the project is implemented as per the measures outlined EIS. RMS is also satisfied with the findings of the EIS in relation to vibration and groundwater drawdown related impacts on the Hume Highway and expects the vibration effects of heavy vehicles on the highway will likely exceed the vibration impacts from the mining process.

ARTC noted in their submission that it operates the network on a commercial basis and aims to increase freight volumes on the rail, a goal which the Hume Coal Project, if approved, will play an important part in achieving. Further, Port Kembla Coal Terminal (PKCT) stated that the terminal is currently an under-utilised asset that is ready to accept coal from the Hume Coal Project.

17.2 Assessment approach and adequacy – Berrima Rail Project

The following concerns were raised about the adequacy of the traffic and transportation assessment and modelling for the Berrima Rail Project in some community and special interest group submissions:

- i. OpenTrack modelling – this was not provided in the EIS. It was also submitted that the EIS does not adequately consider interaction between coal trains and the relatively frequent passenger services along the route.
- ii. Existing users and future increases in rail usage by other users - It was claimed that existing rail uses of the Berrima Branch Line were not captured in the Berrima Rail Project EIS, and therefore does not consider the impact of any increases in future usage of this rail infrastructure by these parties. Respondents also requested a thorough analysis of how the project's additional trains will impact the Main Southern Railway Line in 20 to 30 years time when freight and commuter traffic increases. One submission notes that Hume Coal incorrectly assumes that demand for access to the same rail network (ie Berrima Branch Line) from businesses and activities in the Moss Vale Enterprise Corridor (MVEC) will not increase in the next 20 years. It was submitted this is highly unlikely as WSC regards the encouragement of development in this corridor as a priority.
- iii. The scope of rail line assessed and future changes to Hume Coal rail usage - Some respondents submitted that the EIS is limited, only taking into account a small part of the rail line that Hume Coal is going to use. The respondents submit that the Hume Coal Project and the Berrima Rail Project will impact the Berrima Branch Line, the Main Southern Railway Line, and the Unanderra to Port Kembla Branch Line (ie the entire route from the coal mine down to Port Kembla). The respondents requested that the impact of hauling 3.5 million tonnes of coal down the entire route be assessed.

It was also claimed that train volumes assumed in the Berrima Rail Project do not account for any future increases in Hume Coal train movements should variations in mine production, scheduling, market conditions and several other factors eventuate and lead to the uneven rail volumes from year to year as documented in the Berrima Rail Project EIS.

- iv. Tahmoor Colliery - The Berrima Rail Project EIS assumed that operations at Tahmoor Colliery would be completed by the time the Hume Coal Project and Berrima Rail Project commence. However, it was submitted that Tahmoor Colliery may continue beyond the assumed cessation of operations between 2018 and 2021. Under this scenario, Hume Coal would add additional train movements to the existing rail traffic, rather than replacing the Tahmoor Colliery trains.
- v. WSC Berrima Road Deviation Project - WSC noted that the Berrima Rail Project EIS presents two possible rail proposals. However, WSC submitted that it is committed to proceeding with the Berrima Road Deviation project that will deviate Berrima Road to the east of the existing rail level crossing that provides rail access into the Boral Berrima Cement works. Council's preferred route for the rail maintains the existing rail connection into the cement works in conjunction with a new spur leading to the proposed Hume Coal site. Council also noted that plans to construct the Berrima Road deviation project are advanced.
- vi. Incident management - Water NSW stated that there was no discussion on potential incident management for the railway line construction and future use incorporated in the documentation.

i Open track modelling and interaction of coal trains with passenger and freight services

The EIS rail transport investigations separately quantified and analysed the likely future capacity for, and operational impacts from, the proposed project coal train movements. These analyses, which included OpenTrack modelling for the existing and future Berrima Branch Line train operations, were undertaken by specialist rail freight operations and logistics consultants (Plateway 2014 and 2015). As described in Section 9.4.3 of the Berrima Rail Project EIS (EMM 2017b), network modelling using the OpenTrack modelling software package and current ARTC/TfNSW timetables was undertaken, and this confirmed the availability of sufficient capacity on the network between the proposed Hume Coal mine site and Port Kembla. The modelling demonstrated at least 4 Mtpa of capacity exists, without upgrades to passing loops on the Moss Vale to Unanderra line. This is consistent with the findings of the Maldon to Dombarton feasibility study (ACIL Tasman 2011) which found that around 7 Mtpa of capacity existed along the Moss Vale to Unanderra line at the time, without any upgrades.

Specifically, detailed investigation were undertaken for the two primarily single track, freight only, sections of the route (the Berrima Branch Line and the Moss Vale to Unanderra line) where the rail capacity constraints for the project were most likely to be significant. For the other sections of the route, where the tracks are shared with passenger trains in addition to other freight trains, the capacity constraints are less significant as the provision of double or multiple tracks over these sections of the route provides a much greater level of spare capacity for the proposed coal train movements.

ii Existing rail users and future increase in use

The claim that the Berrima Rail Project EIS did not consider existing rail movements is incorrect. The EIS conservatively assessed the future Berrima Branch Line baseline train movements (excluding the Hume Coal trains) as being up to 26 train movements daily. Current Berrima Branch Line train movements on an average day are typically four or five train movements in each direction (between eight and nine train movements daily) which are mainly trains accessing the Berrima Cement works. The assessment was therefore highly conservative, assuming maximum movements by existing users to ensure that appropriate capacity is available on the line. Notwithstanding, these train movements do not represent any significant constraint to the proposed future Hume Coal trains (up to four trains per day in each direction) which will also use this section of the rail transport route.

Further, following approval of the Hume Coal Project and the Berrima Rail Project and the subsequent commencement of Hume Coal train operations, these train movements will become part of the future baseline rail transport operations in the Illawarra and inland regions south of Sydney. Therefore, any proposed changes to passenger and freight train operations in the future will need to consider the Hume Coal trains as part of the baseline rail transport movements against which the impacts of the other proposed changes are to be assessed. This includes any future development proposals in the Moss Vale Enterprise Corridor.

iii The scope of rail line assessed and changes to future Hume Coal rail usage

As presented in Section 9.4.3 of the Berrima Rail Project EIS, the entire route from the Hume Coal Project area to Port Kembla was assessed in the traffic and transport assessment, including the Berrima Branch Line, the Main Southern Rail Line, the Moss Vale to Unanderra Line, and the Unanderra Line to Port Kembla Coal Terminal. The assertion that the scope of the rail assessment was limited is incorrect. The most highly constrained part of the rail transport route is considered to be the predominantly single track Moss Vale to Unanderra section, which in 2015 had between 11 and 12 daily freight train movements in each direction. With the current track configuration and minimal changes to passing loops, four additional coal train paths each way for the Hume Coal trains can reasonably be achieved using the route.

The Berrima Rail Project states that to transport up to 3.5 Mtpa of product coal from the Hume Coal mine to Port Kembla, about 25 loaded coal trains each week (50 coal train movements) will be required. This represents on average four loaded and four empty coal train movements daily. In general, this will require eight daily coal train paths on most days of the year. It is acknowledged that this would represent a peak year of production, with a more typical year requiring between two and three loaded and empty trains per day.

The EIS therefore assessed the higher expected train movements of eight per day. With the addition of these Hume Coal train movements, the Moss Vale to Unanderra Line would be operating at around 70% capacity. There is still therefore spare capacity in the system to account for some variability in train movements pending variations to coal production.

iv Tahmoor Colliery

The existing maximum daily usage of the Moss Vale to Unanderra Line was established in the Berrima Rail Project EIS as part of the characterisation of baseline conditions. As reported in Section 9.4.3 (iii) of the EIS and discussed above, the maximum daily usage of the Moss Vale to Unanderra Line by existing trains is between 11 and 12 daily train movements in each direction, which are usually:

- 6 grain and other country freight trains;
- 4 Tahmoor mine coal trains;
- 1 train from Medway Quarry carrying limestone; and
- up to 1 heritage passenger train.

As is evident, Tahmoor trains were included in the characterisation of existing rail movements against which the addition of Hume Coal trains was assessed. Again, as reported in the EIS, the addition of up to four loaded and four empty daily Hume Coal train movements will increase the use to between 15 and 16 daily train movements in each direction, which will then represent about 70% of the line's maximum operating capacity.

v WSC Berrima Road deviation

It is noted that WSC is now committed to proceeding with the Berrima Road Deviation project, which will deviate Berrima Road to the east of the existing rail level crossing that provides rail access into the Boral Berrima Cement works. At the time of preparation of the Berrima Rail Project EIS, the decision to proceed with the deviation had not been made by WSC, and therefore two possible rail alignments for the Berrima Rail Project were presented and assessed by Hume Coal; one without implementation of the Berrima Road alignment project (labelled the 'preferred option' in the EIS), and another assuming the deviation was constructed (the alternative option). Hume Coal acknowledge that it is now likely Berrima Road will be deviated, and therefore the 'alternative' rail alignment presented in the Berrima Rail Project would be constructed, should the Berrima Rail Project be approved.

vi Incident response

The construction of the rail line and associated infrastructure will be undertaken in accordance with a Construction Environmental Management Plan (CEMP), which will include an incident response procedure. This CEMP will be prepared prior to construction works commencing, and all contractors will be required to undertake operations in accordance with this document.

17.3 Assessment approach and adequacy – Hume Coal Project

17.3.1 Site access and transport routes

The RMS requested that additional information be provided to allow an assessment of the impacts of the development on the classified road network relating to:

- i. Mereworth Road - the proposed upgrade works for Mereworth Road and the proposed link road to access the mine infrastructure from Mereworth Road.
- ii. Transport routes - further details of key transport routes; ie for vehicles travelling southbound along the Hume Highway accessing Mereworth Road and vehicles travelling northbound along the Hume Highway accessing Medway Road.
- iii. Infrastructure access - RMS noted they do not support direct access to infrastructure being provided from the Hume Highway, such as to the ventilation shaft on the Carlisle Downs property during construction and operation. RMS requested options for alternative access that are not from the highway be considered and details provided.
- iv. Hume Highway/Golden Vale Road - RMS noted a concern over increased traffic movements and potential increased safety risks at the Hume Highway/Golden Vale Road intersection, particularly right turns into and out of Golden Vale Road. RMS therefore requested further analysis of the acceleration and deceleration facilities at the Hume Highway/Golden Vale road interaction, including their suitability with the potential for increased usage as a result of the Hume Coal Project.

The concerns of the RMS are noted in relation to the project access constraints which are listed above, and are responded to below. Notwithstanding, prior to the construction and operational stages of the Hume Coal Project commencing, a traffic management plan will be prepared in consultation with the RMS for each stage to ensure that all identified RMS requirements are addressed, and appropriate management measures documented and implemented. The roads referred to in the RMS submission are shown in Figure 17.1.

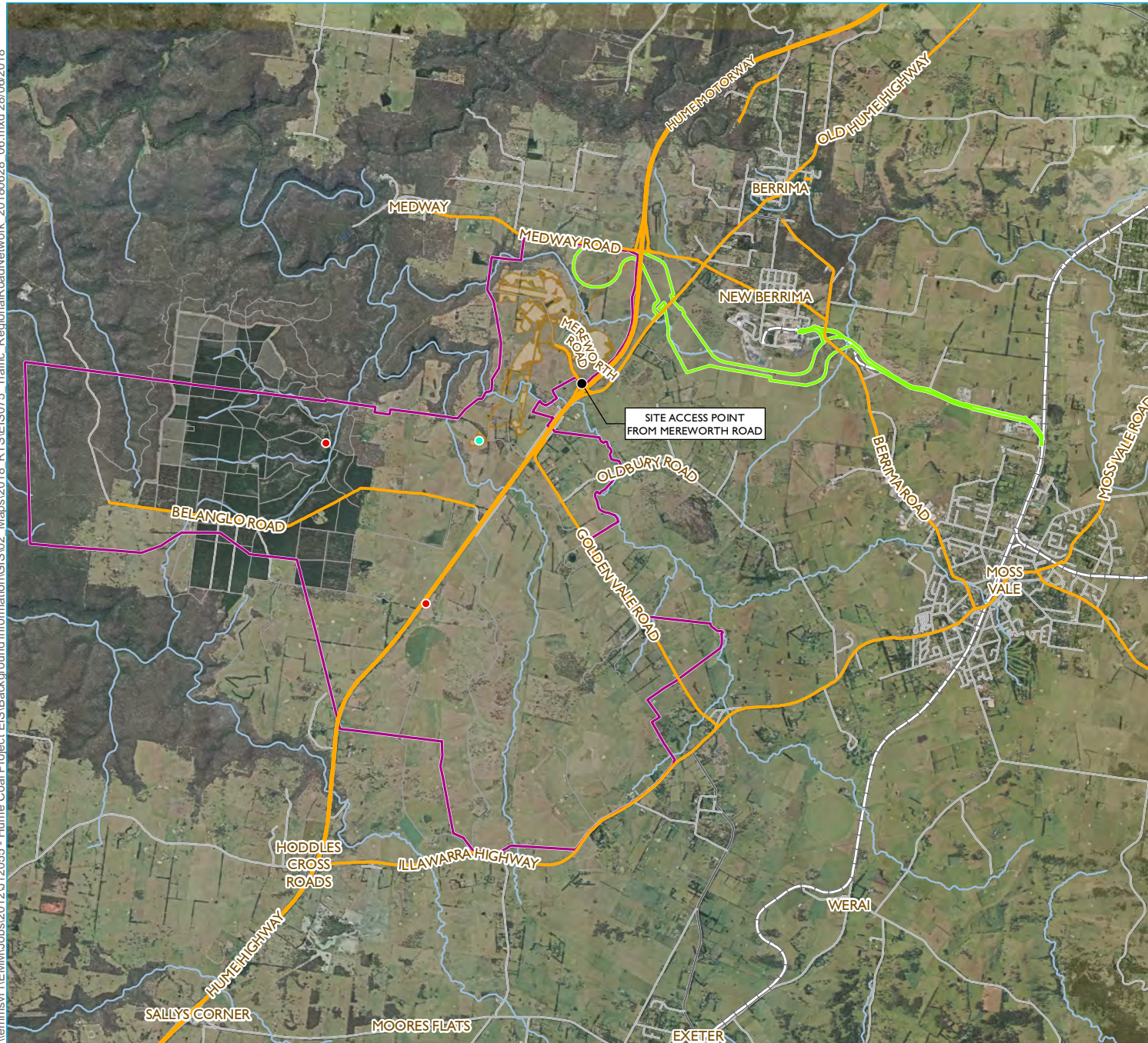
i Mereworth road

The proposed link road from Mereworth Road to the mine surface infrastructure area will be a private road, and will be constructed to appropriate standards to ensure safe, all weather access. Further detail on the design and maintenance of the road will be developed and included in the traffic management plan for the project.

ii Transport routes

Mereworth Road is proposed as the sole vehicular access to the Hume Coal Project area for traffic travelling from both the north and the south on the Hume Highway. For traffic which is travelling from the north, vehicles will exit the highway at the Medway Road interchange, and will have to travel via a section of Medway Road and the Old Hume Highway for a distance of approximately 4 km, between the Medway Road and Mereworth Road interchanges.

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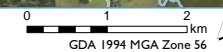
- Hume Coal Project area
- Berrima Rail Project area
- Hume Coal Project indicative surface infrastructure footprint
- Upcast ventilation shaft location
- Downcast ventilation shaft location
- Key roads around project area
- Main road
- Local road
- Access ways
- Rail line
- Drainage line

Regional road network

Hume Coal Project and Berrima Rail Project
Response to submissions
Figure 17.1



Source: EMM (2018); DFSI (2017); Hume Coal (2017)



While there is some potential for this traffic to alternatively travel further south via the Hume Highway (non Motorway section) to Golden Vale Road and make a U-turn there utilising the gap in the median strip on the Highway so as to travel back in a northerly direction and exit at the Mereworth Road off-ramp, this tendency can be managed and generally prevented by appropriate traffic signage as follows:

1. For traffic approaching the Medway Road exit from the north, large signs could be erected at an appropriate distance before the exit advising traffic to "Use the Medway Road exit for access to the Hume Coal mine".
2. At the Golden Vale Road intersection for traffic travelling south, on the approach to the intersection, additional signage could be erected advising traffic on the Hume Highway that U-turn movements are not permitted at Golden Vale Road for access to the Hume Coal mine.

The control of site access routes will be further discussed with the RMS and confirmed as part of the preparation of the traffic management plan for the project.

Site access protocols will also be included in the induction for all new employees and contractors.

For vehicles travelling from the south, access to the Hume Coal mine will be via the existing off-ramp from the Hume Highway at the Mereworth Road interchange. Signage will be installed at this off-ramp indicating this access. As stated in the EIS, the traffic priority at the interchange will be reconfigured, which will have minimal impact on the Hume Highway off-ramp traffic. The future intersection traffic impacts from Hume Coal related traffic at this interchange will be minimal in comparison to either 2015 or 2020 baseline traffic conditions, with the future intersection levels of service remaining at either A or B for all traffic scenarios considered. The maximum intersection traffic delays would not increase with the addition of Hume Coal traffic.

iii Access to the ventilation shaft on the Carlisle Downs property

The proposed vehicle access from the southbound carriageway of the Hume Highway to the ventilation shaft on the Carlisle Downs property is approximately 2.75 km south of the Golden Vale Road intersection. Vehicular access via the Hume Highway is necessary as this is the only currently feasible access route to the relevant area of the Carlisle Downs property.

This access point is considered appropriate for a number of reasons. The Hume Highway has a relatively straight and level alignment at this location and an appropriate median gap and access intersection already exists on the highway. The volume of traffic using this intersection will be very low, at approximately 5-10 vehicle movements per day during the construction period of a couple of months, and approximately one per week during operation. Given this low level of daily traffic there would be minimal additional public traffic safety risk from allowing access at this location. There is also sufficient room for long vehicles to pull off the highway fully before encountering a gate, and there is already informal deceleration/acceleration lanes and shoulder widening in the area, which could be formalised if required.

Further, the provision of appropriate construction and operational stage traffic management plans, including appropriate warning signage, will be prepared in consultation with RMS, prior to works commencing. These management plans will also consider the right hand turns onto the highway, which could be restricted to light vehicles only, or entirely, if required.

iv Golden/Vale Road and Hume Highway Intersection

As described above in response (ii) and (iii), U-turns and right hand turns at the Golden Vale Road/Hume Highway intersection will be managed via the use of signage prohibiting these movements, as well as through the education of employees and contractors on the allowable access points in the induction process. For decelerating traffic making left turns, the existing facilities have been assessed by EMM's traffic engineer as adequate and do not need improvement.

17.3.2 Predicted traffic movements

The RMS requested further information on how predicted traffic movements were derived (specifically Table 15.8 of the Hume Coal Project EIS).

WSC also questioned the predicted traffic movements to be generated by the project, stating that:

1. The traffic impact assessment focuses mostly on construction related traffic. Consideration of operational traffic appears to be unrealistically minimal in movement numbers.
2. The predicted traffic generation is not consistent with experience of traffic generation occurring from mining elsewhere in the NSW.
3. The EIS does not acknowledge the presence of the Moss Vale Enterprise Corridor (MVEC), which is a 640 ha industrial corridor located adjacent to the Moss Vale town centre in the north-west sector. The EIS bases future network traffic growth on a nominal growth rate of 2% per annum without giving consideration to the Moss Vale Enterprise Corridor traffic projections, which are higher than this. WSC therefore requested a cumulative traffic impact assessment of the Hume Coal Project and the Moss Vale Enterprise Corridor.

1. The traffic impact assessment for the Hume Coal Project specifically considered the project generated traffic during two stages of construction and during operation of the project. The full details of the derivation of peak hour and daily traffic movements for the project, which are summarised in Table 15.8 and Table 15.9 of the EIS, are contained in Chapter 4 and Chapter 5 (Tables 4.2, 4.3, 4.4, 4.5, 5.1 and 5.2) of the Traffic and Transport Assessment Report, which is Appendix M of the EIS (EMM 2017n).
2. The Traffic and Transport Assessment was undertaken by an experienced traffic engineer at EMM. The scope and methodology were in accordance with the SEARs and included consultation with RMS, TfNSW, ARTC and Boral. Furthermore, the region's traffic movements are well characterised by the traffic counts which were conducted for the project in 2015 and 2016, in addition to other earlier daily traffic volume counts conducted in the region by RMS.
3. The future potential MVEC development is in itself a major project which, if it succeeds in attracting sufficient future commercial and industrial development to achieve its full potential, will become the major traffic generating source for the Berrima Road and Taylor Avenue route, between Moss Vale and the Old Hume Highway-Medway Road intersection. The future MVEC daily and peak hourly traffic movements would be far greater than that generated by or related to the Hume Coal Project traffic operations, and any future road upgrade to the Berrima Road – Taylor Avenue route required for the MVEC development would be unlikely to be further increased by the Hume Coal Project traffic.

17.3.3 Intersection performance

WSC raised some concerns about the analysis of intersection performance presented in the EIS. WSC claimed that the EIS indicates favourable road network performance at key intersections in the Moss Vale town centre which are not consistent with observations, surveys and the validated and independently audited Moss Vale Town Centre and Surrounds Traffic Micro-simulation Model (Paramics). WSC also claim that undertaking isolated intersection analysis is not considered appropriate as queuing from one intersection will impact on a neighbouring intersection.

In particular, the intersections of Argyle Street with Waite Street and Lackey Road were raised, stating that the EIS underestimates the delays and queue lengths. The council also stated that the assessed ability of the town centre to absorb additional traffic is optimistic, explaining that congestion is evident during morning and afternoon peak periods, and in particular raised concerns about Argyle Street and the approaches to the Argyle Street/Robertson Road roundabout and the southern approaches to the Argyle Street/Yarrawa Street intersection.

The concerns raised by WSC about the intersection analysis also extends to Mereworth Road, stating that inputs to the analysis are likely to have been underestimated and therefore retention of the existing T-intersection with a change in priority may not be the most appropriate treatment.

WSC also noted the capacity of significant infrastructure such as the Old Hume Highway/Medway Road/Taylor Avenue b-double roundabout, as described in the Hume Coal EIS. However, WSC submitted that the EIS does not consider the traffic loading from the Moss Vale Enterprise Corridor and therefore places into question the accuracy of the SIDRA analyses provided for these and other intersections evaluated in the EIS.

In relation to the SIDRA modelling undertaken, the RMS noted that the modelling must consider the full development of the site, AM and PM peak volumes, existing traffic volumes with and without development and 10 year projected volumes with and without development. It also stated that the base SIDRA models must be calibrated with onsite observations in the AM and PM peak, which can be done by measuring existing queue lengths and delays.

The EIS has correctly identified the existing high peak hour traffic delays and intersection queue lengths which occur currently at the intersections of Argyle Street with Waite Street and Lackey Road in the Moss Vale town centre. The intersection counts were undertaken by an independent specialist traffic sub-contractor (ROAR DATA Pty Ltd) in accordance with relevant RMS standards and their standard procedures for undertaking intersection traffic surveys in NSW. The queue length survey results from the intersection traffic counts, when modelled in the SIDRA intersection program, are consistent with the expected results for these types of intersections on a major road route such as the Illawarra Highway travelling through a significant regional township in NSW such as Moss Vale.

Further, it is noted that intersection performance and maximum traffic queue length at any specific intersection can vary on a day to day basis due to local factors. The intersection traffic queue lengths which have been modelled in the SIDRA intersection program are considered to be within the range of observed traffic conditions which normally occur on the Illawarra Highway in the Moss Vale locality.

One of these intersections (at Lackey Road) is currently operating at Level of Service F during both the morning and afternoon traffic peak one hour periods. The other intersection is operating at Level of Service C or D, although this will change to Level of Service E or F in the future year 2020 baseline traffic conditions. However, the major traffic queues during these periods occur on the two minor roads (Waite Street and Lackey Road) and these queues do not generally adversely affect the major road through traffic movements which are travelling via Argyle Street to the extent that this would affect any of the other adjacent intersections along Argyle Street in the Moss Vale town centre.

No intersection traffic queue length measurements were made at the time of the intersection traffic surveys. However, at the majority of the intersections considered (at all the surveyed intersections apart from the two Argyle Street intersections) the maximum peak hour intersection traffic queue lengths are effectively minimal, being no more than one or two vehicles at any location.

The proposed change to the intersection traffic priority at the Mereworth Road/Hume Highway (west side) off ramp intersection is the preferred solution for the Hume Coal site access traffic, which will constitute the largest future peak hourly traffic movements at the intersection. The proposed intersection re-configuration is also the standard intersection priority treatment for a T-intersection where the through traffic route is designated as the priority traffic route and is not required to give way or stop at the intersection, and the stem of the T intersection is the minor road which is subject to give way or stop sign traffic control at the intersection.

In relation to consideration of possible future traffic loading from the MVEC, the EIS assessed the potential impacts of the project against a base year of 2020 when the existing road network traffic volumes will have increased by around 10% (on the Hume Highway) and 5% on other routes, compared to the surveyed (year 2015) base road network traffic volumes, based on an estimated annual traffic growth of 2% for the Hume Highway and 1% for other routes. An increase in traffic volumes was thus accounted for. Further, following approval of the Hume Coal Project and the Berrima Rail Project and the subsequent commencement of construction and operation, the associated traffic movements will become part of the future baseline traffic movements. Therefore, the impacts of increased traffic movements as a result of any future development in the MVEC will need to consider baseline traffic volumes which, if approved, will, include Hume Coal related traffic.

Regarding the RMS request for ten year future traffic projections to be included in the future project intersection traffic analysis, the future SIDRA intersection analysis for the additional future Hume Coal project traffic at all intersections (a total of eleven intersections were analysed) has been undertaken for the most likely future time interval around which all the estimated future project traffic movements would generally be occurring. This time interval is effectively a five year traffic growth period (from the year of the baseline traffic surveys, 2015, to the future year 2020) which gives a consistent baseline set of traffic volumes against which all the main project construction and operations stage traffic can be assessed.

17.4 General impacts of the Berrima Rail Project

Macquarie University submitted that the Berrima Rail Project EIS promotes a sentiment that the upgrades of rail infrastructure are as much a public service, in that it involves the efficient use of existing rail infrastructure. It was submitted that this argument fails to recognise that what is possibly of greater interest to the public is the potential for expected increases in rail and road traffic, and that any increased rail usage and 24 hour operations will have a greater impact on local communities in terms of noise, and dust and diesel emissions.

The Australian Institute also submitted that the additional rail traffic will cause increased noise and disturbance to residents living near the rail line, and cause further road delays at every private and public level crossing on the 80 km route to Port Kembla Coal Terminal.

At the proposed frequency of the additional Hume Coal trains operating between the mine and Port Kembla (a maximum of four daily coal train movements in each direction), these train operations are considered to be a legitimate and efficient utilisation of the existing publicly owned rail network infrastructure and privately owned rail infrastructure (the Berrima Branch Line) within the designed capacity of each section of these rail networks. Notably, the operation of the Berrima Branch Line is currently a 24 hour operation. In addition, the ARTC and PKCT submitted that they aim to increase the use of their respective assets, being the rail line from Moss Vale to Port Kembla and the Port, which the Hume Coal Project will do if approved.

In relation to balancing this benefit of the project with the potential noise, dust and diesel emissions, the potential for these emissions are discussed in detail in Chapters 14 and 15 of this report, respectively. As discussed in Chapter 14, only one assessment location (28) is predicted to be impacted by noise from the project above the trigger level for voluntary mitigation rights, with no other exceedances of relevant criteria predicted. The likelihood of sleep disturbance as a result of the train movements is also predicted to be minimal and consistent with current rail operations. Similarly, in relation to air quality the predicted concentrations for all pollutants from the diesel locomotives were well below applicable air quality impact assessment criteria at all sensitive receptor locations identified. Further, as the Hume Coal rail wagons will be covered, there will be minimal fugitive coal dust emissions released as trains move from the mine site to port.

A significant proportion of the route no longer has any railway level crossings; being the two sections comprising the Main Southern Railway Line between Berrima Junction and Moss Vale, and between Dombarton and Port Kembla. Therefore, the future additional traffic delay impacts at railway level crossings will generally only occur on the more rural sections of the route, which have a total combined length of approximately 50 km, between Robertson and the Berrima Cement works. Also, at one location (the existing railway level crossing on the Berrima Branch Line, at the Berrima Cement Works) the railway level crossing will be replaced by a new road overpass for Berrima Road, concurrently with the timing of the Hume Coal Project and Berrima Rail Line extension construction. This will result in some improvement to the current level of road traffic delays from train movements at this level crossing, which is the only level crossing on the Berrima Road route, between Moss Vale and Berrima. Further discussion on potential delays at level crossings is provided in the response in Section 17.6.2.

These respondents made general comments and objections to an increase in rail and road traffic and transport disturbance as a result of the two projects. Objections related to the general safety of rail traffic passing through towns and villages, pollution, dust, traffic disruption, noise and vibration, at all stages of the journey including the rail level crossings. One of the more specific concerns raised was about trains travelling throughout the night. Other respondents noted that trains should be used for commuters and not coal.

The existing provision of safety controls at each level crossing along the coal transport route has been documented and assessed in the EIS. The assessment confirmed that these existing controls are adequate and appropriate for the existing and future day time and night time train operations, including Hume Coal trains. It was noted in the Berrima Rail Project EIS in Appendix G (section 3.3) that a number of safety improvements have been implemented since 2013 at numerous level crossing along the route. These include the installation of flashing lights at the Sheepwash Road level crossing, as well as the installation of new red level crossing warning signs and clearing of vegetation alongside the rail corridor to improve the visibility of trains to approaching traffic at many of the minor rural road level crossings along the rail transport route.

It is acknowledged that a number of Hume Coal train movements will occur during the night time period through the urban areas of Moss Vale and Robertson. However, the scheduling of these coal train movements at night has the operational benefit of reducing the potential competition for daytime rail network capacity, which is mainly utilised for passenger train operations on the Illawarra and Main Southern Railway lines. In addition, there would generally be fewer vehicles affected by road traffic delays at level crossings at night along the route between Moss Vale and Robertson when compared to coal train movements mainly occurring during the daytime when the roads are busier.

The concerns raised relating to dust and noise emissions are addressed in the response above.

17.5 Curfews and train scheduling

Some community and special interest groups raised train curfews, with some claiming that the EIS omits discussion about the impacts of curfews and the issues with train scheduling. One community submission asked about the impacts if a curfew is imposed at Berrima, Moss Vale or Robertson. Another noted that the current curfew at Port Kembla limits trains between 6:00 am and 11:00 am and questioned whether Hume Coal will ask for the curfew at Port Kembla to be lifted in the future.

The following questions were raised in regards to the curfew hours at Port Kembla:

- where will the loaded coal trains be held during the curfew hours;
- what is the flow on impact from the additional trains parking at the new siding at Moss Vale, and will this impact the Main Southern Railway Line;
- is there a need to create a new and longer siding on the Moss Vale to Unanderra line, or at Port Kembla to hold trains awaiting the curfew lift;
- will a single new siding at Moss Vale be sufficient; and
- what new signalling and traffic control measures are needed due to the curfew at Port Kembla.

In addition, concerns were raised about capacity at Port Kembla, claiming that the EIS does not take into account the proposed access regime for the Port Kembla Coal Terminal, including the expected increase of passenger capacity by 40% and movement of containers by 2031.

In light of the product volumes and train numbers, the Australian Institute is concerned how Hume Coal plans to work around rail access limitations. An interest group respondent questioned how Hume Coal will work around the three-hour ban on freight movement in the morning and afternoon peak periods on the Illawarra line, which was introduced to prioritise commuter trains.

A community respondent noted that the EIS does not include a detailed analysis of the proposed access regime for Port Kembla, and requested more information on a number of matters including hourly train paths available for freight and passenger trains, hourly usage, impact of track possessions on freight paths, rail infrastructure down time, delay due to malfunction, delay due to network issues, and train paths booked but not used to avoid path banking.

The train path and timetable capacity analysis which was undertaken by consultants Plateway (2015) for Hume Coal identified four provisional coal train paths in each direction for the project, which would be arriving and departing from Port Kembla. These train paths would be at the following times, generally on all operating days, which could include both weekday and weekend days, over approximately 316 days per year.

- Coal trains arriving at Port Kembla at 00:50, 08:05, 11:10 and 22:20 hrs each day; and
- Coal trains departing Port Kembla at 00:05, 02:35, 11.40 and 18.45 hrs each day.

One of these coal train paths (the 08:05 am arrival time at Port Kembla) is not compatible with a 6:00 am to 11:00 am weekday curfew affecting coal train movements at Port Kembla. It is not known if the curfew in its current form was operating at the time (2015) at which these potential future coal train paths were identified. However, further investigations will be undertaken by Hume Coal to either identify an alternative operating path time for this train or request an amendment to the current weekday morning curfew for Port Kembla coal train movements.

In their submission ARTC advised that they are focussed on improving the performance of its rail network, including increasing the utilisation of its entire infrastructure. Hume Coal would be an important customer for ARTC, supporting increased utilisation of the freight rail network. ARTC has well developed infrastructure plans that identify future rail traffic and rail network capacity requirements and ARTC considers the Hume Coal Project can be accommodated within the current infrastructure plans.

The last stage of the journey for coal trains from the mine to Port Kembla requires access over the rail tracks which are controlled by Sydney Trains between Unanderra and Coniston. Where there is a bridge carrying the freight trains crossing over the existing passenger rail line to Port Kembla, further consultation will be undertaken in due course between Hume Coal, ARTC and Sydney Trains. This consultation would either confirm the acceptability of the currently proposed four additional coal train paths per day operating over this section of the rail network, or identify alternative times of the day at which the Hume Coal train movements could occur.

On the short section of the route between Berrima Junction and Moss Vale junction, where the coal trains will be crossing over or running along the same tracks of the Main Southern Railway which are used by passenger and other freight trains, satisfactory arrangements have been determined by ARTC in consultation with NSW Trains for the shared operation of passenger and freight train movements over this section of the route. Similar arrangements will be determined in due course by ARTC, in consultation with Sydney Trains, for the future combined operation of passenger and freight trains over the short section of the Illawarra line between Unanderra and Coniston, which is on the approach to the coal export terminal at Port Kembla.

17.6 Rail/road interaction

17.6.1 Extension of the number 1 siding

TFNSW noted that the extension of the western end of number 1 siding at Berrima Junction will result in the siding being located next to the level crossing on Collins Road, which is currently protected by passive control. The siding extension will need to be assessed for compliance with standards for sight distances etc and renegotiation of the Safety Interface Agreement (between track owner and road authority) for the crossing.

The potential safety effects of the extension of the existing Berrima Junction Number 1 siding closer to the Collins Road angled level crossing have been considered in the project design.

Hume Coal have calculated the sight distance for trains approaching the Collins Road level crossing (about 100 m) and found it to be adequate, taking into account the fact that the line speed in this location is 10 km/hr and the stopping distance for the train at this speed is around 30 m. A detailed level crossing safety assessment (ALCAM) will be undertaken for the proposed rail track modification, to confirm the appropriate future level crossing safety control method at the detailed design stage for the proposed works.

17.6.2 Delays at level crossings and safety concerns

Interest group, business and community respondents raised concerns over the time delays at 17 rail level crossings (an extra 24 minutes of closure at rail level crossings each day) as a result of the daily additional four Hume Coal trains travelling on the rail line from the mine to Port Kembla, and the negative effects this may have on traffic congestion.

It was suggested that the delays at rail level crossings would in turn impact the residents and visitors in the area, as well as local businesses, and thus the general quality of life and experience of the area. Specific concerns were raised about delays at the following rail level crossings and the resulting congestion on the following roads; the three level crossings at Robertson (in particular impacting Robertson Primary School as the train is going to be 30 m from the school), Sheepwash Road (identified as an essential route, especially for emergency services); Illawarra Highway (also identified as an essential route); Argyle Street in Moss Vale; Douglas Road; Collins Road; Suttor Road; and Oldbury Farm.

A particular concern raised about delays at level crossings was the potential for delays to emergency vehicles, including police and other critical community vehicles.

Safety concerns were also raised. Many of the respondents raised concerns about the potential pedestrian, rail and traffic accidents that could occur as a result of multiple factors at the rail level crossings. Issues raised relate to limited signage, lack of signal lighting, warning systems and fencing surrounding the rail level crossings. Macquarie University added that the Berrima Rail Project should be delayed until such a time as the Level Crossings Safety Council can convene and assess all existing safety deficiencies at any level crossings identified in this Report and any other level crossing on this line. The steep traverse after Robertson was also raised, submitting that a heavily loaded coal train experiencing mechanical problems on the descent, could result in a major incident.

One of the 17 identified level crossings (the crossing on Berrima Road near the Berrima Cement Works) is due to be replaced by a new road detour including an overbridge, which is to be constructed by WSC.

The majority of the other 16 identified level crossings are located on minor local roads or private roads, where the traffic volumes are very low and the actual number of vehicles affected by each level crossing closure would be a maximum of either one or two vehicles or in some cases no vehicles at all.

There are five significant level crossings which are located on major roads or important local roads in the Robertson and Moss Vale areas and the rural area between these two townships. These are the level crossings at Sheepwash Road, the Illawarra Highway at Robertson, Suttor Road in Moss Vale and Meryla Street and Fountaindale Road in Robertson.

However, as most of the potential additional coal train operating times for the Hume Coal trains at Robertson and Moss Vale will be occurring either after 7 pm in the evening or before 6 am in the morning, the number of vehicles using the roads at these times is likely to be low.

There will generally only be two additional daytime coal train operating paths on a typical weekday through the area; one which travels eastbound from Moss Vale Junction to Robertson between 8.30 am to 9.00 am in the morning and one which travels westbound from Robertson to Moss Vale Junction between 2.30 pm and 3.00 pm in the afternoon. A large number of vehicles are likely to be affected at each of the five identified level crossing locations in or between Moss Vale and Robertson at these times, and through traffic travelling on the Illawarra Highway would also be affected. Notwithstanding, it is noted that the additional train movements on the network proposed by Hume Coal are well within the capacity of all sections of the network.

Hume Coal acknowledges the existing concern of some community members relating to rail crossings. However, the additional delays at level crossings resulting from the extra Hume Coal trains will not be a significant increase to the total length of time each day when the affected level crossings will be closed to road traffic. The management of rail level crossings is the responsibility of the respective rail line operators; that is the ARTC for the line between Moss Vale and Robertson, and Boral for the Berrima Branch Line, and therefore any future decisions to upgrade railway level crossings is the responsibility of these rail line operators.

In relation to the safety concerns raised, it is noted that the railway line through Moss Vale and Robertson is currently used by daily coal train movements from the Tahmoor Mine at a similar frequency to that which is proposed for the Hume Coal trains. The current daily coal train movements from the Tahmoor Mine are not considered to generate any abnormal rail safety concerns and neither will the proposed daily coal train movements from the Hume Coal Project.

Further, the configuration and management of rail level crossings, including the signal lighting, warning systems and fencing mentioned in some submissions, is also the responsibility of the respective rail line operators (ARTC and Boral), with whom Hume Coal has consulted with in relation to the Berrima Rail Project and Hume Coal Project. Hume Coal has also committed to using the latest generation of AC freight locomotives and wagons with electronically controlled braking that are available at the time project approval is granted, which will also provide improved safety and reliability for the Hume Coal train operations, through the use of more powerful braking systems on the latest trains.

17.6.3 Railway bridges

TfNSW submitted that detailed designs need to be undertaken for the proposed railway bridges over the old Hume Highway and Berrima Road. These bridges need to be designed to provide adequate clearance as both these roads are 4.6 m HML B-double routes.

A community submission requested more information on the proposed crossing over the Old Hume Highway near Medway Road, noting that this is the only connection for Berrima residents to Sutton Forest, Exeter and Canberra. The respondent noted that Hume Coal should provide a similar bridge or underpass over the Old Hume Highway as will be built on Berrima Road, and that it should be built over Suttor Road in Moss Vale, Sheepwash Road, Illawarra Highway.

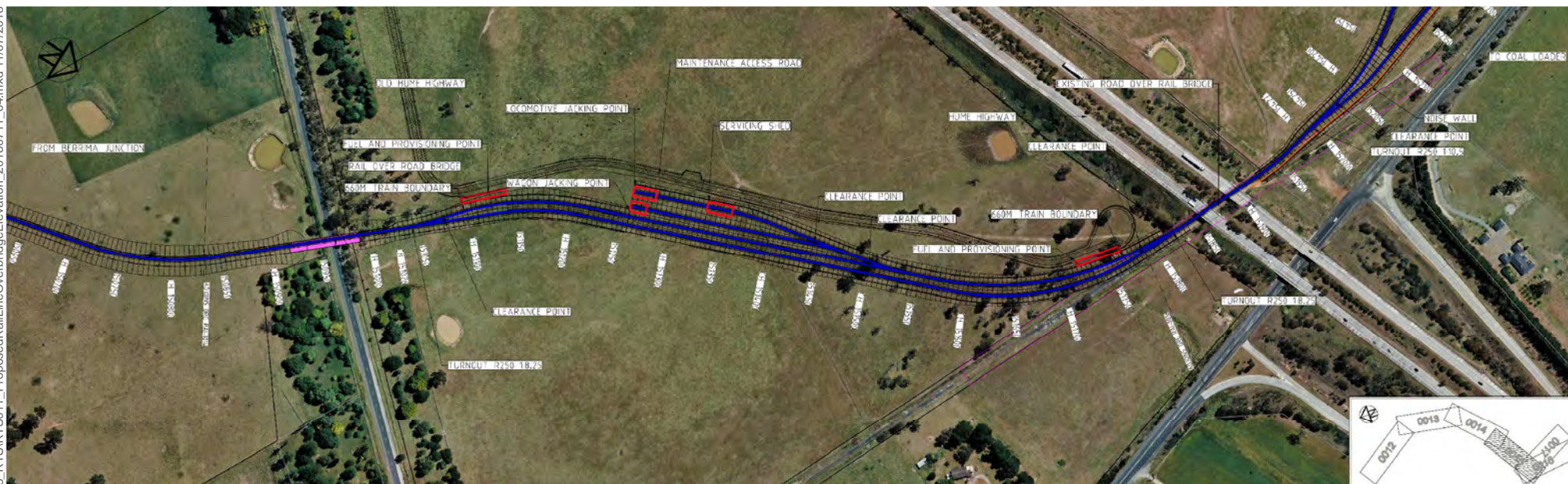
The Berrima Residents Association noted that no design details of the rail bridge over the Old Hume Highway are included in the EIS, and submitted that the rail bridge over the Old Hume Highway should be turned into a road bridge over the rail tracks.

The proposed elevation of the new railway line (track level) over the Old Hume Highway near Medway Road is shown in the extract from the relevant design drawing in Figure 17.2.

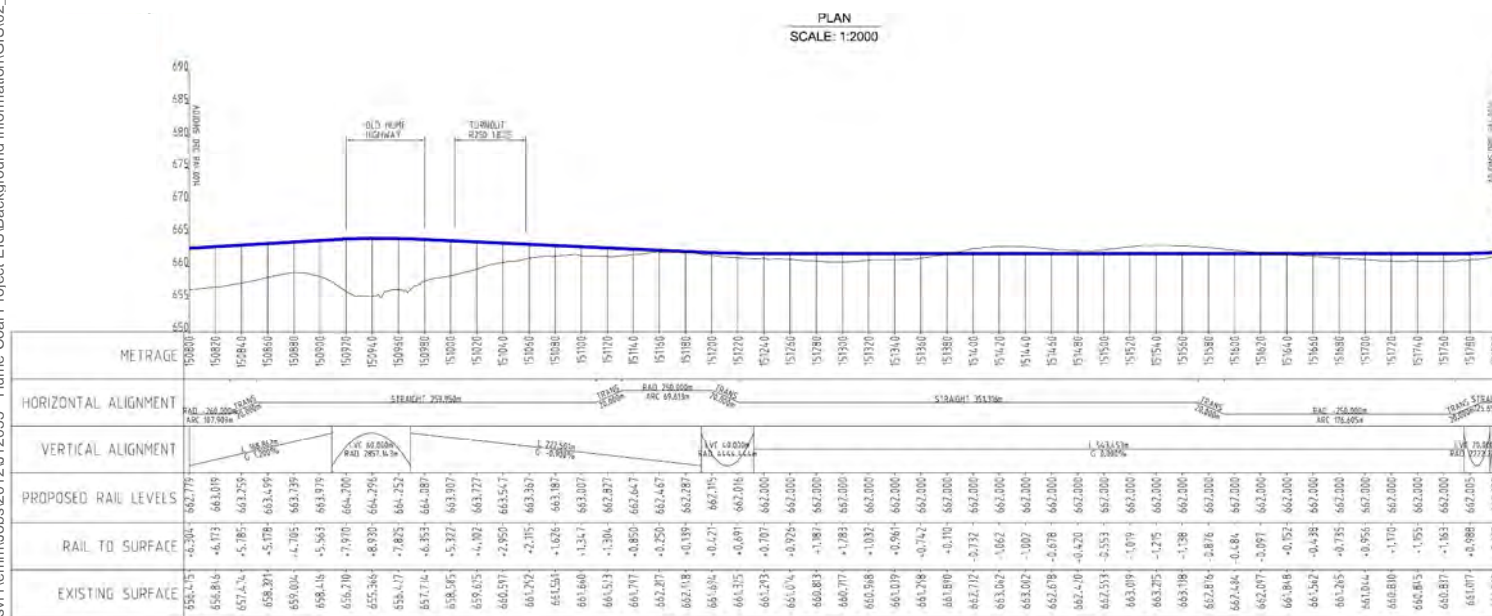
The minimum design clearance requirement of 4.6 m height for traffic travelling under the bridge is noted, and this is consistent with the concept design for the proposed bridge. The proposed rail long section drawing in Figure 17.2 allows for more than 7.8 m clearance between the existing road surface and the rail track level (chainage 150960), which will provide at least 5 m clear height for road traffic travelling under the bridge. Typical bridge designs require 1-2 m of vertical depth between the top of the rail level and the base of the bridge.

Similar design principles will be applied by Hume Coal to the design of the proposed bridge over Berrima Road.

At the existing three railway line level crossing locations which are noted in the submissions (at Suttor Road in Moss Vale, Sheepwash Road and the Illawarra Highway at Robertson), the existing railway line at these locations is already used by a much larger number of daily freight train movements (including existing coal trains from the Tahmoor Mine) than would be generated by the Hume Coal Project. The responsibility for any future infrastructure works to provide either road or rail overbridges or underpasses at these locations would lie with the government road and rail transport agencies, rather than with Hume Coal.



KEY
 Proposed alignment



Proposed elevation of the rail line overbridge across the Old Hume Highway

Hume Coal Project and Berrima Rail Project
 Response to submissions

Figure 17.2



17.6.4 Emergency Plan

Respondents raised concern that Hume Coal has no emergency plan outlined in the EIS for additional coal trains in case of crashes or derailment.

The management of the rail line, including implementation of emergency procedures, is the responsibility of the rail line operators, being Boral (for the Berrima Branch Line) and ARTC (for the rail line between Moss Vale and Robertson). ARTC has a documented Emergency Management Procedure in place, which is publicly available on their website.

There is no formal contingency plan outlined in the Hume Coal and Berrima Rail project EIS for alternative train operations in the event of rail traffic incidents or disruptions which would make the proposed rail transport route to Port Kembla unavailable for a significant period (more than 24 – 48 hours). In principle the most feasible alternative export coal transport operation which could be established in such a short time period would be to alternatively transport coal by rail to the Port of Newcastle for stockpiling and/or export via the PWCS and NCIG Coal Terminals there.

No specific train paths are identified for potential export coal train operation from the Hume Coal project to be diverted to travel via Sydney to the Port of Newcastle. However, there is now a dedicated freight rail bypass route established through a major proportion of the Sydney Metropolitan area, between Macarthur and Rhodes, which now facilitates coal and other freight train movements operating through the western and south western parts of Sydney at all times of the day, and could be utilised by diverted coal trains from the Hume Coal project, to travel to and from the Port of Newcastle if this was required.

17.7 Locomotives and wagons

TfNSW requested advice on how the commitment to use the latest generation of AC locomotives and wagons with electronically controlled pneumatic brakes will be assessed at the commencement of the project and on an ongoing basis. TfNSW recommended that Hume Coal specify that locomotives using the facility will satisfy the noise criteria in the Environment Protection Licence (EPL) imposed by the Environment Protection Authority (EPA) for the relevant networks. Hume Coal would then be required to restrict access to their facility to any locomotive that did not meet these requirements.

Hume Coal will be required by the development consent to conduct operations in accordance with the Hume Coal Project EIS and the Berrima Rail Project EIS, which includes satisfying the noise and air quality criteria specified in the EIS and reflected in the EPL. As such, all locomotives using the facility must satisfy the noise criteria in the relevant EPL imposed by the EPA. An ongoing environmental monitoring program will be implemented at the assessment locations identified in the EIS to monitor compliance with the imposed criteria. This monitoring program will be documented in the Environmental Management System that will be developed for the Hume Coal Project and Berrima Rail Project.

Hume Coal is committed to using the latest generation of AC freight locomotives and wagons with electronically controlled braking that are available at the time project approval is granted. All relevant environmental assessments undertaken for the Berrima Rail Project EIS (such as the noise, air quality and GHG impact assessments) were undertaken based on the specifications of the latest locomotives that are currently available.

17.8 Interactions with other rail users


Some community respondents submitted that the coal trains will inconvenience passengers, as goods trains will be prioritised over commuter trains. Workers commuting to Sydney are concerned that commuter trains will be delayed due to an increase in freight trains.

Macquarie University submitted that the Hume Coal Project and the Berrima Rail Project have no authority to influence the future operations of the other existing local rail using industries, including Boral, Inghams and Omya.

Within the urban areas of Sydney, Newcastle and Wollongong and on the Sydney Trains controlled rail tracks between these urban centres it is indisputably accepted by all the rail network operators that passenger train have priority over freight trains on all sections of the rail network, except for dedicated freight only lines. The network management principles adopted by ARTC in managing train movements is consistent with this, as shown in the extract below (ARTC 2011).

Table 17.1 ARTC network management principles

Table D1 – Train Priority Matrix

Decreasing order of priority	Type of train service in ARTC Network
From Highest	Long-distance Passenger Services
	Commuter Peak Services and rail passenger services likely to affect Commuter Peak Services or Special Event services
	Limited -Stop Services that are not Commuter Peak Services or Special Event Services
	Freight services likely to affect Commuter Peak Services or Special Event services
	Frequent-Stopping Services that are not Commuter Peak Services
	Freight Services
To Lowest	Non-Revenue Positioning Movements

As noted in the response in Section 17.5, the priority for passenger trains is now enforced by curfews for freight train operations which are now imposed in the Sydney, Newcastle and Wollongong Urban areas. This preserves the rail network capacity for passenger trains during the relevant parts of the morning and afternoon commuter peak passenger demand periods.

On the Berrima Branch Line, the rail line operations are managed by Boral at the Berrima Cement Works. Boral are the primary rail operator on the line and are directly responsible for approximately 80% of the current train movements using the line. Hume Coal has planned the infrastructure works for the future extension to the Berrima Branch Line and their future coal train operations in close consultation with Boral.

17.9 Rail capacity

17.9.1 Train paths

TfNSW note the Berrima Rail Project EIS states that ARTC has been consulted and confirms future availability and train paths between the Berrima Branch Line and Port Kembla. However, TfNSW go on to note that the proposed haulage route between the mine site and Port Kembla involves travel on a short section of line managed by Sydney Trains through Unanderra. TfNSW therefore submit that Hume Coal need to engage with Sydney Trains to confirm train path availability and future network enhancements which may be required to support the proposed operations and maintain sufficient capacity for other rail users over the life of the project.

Further information on train paths is provided in TfNSW's submission as follows:

- There is an interface with existing passenger and freight operations between Unanderra and Unanderra North Junction on the Sydney Trains network; passenger and freight share the bi-directional dual track in this section. The proposed eight Hume Coal Services to/from Port Kembla potentially impact the existing freight and passenger services to the area.
- There are currently up to 14 freight paths in each direction per day between Unanderra and Unanderra North Junction.
- Existing operation of the Moss Vale to Bomaderry Manildra service involves reversing direction up to two times per day at Unanderra. The timetabled dwell at Unanderra is approximately 30 minutes.
- There are up to 33 passenger trains in each direction per day between Unanderra and Unanderra North Junction.

i Consultation

Hume Coal has contacted Sydney Trains as per the request by TfNSW, to discuss potential timetabling and infrastructure constraints through Unanderra. This consultation is ongoing.

ii Train paths

The Plateway modelling and preliminary train paths identified for the Hume Coal Project were based on the passenger and freight train timetables in force in 2014, when the report was prepared (Plateway 2014).

The interface with the existing passenger and freight train paths around Unanderra was considered in the modelling and included the Port Kembla freight train curfew (as published at the time). Also, since 2014 there has been a tendency in the current coal export market to shift exports away from Port Kembla to Newcastle, which has created additional spare train paths and tipping slots for coal train to operate to Port Kembla.

The Moss Vale to Bomaderry "Manildra" Train turning back was not modelled on the main South Coast line, although it was modelled on the branch line to Robertson and Moss Vale. As noted in the TfNSW submission, Unanderra has a very flexible track layout with three bi-directionally signalled tracks. Given that the Moss Vale to Bomaderry "Manildra" Train 3930 is timetabled to turn back at Unanderra in the middle of the night between 00:15 and 00:45, there is enough flexibility to work Hume Coal trains through Unanderra on another vacant track, noting that the sectional run time from Unanderra to Unanderra North Junction is five minutes, and hence the section has a theoretical capacity of at least six trains per hour on each track.

Between 00:00 and 01:15 there are three passenger trains and one freight train scheduled through the section travelling either northbound or southbound, leaving adequate spare capacity for the two provisional Hume Coal train paths, one of which will travel directly behind a passenger train. The reverse Bomaderry to Moss Vale "Manildra Train" 9329 turns back between 11:50 and 12:44 at a time which doesn't impact the provisional Hume Coal train paths.

Potential future rail infrastructure works which are identified in the "Fixing Country Rail" program include provision for an additional refuge siding at Unanderra, presumably to facilitate this midday turn (or to allow more flexibility in its timing).

17.9.2 Rail track capacity and axle loadings

Some community and special interest groups raised concerns about the proposed railway line being able to cope with a significant increase in load and use. It was submitted that the railway line to Port Kembla is unsuitable due to location, route and that the general age and state of the infrastructure may pose a safety risk to passengers, traffic and pedestrians.

It was submitted that the Moss Vale to Unanderra Line was not designed for the heavy haulage traffic of coal by diesel and electric locomotives. Macquarie University notes that the proposed rail loop and spur, the subject of the Berrima Rail Project, will be constructed to accommodate a 30 tonne axle load. The maximum axle load capacity of the ARTC controlled Moss Vale – Unanderra rail route (22.8 tonnes for locomotives and 25 tonnes for freight wagons) is well below the capacity of the proposed Berrima Rail Project track.

Macquarie University recommends in their report that prior to any approval of the Hume Coal Project and Berrima Rail Project be considered, the ARTC should establish the suitability of the entire length of the Moss Vale to Unanderra Line to safely accommodate rail movements associated with the Hume Coal Project.

As is noted in the submissions, the Moss Vale to Unanderra line has been designed to cater for 25 wagon axle loadings. All the proposed coal trains which would operate from the Hume Coal mine to Port Kembla would therefore only use wagons with a 25 tonne maximum axle loading.

Whilst the Berrima Branch Line extension has been designed to accommodate 30 tonne axle loadings for the coal wagons, this is to provide the flexibility to use higher axle loadings on other lines in the future if the Hume Coal trains are required or permitted to travel to other destinations in addition to Port Kembla.

It is also noted that the ARTC has well developed infrastructure plans that identify future rail traffic and rail network capacity requirements. In their submission on the Berrima Rail Project, the ARTC states that they consider the project can be accommodated within the current infrastructure plans.

17.10 Rail maintenance facility

WSC noted that the access road to the rail maintenance facility is shown to intersect with the Old Hume Highway (between Taylor Avenue and the south bound freeway on-ramp); however submits that the EIS does not discuss the expected traffic generated at this intersection. Council also submitted that any use of this intersection other than for maintenance activity is not supported. Regardless of traffic volumes, the minimum treatment is recommended to be an Austroads "BAR" and "BAL" treatment.

The Berrima Residents Association submitted that the proposed rail maintenance facility will have adverse impacts, and propose that it be located on the western side of the Hume Highway. Concerns were raised over the minor maintenance tasks, refuelling and oil refilling that will take place 24 hours a day.

The assessment of the future traffic demand and intersection requirements for the intersection of the rail maintenance facility access road and the Old Hume Highway is contained in the Berrima Rail Project EIS (EMM 2017b) (refer to Section 9.4 and 9.5).

The future access requirements for the intersection were assessed in the Traffic and Transport Assessment Report (Section 4.2) prepared for the Berrima Rail Project EIS (EMM 2017o). Based on this assessment, it is proposed to provide a Type CHR/S intersection design at the location of the rail maintenance and refuelling facility access road, which is a higher design standard than the type BAR intersection design which has been requested by WSC in their submission.

One reason the higher standard access intersection design, with improved traffic safety, is proposed to be provided at this location is that the additional traffic movements using the intersection will include a number of fuel delivery truck movements each day. As the proposed access arrangements for these truck delivery movements using the Old Hume Highway will have a high level of safety due to the improved intersection design, there is not considered to be any corresponding need or justification for WSC to recommend that it is re-located to an alternative location on the western side of the newer Hume Highway (Motorway) alignment.

17.11 Increased road traffic movements (Hume Coal Project)

A number of community and special interest group submissions raised concerns about the increase in traffic movements and subsequent traffic congestion as a result of the project. Specific concerns were expressed in regards to 400 workers commuting during the Hume Coal Project and Berrima Rail Project construction period and an operational workforce of 300 workers thereafter. Traffic will also be impacted by the 24 hour operation of the rail maintenance siding.

It was also submitted there is potential for the need to upgrade secondary roads, and that of particular concern is the potential impact on Golden Vale Road, which it was claimed could become a cross-country thoroughfare for workers to access the administration area. Other roads that may be impacted by similar traffic are Old Argyle Road and Exeter Road.

Other community respondents raised concerns about increased trucks damaging local roads, and questioned how road repairs would be funded if required.

DPI Agriculture submitted that the information provided by Hume Coal is not sufficient for an assessment to be made until further detail is provided regarding the traffic management plan (TMP). DPI Agriculture suggested the TMP should include specific reference to agricultural related traffic in detail, including how agreed management and mitigation measures would be developed, implemented, monitored and reported, and what mechanisms for dispute resolution would be implemented.

WSC also question the conclusion that the traffic impact on local state roads would be "low impact", claiming that whilst coal will be transported by rail, RMS has advised 10% of that production would have a road generated impact, based on RMS experience with coal extraction in the NSW Hunter Valley. Therefore it is submitted that there appears to be a significant difference in what would be expected to be higher traffic generation based on the RMS advice and the 'modest' generation provided in the EIS.

A detailed assessment of the potential road traffic increases from the Hume Coal Project related traffic has been undertaken for three stages (early construction, peak construction and project operations) at 23 locations on the surrounding major road and local road networks. The assessment is reported in detail in Tables 4.2, 4.3 and 5.1 of the Traffic and Transport Assessment report which is Appendix M of the Hume Coal Project EIS.

The project construction traffic movements during the peak stage of the project construction, with a workforce of over 400 persons, will be mitigated by having an on-site accommodation village, which will greatly minimise the extent of the project related peak hourly and daily traffic movements that would otherwise be using the roads in the area at these times.

During all of the three identified stages of the project at which the additional generated traffic movements have been assessed, the vast majority of the project related traffic will travel via the Hume Highway, Old Hume Highway and Medway Road routes. The proportions of project related traffic that will travel via the identified routes which are of most concern to the Council (Argyle Street and Golden Vale Road) will be minimal and will have minimal impact to the existing daily traffic volumes or peak hourly traffic conditions for other road users travelling via these routes. The following project related traffic increases are identified in the EIS for these routes for each stage of the project:

- either 4,8 or 12 additional daily vehicle movements (during the early construction, peak construction and project operations respectively) using Golden Vale Road, which would be increases of between 0.5% and 1.4% of the existing daily traffic;
- either 14,16 or 30 additional daily vehicle movements using Argyle Street west of Waite Street, which would be increases of between 0.1% and 0.3% of the existing daily traffic, and
- a consistent 46 additional daily vehicle movements using Argyle Street east of Waite Street which would be an increase of approximately 0.3% of the existing daily traffic.

A Traffic Management Plan will be produced and implemented for both the construction and operational stages of the project. This plan will include management and monitoring procedures, as suggested by DPI Agriculture, and will be prepared in consultation with relevant authorities. Notwithstanding, the future traffic movements generated by the project will not have any significant impacts on the road network traffic capacity, intersection traffic operations, and the efficiency of operation of the road network. In coming to this conclusion, the traffic assessment included the existing baseline traffic movements, which includes the existing agricultural related traffic in the region.

In relation to submissions regarding the potential for damage to local roads as a result of increased project related traffic and the funding of repairs, it is noted that the maintenance of public roads is the responsibility of the relevant government authority; that being the local council for local and regional roads and RMS for State roads. Hume Coal will enter into a Voluntary Planning Agreement with WSC or a similar agreement with the appropriate regulatory party, which takes into account any increased pressure on local infrastructure such as roads as a result of the project, and could be used to fund local community services and facilities such as road maintenance. Notwithstanding, it is again noted that no significant adverse traffic impacts have been identified for the future traffic movements generated by the project for either the road network traffic capacity, intersection traffic operations; the road network condition; road safety and the efficiency of operation of the road network.

In relation to the RMS claim that based on Hunter Valley experience, 10% of production would have a road generated impact, it is noted that the majority of Hunter Valley mines are large open cut mines where the coal production is exclusively for export or domestic power generation consumption and is 100% transported by rail. However, many of the mines have subsidiary sales of surplus rock materials from overburden removal or rejects from the onsite coal processing which is in most cases transported by road. This type of subsidiary (non carboniferous) product sales by road is specifically excluded from the Hume Coal Project, with the commitment that all mineral waste and reject material produced will be retained on site, and therefore this type of possible road transport operation is not applicable to the Hume Coal Project.

17.12 Site access (Hume Coal Project)

The Berrima Residents Association submitted that the proposal to make Mereworth Road the main entry to the mine is problematic, stating it is unlikely that traffic to the mine coming south of the Hume Highway will exit at Medway Road, travel east, turn right onto the Old Hume Highway, continue south for 2 km, pass under the Hume Highway to join Mereworth Road. More likely is the scenario that traffic coming to the mine will continue past the Medway Road exit for 2 kms before slowing down (in the fast moving right lane) to turn right into the short median strip at Golden Vale Road in order to make a U-turn back on to the Hume Highway, then travel north for 500 m before taking the Berrima exit and turning left onto Mereworth Road.

The Berrima Residents Association suggest this could be avoided if an alternative entrance to the mine is opened off Medway Road, to the west of the Hume Highway. In doing so, traffic heading south to the mine along the Hume Highway could exit at Medway Road and turn right toward the west along Medway Road to the new mine entrance.

A response to these issues is provided in the response in Section 17.3.1, in relation to site access and transport routes for the project, including proposed additional Motorway signage.

In principle, as the proposed Mereworth Road access route for the mine infrastructure area has adequate capacity for all the predicted project traffic movements, with minimal additional delays for either the project traffic or other locality traffic, there is no reason why an additional vehicle access route for traffic travelling via Medway Road, would be required for the project.

It is acknowledged that an additional vehicle access route via Medway Road would result in shorter travel times and journey distances, by approximately 2 km for all the project related traffic which would be travelling either to or from the north via the Hume Highway. However, Hume Coal does not consider this access to be necessary for satisfactory traffic operations for either the project construction or operations stage access requirements.

17.13 Coal transport by trucks

A number of community submissions raised the concern that coal will be transported by truck and not rail, as stated in the EIS.

WSC claimed that increased frequency of delays at level crossings should be considered against the improved overall road safety and reduced congestion that would be created should all coal be transported on road.

Hume Coal is seeking approval for the transportation of product coal by rail. The EIS does not assess the transportation of coal by trucks and as such, if the project is approved all product coal must be delivered to market from the mine by rail. Approval is not sought for road transportation of coal.

It is anticipated that all of the potential project coal customers for either export or domestic coal consumption will have a preference for receiving the coal deliveries by rail and there would not therefore be any potential situations where the product coal transport operations would preferably utilise road transport.

The assertion by WSC that coal transport improves road safety and reduces congestion is not accepted, and is contradicted by facts about road versus rail transport. Over the past 30-40 years, the coal transport industry in NSW for both domestic and export coal transport has gradually evolved from a position of frequently utilising road transport to now almost exclusively using only rail transport. This transition has occurred for a number of reasons, including that rail transport is usually cheaper (on a cost per tonne/km basis), is less energy intensive, and is now almost universally accepted to be safer and to have lower environmental impacts than road transport. Information published by the Australasian Railway Association ([https://ara.net.au/sites/default/files/u1/ARA_Freight-on-Rail-REDUCED\(1\).pdf](https://ara.net.au/sites/default/files/u1/ARA_Freight-on-Rail-REDUCED(1).pdf)) states that rail is up to nine times safer than road freight, and that the average freight train takes 110 trucks off the road. By replacing trucks, rail transport assists in alleviating road congestion particularly in urban areas.

17.14 Management and mitigation measures

TfNSW suggested monitoring the functionality of the intersection at the Illawarra Highway and Wait Street, and the Illawarra Highway and Lackey Road prior to and post construction.

Macquarie University's report recommends that Hume Coal produce a Coal Transport Plan that outlines the protocols for transporting coal along the Moss Vale to Unanderra line safely, including monitoring and management procedures.

A commitment to undertake monitoring at the intersection of the Illawarra Highway and Wait Street, and the Illawarra Highway and Lackey Road, will be included in the construction traffic management plan. This will include periodic reporting of the intersection traffic survey results (6-9 am and 3-6 pm) on a typical weekday and the results of SIDRA intersection analysis to determine the average intersection traffic delay, level of service and 95th percentile queue length for each intersection approach. Monitoring is proposed to be undertaken at six monthly intervals during the project construction phase. The need for further monitoring of these intersections during the operational phase will be determined during the preparation of the operational traffic management plan, and will be informed by the outcomes of monitoring undertaken during the construction phase.

The project coal transport operations will be subject to the oversight and control of ARTC, who will specify all the operating conditions which Hume Coal (or its contracted train operator) shall comply with for the project rail transport operations. Additionally, the ARTC will review all the existing level crossing safety controls along the coal transport route and make appropriate alterations and improvements to these controls to ensure the level crossing safety controls meet the accepted standards which are defined by the Australian Level Crossing "Safety" Assessment Method (ALCAM) Guidelines.

18 Visual amenity

18.1 Adequacy of assessment and methodology

WSC stated in its submission that it disagrees with the conclusion of the visual impact assessment that the Hume Coal Project will have a minimal impact on the landscape. The National Trust of Australia (NSW) suggested that the combined visual impacts of the coal mine infrastructure and railway project will be considerably greater than the low to moderate rating given the EIS.

Concerns were also raised in community and special interest group submissions that the Hume Coal Project EIS only included a limited set of viewpoints and views from Oldbury Road were not considered (including views from Oldbury Estate which is listed on the State Heritage Register). It was also submitted that views to and from private properties toward the surface infrastructure of the mine were not considered. Some community submissions also suggested that the presence of the Berrima Cement Works should not have been considered in the visual assessment, with others stating that the presence of one industrial facility doesn't make it acceptable to add another to the landscape.

The National Trust Southern Highlands Branch and The National Trust of Australia (NSW) also raised concerns that views to the surface infrastructure area from surrounding properties and surrounding roads respectively, including Medway Road, the Old Hume Highway, the Hume Highway, Mereworth Road, Oldbury Road and Golden Vale Road were not taken into consideration in the VIA.

18.1.1 Methodology and viewpoint selection

The Visual Impact Assessment (VIA) for the Hume Coal Project (EMM 2017g) and the Berrima Rail Project (EMM 2017p) was prepared in accordance with the SEARs and relevant government assessment requirements, guidelines and policies. Specifically, both projects were assessed with regard to the UK document *Guidelines for Landscape and Visual Impact Assessment* (GLVIA) Third Edition (2013), prepared by the Landscape Institute. Standards Australia (AS4282) *Control of Obtrusive Effects of Outdoor Lighting* was also taken into consideration in the assessments.

In accordance with the GLVIA, the VIA included seven stages:

- i. Analysis of view type and context – the purpose of this stage is to analyse the existing landscape features and characteristics. To do so, a site inspection was conducted in and surrounding the project area for both the Hume Coal Project and Berrima Rail Project to gain an understanding of the landscape, and to take photos for use in the assessment.
- ii. Visibility baseline assessment – this stage establishes the area in which the development may be visible. This was conducted in conjunction with Stage 3.
- iii. Viewpoint and photomontage selection – this stage involves the selection of viewpoints to provide a representative sample of the likely impacts on the different users of the areas surrounding the project, and their visual exposure to various project elements. Viewpoints considered to have potential exposure to various project elements, or areas available to public access such as roads, are then selected for detailed assessment. The viewpoint selection process undertaken for the Hume Coal Project and Berrima Rail Project is discussed in more detail below.
- iv. Magnitude of change – the criteria against which the magnitude of change is assessed is set out in the GLVIA, such as whether the impact is temporal or permanent, and the distance of the viewer from the altered elements in the landscape.

- v. Visual sensitivity – this is a measure of the landscape's ability to absorb development without a significant change in the character, and is assessed based on a number of factors including the length of view (ie a transient view by motorists, or long term view by residents) or importance of the view.
- vi. Evaluation of significance – which is based on the magnitude of change and visual sensitivity of a receptor.
- vii. Mitigation – this stage involves determining the mitigation measures that can be incorporated into the project design to ameliorate or eliminate the potential visual impact.

18.1.2 Viewpoint selection

Stage 3 of the assessment involved a viewpoint selection process. Detailed analysis using GIS software and a 3D model of the surface infrastructure was firstly undertaken to identify the viewshed of both projects, which is the geographical area visible from a location. Analysis of this viewshed enabled the areas within and surrounding the Hume Coal Project area and the Berrima Rail Project area which have the potential to have views of the proposed surface infrastructure to be identified. This included identification of private residences that may have views of project-related infrastructure, as well as locations on major roads surrounding the project area where motorists may have views of the infrastructure. A site inspection was then conducted to confirm these locations and to take photos of the existing views, which formed the basis of the photomontages produced for the VIA.

As a result of this process, seven viewpoints were selected for both projects. These viewpoints were chosen as they were identified as having the greatest potential for experiencing visual impact due to the line of sight to surface infrastructure. These viewpoints include private viewpoints from residential properties surrounding both projects, and viewpoints on roads in the area. Photomontages were prepared to simulate the expected visual changes to the landscape and to provide an illustration of surface infrastructure from a particular viewpoint. Chapter 5 of the VIA for the Hume Coal Project outlines the selected viewpoints. Viewpoints 3 and 6 were chosen to represent typical views from private residential properties located on Medway Road, which are the nearest and most exposed to the surface infrastructure.

Section 15.5 of the Berrima Rail Project EIS outlines the selected viewpoints for this project, and includes Viewpoint 6 which is the view looking north from Oldbury Road. This viewpoint was selected to illustrate the typical view for motorists travelling along Oldbury Road and from a number of rural residential properties on the northern and southern side of the road. It is representative of views from the south-east of the surface infrastructure associated with the Berrima Rail Project. The assessment found that viewers will not have views of the project-related infrastructure from this viewpoint due to distance, intervening topography and existing tree plantings. Therefore, the assessment concluded that views from this location were unlikely to change, including those from Oldbury Farm.

18.1.3 Adequacy of findings

In its submission, the National Trust of Australia's (NSW) questioned the findings of the visual assessment, claiming that the combined visual impacts of the coal mine infrastructure and railway project will be considerably greater than the low to moderate rating given in the EIS. Firstly, the visual assessment was conducted in accordance with relevant government guidelines, as explained above. Secondly, not all viewpoints were predicted to experience a low to moderate impact. The predicted visual impact on a selected viewpoint is based on the assessed visual sensitivity combined with the proposed magnitude of change at a particular viewpoint. For the Hume Coal Project, a negligible impact on the visual amenity of the area was predicted at two viewpoints (the Hume Highway south of the surface infrastructure area and Belanglo Road looking north-east towards the surface infrastructure area); one was predicted to experience a low impact (from the Old Hume Highway adjacent to the surface infrastructure area); two were predicted to experience a low to moderate impact (along Medway Road north of the surface infrastructure area) and two were predicted to experience a moderate visual impact.

For the Berrima Rail Project, the mitigated visual impact of the project was predicted to be negligible at one viewpoint (along Oldbury Road), low at four viewpoints (two along Medway Road east of the Hume Highway in the vicinity of the siding and maintenance facility, another on the Old Hume Highway looking south towards the railway crossing, and along Berrima Road looking north-west towards the proposed bridge crossing) and moderate at two viewpoints (along Medway Road west of the Hume Highway).

Further discussion on the predicted impacts of the project on the visual amenity of the surrounding area is provided in the response in Section 18.2.

18.1.4 Inclusion of the Berrima Cement Works

In relation to the submissions claiming that the presence of the Berrima Cement Works should not have been considered in the visual assessment, it is noted that the first step in the methodology set out in the GLVIA involves the analysis of view type and context. The purpose of this stage is to analyse the existing landscape features and their characteristics. The Berrima Cement Works has been present in the landscape for over 80 years, and could not be ignored in the characterisation of the existing landscape features.

Notwithstanding, Section 6.2 of the VIA notes that the majority of the existing industrial facilities in the area are not located within immediate proximity to each other or the project area; with only the cement works, Omya and the feed mill having visual significance in the locality due to their height. As outlined in Chapter 6 of the VIA, the cumulative impact of the existing industrial facilities within the locality with the surface infrastructure proposed by the Hume Coal Project and Berrima Rail Project was assessed as minimal, primarily due to distance between facilities and the intervening topography and vegetation.

18.1.5 Assessment of views from surrounding roads

Views from surrounding roads were taken into account in the Hume Coal Project VIA, as follows: Belanglo Road (viewpoint 2), Medway Road (viewpoints 3 and 4), the Old Hume Highway (viewpoint 7), and the Hume Highway (viewpoints 1 and 5). Views along Oldbury Road were assessed as viewpoint 6 in the Berrima Rail Project VIA. Views to the surface infrastructure area of the Hume Coal Project from Mereworth Road and Golden Vale Road were taken into consideration during the initial assessment stage as part of a detailed analysis of aerial photography, topographic plans and field investigations. This research phase demonstrated that surface infrastructure would not be visible from these roads.

18.2 General impacts on the visual amenity of the area

Numerous submissions raised concerns over the perceived impact of the Hume Coal Project and Berrima Rail Project on the visual amenity of the area, including the impact of the proposed tree planting, stockpiles, coal loader and rail maintenance shed on the rural landscape. It was submitted that the two projects will have a negative impact on visitor experience and the quality of life for residents. In addition, it was claimed the two projects are not complimentary to the scenic rural residential and historic character of the locality and the cumulative impact of the Hume Coal Project and Berrima Rail Project with existing large industrial facilities in the area will be significant. One submission claims that it is an unacceptable approach to allow more large and visually intrusive structures into the landscape as there are existing prominent structures in the landscape (eg the cement works).

WSC considers that the proposed mine and rail infrastructure (including the rail embankments) will be very large and visually prominent resulting in significant impacts on public and private views. It was also claimed that the undulating nature of the topography will also reduce the effectiveness of mitigation measures, such as tree planting.

Specific concerns were also raised in relation to the visual impact on the Zen Oasis and on the attractiveness of the area for tourism and heritage related activities.

One submission claimed that the proposed mine is larger than any previously in the Southern Highlands and the above ground infrastructure will be more visible than the nearby Boral Medway Colliery.

A cumulative assessment of the visual impacts from both the Hume Coal Project and the Berrima Rail Project was included in the Hume Coal Project VIA, in Chapter 6 (Section 6.2). The design of both projects evolved considerably over several years from when the original concept was first developed. Evolution of the project design included the re-location of surface infrastructure to areas which would be less exposed to viewers surrounding the project areas. These amendments reduced overall visual impacts. Various mitigation measures were recommended to address residual impacts both generally and from specific viewpoints as described in the VIA prepared for the Hume Coal Project and the visual chapter for the Berrima Rail Project. These measures include tree screening and construction of a noise mitigation wall adjacent to the rail loop.

A detailed assessment of the potential visual impacts from each of the selected viewpoints for both projects highlighted that in most instances, distance combined with intervening topography and/or new or existing vegetation means that there will not be a significant impact on public and private views.

As well as refinement to the design of the two projects to minimise visual impacts, the location and extent of tree planting by Hume Coal was implemented to mitigate potential views from Medway Road and the Hume Highway. Once established, the planting will provide a natural screen to the various elements of the surface infrastructure from either roadways and a selection of private landholdings.

The Berrima Rail Project EIS describes Viewpoint 5 – view looking south along the Old Hume Highway towards the proposed railway crossing (bridge) location (Chapter 15 Table 15.5). This viewpoint is representative of views which are typical of the view for motorists travelling south along the Old Hume Highway and potentially from the frontages of a limited number of rural residential properties on the eastern side of the road. This part of the Old Hume Highway is also the nearest public road to the south of the project. The assessment concluded that the bridge will not be visible from the nearest privately owned residence.

Although motorists will view the bridge, the visual impact is considered to be low, given that the bridge will only be temporarily viewed as motorists pass underneath it. Whilst the bridge crossing will be a new built element in the landscape, viewers are unlikely to be highly sensitive to the change. Existing dense vegetation will also soften the visual impact of this structure in the landscape. Further, viewers are unlikely to be highly sensitive to the change in view due to the close proximity of large built structures associated with existing industrial uses within the locality.

The Berrima Rail Project EIS also describes Viewpoint 6 – view looking north from Oldbury Road (Chapter 15 Table 15.6). This viewpoint was selected to illustrate the typical view for motorists travelling along Oldbury Road and from a number of rural residential properties on the northern and southern side of the road. Visual impacts from this viewpoint were assessed as negligible as the project will not be seen due to intervening topography and vegetation.

As stated in Section 6.2 of the Hume Coal Project VIA, the majority of the existing industrial facilities in the area are not located within immediate proximity to each other or the project area. As noted in the response above in Section 18.1, it is only the cement works, Omya and the feed mill that have visual significance in the locality due to their height. The cumulative impact of the existing industrial facilities within the locality with the surface infrastructure proposed by the Hume Coal Project and Berrima Rail Project was assessed as minimal, primarily due to distance between facilities and the intervening topography and vegetation.

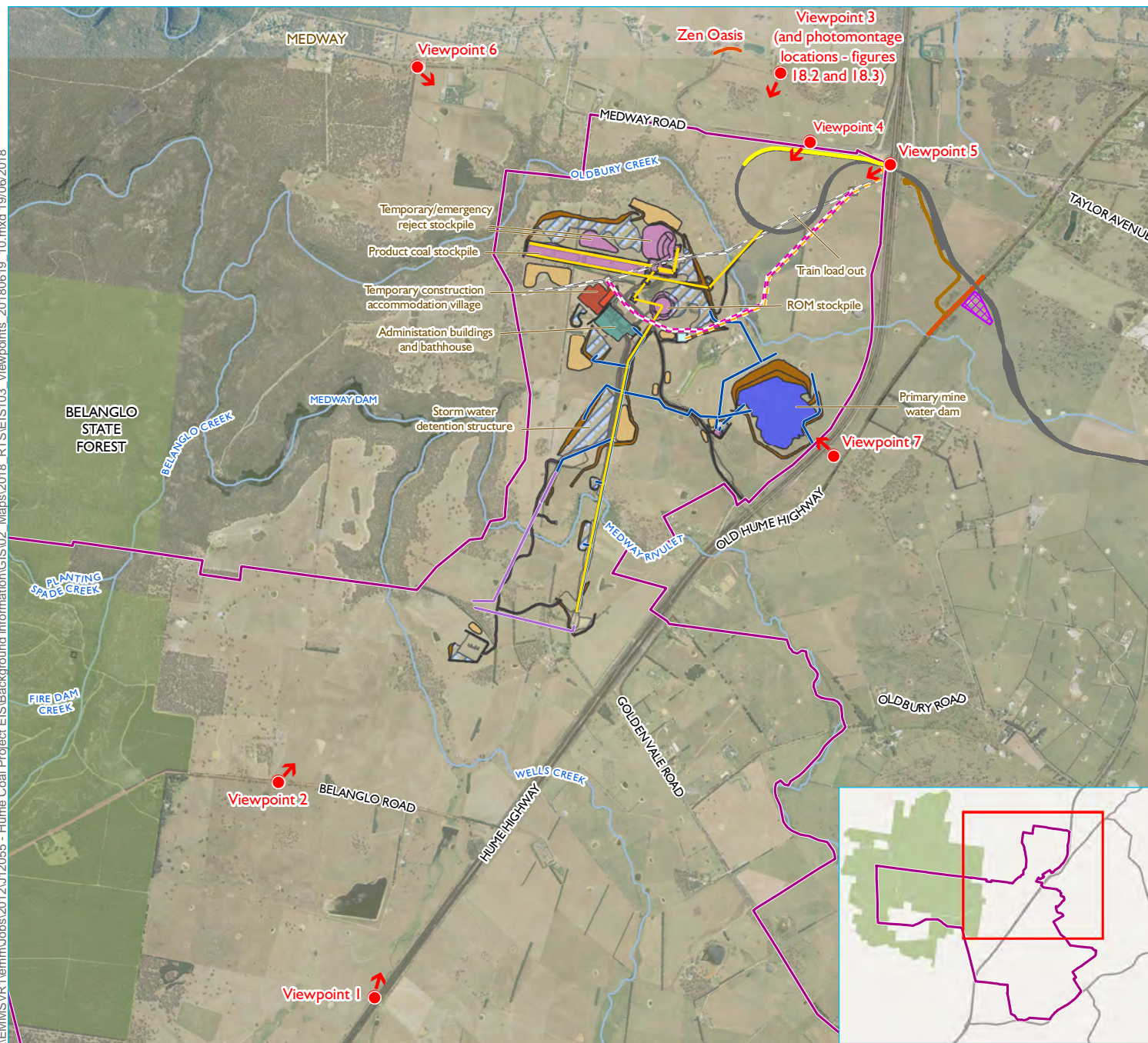
The visual impacts of the Hume Coal Project and Berrima Rail Project on the Zen Oasis function centre is predicted to be low (refer to Section 15.6.2 of the Berrima Rail Project EIS). The railway line will only be intermittently visible from the ground level of the function centre. The function centre includes small window openings on the second floor level of the southern elevation, facing the project area, which would only allow partial views of the railway line. On occasion the Zen Oasis holds art shows within the landscaped area between Medway Road and the function centre. It is acknowledged that from this location surface infrastructure may be visible. The garden is around 1 km from the train load out, stockpiles and CHPP, which will be the more visually prominent pieces of infrastructure due to height. Views directly to the south and south-west of the property look towards the proposed location of the CHPP and stockpiles. However, this infrastructure will be constructed south of Oldbury Creek, and therefore partially screened by the existing stand of trees along this creek. Views to the south-east will look towards the rail loop and train load-out. This infrastructure will also be partially screened by the noise wall and tree screen, which has already been planted. Further, the visual impacts experienced will not be permanent due to the irregularity of these types of events.

A photomontage representing the view from the private residence next door (to the east of) Zen Oasis was produced in the Hume Coal Project visual assessment (EMM 2017g), where access was available to conduct the assessment (refer to Figure 18.1 – viewpoint 3). The existing view and the photomontage showing the unmitigated view of the proposed project-related infrastructure is re-produced in Figure 18.2. The views in year 5 and 15, as the tree screen grows, are presented in Figure 18.3. As shown, viewers from this location will have distant views of the coal loading facility within the landscape. The visual assessment found that the impact of the project on views from properties along this section of Medway Road will be ‘moderate’, with distance, the proposed green colour of the infrastructure and the tree screens all contributing to substantially mitigating the impact of the change in view. Existing and new tree planting along Medway Road will provide considerable screening to a majority of the surface infrastructure.

A detailed response to submissions relating to the potential impacts on tourism of the Hume Coal Project and Berrima Rail Project is provided in Chapter 23.

In relation to concerns about the mine being larger than others in the locality, the project was specifically designed in consideration of the rural landscape. The adopted underground mining method and underground reject disposal are two critical aspects of the Hume Coal Project that reduced the potential visual impact of the project on the broader landscape. During the project pre-feasibility and design phase, elements associated with other methods of mining and reject disposal that would have much greater surface impacts were quickly eliminated. Furthermore, numerous coal mines operate across the Southern Coalfields. Coal mining also continues in the Wingecarribee LGA after a long history of coal mining in the area, with CCL 747 of Tahmoor Colliery, an underground longwall mine operating in the Bulli Seam, extending into the northern end of the LGA. The mining leases associated with Dendrobium and Wongawilli Collieries also extend into the north-west of the LGA.

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KEY

□ Hume Coal Project area

● Viewpoint locations (Arrows show direction of view)

Indicative surface infrastructure features

■ Temporary construction accommodation village

■ Administration / bathhouse / workshop

■ CPP and stockpiles

■ Topsoil stockpiles

■ Stormwater management earthworks

■ Water management area

■ Top water level

--- Existing WSC easement

--- Proposed powerline and pipeline easement

--- Powerline route

--- Drift (underground)

--- Conveyor

--- Water pipeline

--- Internal roads

Indicative Berrima Rail Project components

--- New rail line

--- Noise wall

--- Turning lane/shoulder

■ Rail temporary construction facility

--- Rail maintenance facility access road

Existing features

■ Rail line

--- Drainage line

■ State forest

Viewpoint locations - Hume Coal Project
visual assessment

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 18.1



Source: EMM (2018); DFSI (2017); Hume Coal (2017); LPI (2015)





Photomontage from Medway Road property (viewpoint 3) – existing and unmitigated view

Hume Coal Project and Berrima Rail Project
Response to Submissions

Figure 18.2



Photomontage from Medway Road property (viewpoint 3) – year 5 and year 15

Hume Coal Project and Berrima Rail Project
Response to Submissions

Figure 18.3

18.3 Impacts of the final landform on visual amenity

The National Trust Southern Highlands Branch raised concern that the Hume Coal Mine will be permanently etched into the landscape as a result of changes to views and vistas.

As described within Appendix N of the Hume Coal EIS (Visual Amenity Assessment Report, EMM 2017g), upon the cessation of mining and closure of the Hume Coal Mine, all infrastructure will be removed. Importantly, being an underground mine with no permanent surface waste emplacements proposed, the Hume Coal Project will not involve any significant permanent changes to the landform. Throughout the project life, mined-out panels will be progressively sealed and reject material placed in these voids as they become available, avoiding the need for surface emplacements of this reject material. Reject produced during the initial period of mining before sufficient void space is available for underground reject emplacement, will be stored in the temporary coal reject stockpile within the surface infrastructure area. This stockpile will be progressively constructed, contoured and when full, top dressed and revegetated. At the end of the operational phase of the project the reject on the temporary coal reject stockpile will be put back through the reject plant and pumped underground prior to sealing the surface entries to the underground mine.

Dams and stormwater retention basins will also be re-contoured during mine closure and rehabilitation to match the surrounding topography.

18.4 Light spill

Several submissions from the community and special interest groups raised concerns relating to the potential impact of light spill from the Hume Coal Project and the Berrima Rail Project on the surrounding area. Specific issues raised included night lighting of mine infrastructure which it was suggested will be visible from Berrima Village and to motorists travelling along the motorway, Medway Road and the Old Hume Highway. Issues were also raised in relation to the cumulative impact of the light spill with the existing Berrima Cement Works. Further concern was raised with regard to lighting during construction of both projects.

The National Trust of Australia (NSW) submitted that lighting associated with the Hume Coal Project and the Berrima Rail Project at night will negatively impact on visitor experience and the quality of life for residents. Another respondent stated that the proposed train movements will result in light spill that will affect the aesthetic character of the Berrima/Sutton Forest region.

The VIA acknowledges that lighting associated with surface infrastructure will be visible to residents surrounding the project area and to motorists travelling along roads in the immediate vicinity. However, the potential for light spill will be considered and designed accordingly during the detailed assessment of the surface infrastructure area for the Hume Coal Project. Lighting will be incorporated into the design in accordance with the requirements of Australian Standards 4282 *Control of Obtrusive Effects of Outdoor Lighting*.

Detailed lighting protocols will be developed and documented in a Visual Management Plan for the Hume Coal Project, which will adopt the following principles:

- the amount of lighting will be kept to a minimum, consistent with ensuring a safe and efficient working environment for operations and staff;
- appropriate lights will be fitted on conveyor walkways and other infrastructure that are infrequently utilised with sensor switches or time switches to keep their use to a reasonable minimum;
- mobile lighting plant will be set up such that lighting is directed away from external private receptors;

- lighting sources will be directed below the horizontal to minimise potential light spill;
- light systems will be designed to minimise wastage;
- screening of lighting will be undertaken where possible for viewers external to the project; and
- lighting of light coloured surfaces which have greater reflectivity will be avoided.

These lighting protocols will also be adopted for the Berrima Rail Project where possible. Incorporating these protocols as part of both projects will minimise the impact of night lighting on visitor experience and the quality of life for all residents within the locality.

For construction, lighting protocols to minimise light spill (consistent with those listed above) will be developed and documented in the Construction Environmental Management Plan (CEMP).

With regards to lights on trains for the Berrima Rail Project, lights will need to comply with the relevant ARTC codes of practice. Trains already travel in the vicinity of the Berrima region along the Main Southern Rail Line and the Berrima Branch Line.

In relation to the cumulative impacts with the Berrima Cement Works, the Hume Coal Project will add a visual element in the form of night lighting to the area. From the Hume Highway the surface infrastructure area will be viewed at times on the western side of the Highway, and the cement works will be visible to the east. However, the view will be transient in nature, with motorists travelling at 110 km/hr along this section of the highway. Further discussion on the impacts on motorists is provided in the following section.

It is anticipated that with the adoption of the relevant lighting protocols, light spill and skyglow associated with the mining activities will be minimised.

18.5 Impacts on motorists

A number of special interest group submissions raised the issue of the visual impact on motorists travelling along the Hume Highway and the resulting impact on the aesthetic qualities of the landscape due to the infrastructure associated with the two projects, including the final landform.

WSC submitted that the assumption of a low visual impact on travellers using the Hume Highway or other local roads is incorrect. The Council submits that both the coal mine and railway will be highly visible to visitors entering the local area from the Hume Highway, and that glimpses of views of mining infrastructure will adversely affect perceived aesthetic qualities of the landscape. Similarly, a special interest group submitted that visitors seeing the infrastructure from the Hume Highway will have a significant negative impact on how the visitor will feel about the town and its surrounding rural landscape setting.

The National Trust Southern Branch believes that the views from the Hume Highway, Old Hume Highway, Medway Road and other minor roads were not taken into account in the VIA of the proposal and these views will change from rural to industrial in nature.

A detailed assessment of the views motorists may experience of the Hume Coal Project and the Berrima Rail Project was undertaken. As part of Stage 3 of the VIA (refer to the response in Section 18.1), a number of viewpoints representative of the potential exposure to each project for motorists travelling in the vicinity of the mine were identified. Five of the seven viewpoints assessed for the Hume Coal Project are representative of views motorists are likely to have of project related infrastructure, and all of the viewpoints for the Berrima Rail Project assess the views motorists are likely to experience of the project. The applicable viewpoints for the mine and rail projects are shown in Figures 18.1 and 18.4, and are described in Tables 18.1 and 18.2 respectively.

Table 18.1 **Assessed viewpoints – Hume Coal Project**

Viewpoint	Description
1	This is representative of the view to the project for motorists travelling north along the Hume Highway. It is the closest position on the highway south of the surface infrastructure area that a motorist travelling north could safely stop to view the surface infrastructure in a forward facing manner. Further north along the Hume Highway, closer to the surface infrastructure area, there is dense tree planting which provides a substantial landscaped screen on the western side of the highway. Therefore, if motorists travelling north were to look left towards the surface infrastructure area, without stopping, it is unlikely that any elements of the project would be visible until they reach approximately viewpoint 5.
2	The view from this location is typical of the view for motorists travelling along Belanglo Road and from a limited number of rural-residential properties that are located on the northern side of the road. This viewpoint was selected on the basis that Belanglo Road is the nearest public road to the south of the infrastructure area.
4	The view from this receptor is typical of the view for motorists travelling east and west along Medway Road, alongside the project area's northern boundary, and from the rural-residential properties located on the northern side of the road.
5	This view is typical of the view from the western side of the Hume Highway travelling north (being the main transport corridor which runs through the project area) in closest proximity to the surface infrastructure area and the proposed rail loop and noise wall associated with the Berrima Rail Project. This viewpoint is in an elevated position looking towards the surface infrastructure.
7	This view is an elevated position on a main transport route (Old Hume Highway) which allows views across the project area in a westerly direction.

Table 18.2 **Assessed viewpoints – Berrima Rail Project**

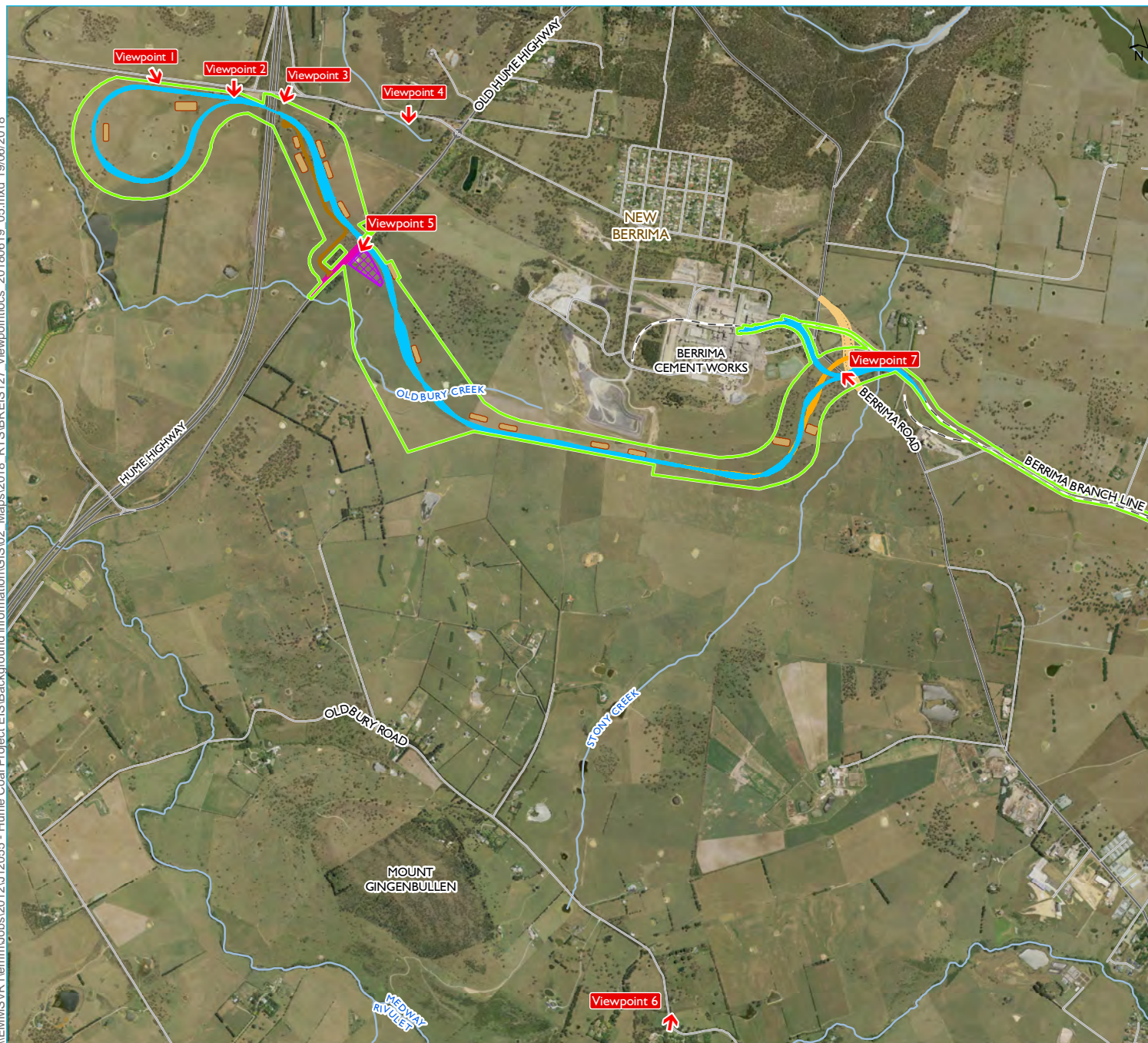
Viewpoint	Description
1	This is the view from Medway road, looking south-east towards the location of the rail loop.
2	This is the view from Medway road (further east than viewpoint 1, closer to the Hume Highway), looking south towards the location of the rail loop.
3	This is the view from northern side of Medway Road (east of Hume Highway) looking south west towards the Hume Highway underpass.
4	This is the view from Medway Road (east of Highway) looking south-west towards rail maintenance facility and railway line.
5	This is the view from looking south-west along the Old Hume Highway towards proposed rail crossing location.
6	This is the view looking north from Oldbury Road.
7	This is the view looking along Berrima Road north-west towards the Berrima Road bridge crossing associated with the preferred option.

As evident in the tables above, views from all of the major and minor roads in the area, including the Hume Highway, Old Hume Highway and Medway Road were taken into account in the VIA.

In accordance with the methodology described in the GLVIA, the visual sensitivity of a receptor was assessed based a number of specific criteria. Of particular relevance to the views of motorists is the length of view. The transient nature of a view by motorists from roads is considered less sensitive compared to a long term view from a private residence.

The results of the visual analysis are presented in Tables 18.3 and 18.4 for the Hume Coal Project and the Berrima Rail Project respectively. The predicted impacts on the view to motorists ranges from negligible, to moderate to low. The analysis showed that generally due to existing mature vegetation in the landscape, the tree screens already planted by Hume Coal, and the area's topography, the infrastructure associated with both project's will be relatively shielded from view, and where views are possible the view will be brief as motorists travel along the road.

\\EMMSVR1\emm\Jobs\2012\12055 - Hume Coal Project EIS\Background information\GIS\02 Maps\2018 RTSLBREIS127 viewpointlocs_20180619_05.mxd 19/06/2018



- KEY**
- Berrima Rail Project area
 - ➔ Viewpoint location
- Project elements**
- New rail line - preferred option
 - New rail line - alternate option (where different to the preferred option)
 - Berrima Road relocation (works by Wingecarribee Shire Council)
 - Rail maintenance facility access road
 - Rail temporary construction facility
 - Turning lane/shoulder
 - Topsoil stockpiles
- Existing features**
- Main road
 - Local road
 - - Rail line
 - Drainage line

Viewpoint locations - Berrima Rail Project visual assessment

Hume Coal Project and Berrima Rail Project
Response to submissions
Figure 18.4



Source: EMM (2018); DFSI (2017); Hume Coal (2017)

0 0.5 1 km
GDA 1994 MGA Zone 56

Table 18.3 Viewpoint analysis results – Hume Coal Project

Viewpoint	Description	Evaluation of significance
1	Hume Highway - looking north towards surface infrastructure area.	Negligible - topography and vegetation will prevent views of the project.
2	Belanglo Road – on the northern side looking towards the project surface infrastructure area in a north-easterly direction, approximately 1.5 km from the nearest surface infrastructure (upcast ventilation shaft).	Negligible - the project will not be seen due to intervening topography and vegetation.
4	Medway Road - on the northern side looking in a south-westerly direction, approximately 460 m west of the Hume Highway overpass.	Moderate to high – There will be intermittent views of the construction phase of the project. The tree planting that has already been planted will provide some screening of the noise wall and will reduce the visual impacts to moderate to low .
5	Hume Highway – on the western side facing south-west near the overpass with Medway Road, on the north-eastern corner of the project area.	Moderate unmitigated visual impacts. To reduce impacts the visible components of the surface infrastructure area will be coloured in natural tones that are compatible with the surrounding landscape.
7	Old Hume Highway – eastern side of the highway adjacent to the surface infrastructure area.	Moderate to low - due to distance and existing mature tree planting in the background. Prior to the tree planting maturing there will be intermittent views of the project during construction. Once matured the tree screen will reduce the visual impact to low .

Table 18.4 Viewpoint analysis results – Berrima Rail Project

Viewpoint	Description	Evaluation of significance
1 & 2	Medway Road - viewpoints on the northern side of Medway Road and west of the Hume Highway. They will have views south towards the rail loop and coal loading facility.	Moderate to high unmitigated impact - Planting will obscure the noise wall from the roadway and private residences on the northern side of Medway Road. It will take 5-15 years for the trees to mature and some of the trees will be almost mature when construction starts, which will reduce the magnitude of change from high to moderate .
3	Medway Road – east of Hume Highway and provides a direct view towards the proposed railway, Rail Maintenance Facility, northern provisioning point, topsoil stockpiles and the Hume Motorway underpass.	Unmitigated visual impacts from this viewpoint will be moderate . Although the railway and sheds will introduce new built elements, the distance from the road will reduce its visual influence. Tree screens already planted along Medway Road will provide a substantial landscape buffer, reducing the impact to low .
4	Medway Road - approximately 700 m to the east of the Hume Highway. The relevant view is south towards the sheds, railway and topsoil stockpiles.	Unmitigated visual impacts will be low to moderate . Views of the trains will be temporary, with trains not generally stationary in one location along the track for lengthy periods of time, and limited to four trains per day. Primary changes at this viewpoint are the railway which will follow the flat land. As the vertical projection of the railway track will be minimal there will be little interruption to the views. Tree screens already planted along Medway Road will provide a substantial landscape buffer, combined with the distance to the infrastructure, reducing the impact to low .

Table 18.4 Viewpoint analysis results – Berrima Rail Project

Viewpoint	Description	Evaluation of significance
5	Old Hume Highway - looking south towards the proposed railway crossing	Visual impacts of the bridge are considered to be low , given that the bridge will only be temporarily viewed as motorists pass underneath it.
7	view in a northerly direction towards the project area on the eastern side of the Hume Highway	Negligible - as the project will not be seen due to intervening topography and vegetation

In relation to submissions regarding the impact of views of the Hume Coal Project and the Berrima Rail Project on visitors to the area, detailed discussion on the potential impact on tourism is provided in Chapter 23.

18.6 Mereworth House and Garden

A number of special interest group submissions did not support that the visual impact on public views across the Mereworth landscape will be low to moderate as stated in the Statement of Heritage Impact for the Hume Coal Project. They submitted that views from Mereworth House and its garden will be adversely impacted as a result of the project and the view to the rural landscape of Evandale will be greatly altered.

Hume Coal owns both Evandale and the Mereworth house and garden, as such these are privately owned properties and not accessible to the public.

The Hume Coal Project EIS Statement of Heritage Impact (EMM 2017r) states that field surveys confirmed that Evandale did not display any areas of archaeological sensitivity and that the cluster of farm buildings does not demonstrate heritage values (refer to Chapter 4 Section 4.2.1). It is not a statutory listed property and is located several kilometres south of the primary area of surface infrastructure. One upcast ventilation shaft will be constructed on Evandale approximately 450 m from the main house. The shaft will be placed on the western side of a row of trees and will be shielded from the homestead buildings and the Hume Motorway.

The Statement of Heritage Impact for the Hume Coal Project (refer to Section 7.5.2) states that views to the surface infrastructure area from Mereworth House are obscured by the surrounding garden and no noticeable visual impacts will be evident. Views to Mereworth House and garden from the Hume Highway are fleeting when travelling north. Views to the property and garden from the southbound lane are as just as fleeting due to the deep cutting alongside the western side of the motorway.

Further discussion on Mereworth House and responses to submissions in relation to this property is provided in Chapter 25 (Historic Heritage).

18.7 Visual impacts relating to dust

A community submission raised concerns regarding dust pollution and how the visual amenity will be affected during storms.

As described in Chapter 15 of this RTS report, an assessment of the potential impacts on air quality was undertaken by experienced air quality specialists at Ramboll Environ in consultation with the EPA. The scope and methodology was in accordance with the SEARs and the *Approved Methods for Modelling and Assessment of Air Pollutants* (EPA 2016), and included quantitatively modelling and assessment of the project's predicted particulate matter and combustion emissions from a range of scenarios and climate conditions. Conservative assumptions were used to provide upper bound estimates of the project's impacts. The EPA stated in its submission that the air quality modelling was conducted generally in accordance with the approved methods and had no requirement to alter the scope or methodology.

Being an underground mine with no active, permanent surface waste emplacements, there will be limited sources of dust from the project area. Accordingly, the air quality assessment found that emissions of particulate matter, dust deposition rates, gaseous pollutants and odour concentrations as a result of the Hume Coal Project and Berrima Rail Project are predicted to be well below applicable air quality impact assessment criteria and minor relative to existing ambient conditions.

Prominent sources of visible dust 'clouds' from a mine are generally related to blasting activities and the bulk movement of overburden materials; activities which are both associated with open cut mining. Being an underground mine, surface blasting will not occur during operations, nor will the bulk movement of material by haul trucks. Therefore, there will be no activities at the proposed Hume Coal mine to generate visible dust cloud. Further, the design of the project incorporates a range of dust mitigation measures. A best practice dust control measures review was undertaken for the proposed measures. Mitigation measures include full enclosure of rail wagons to avoid coal dust emissions, wind shielding of conveyor belts and regular stockpile watering. The review identified that proposed measures are in accordance or above accepted industry best practice dust control (Ramboll Environ 2017a).

In view of the above, it is unlikely that dust clouds would be visible during a storm and/or high wind conditions.

18.8 Visual impact on the township of Berrima

Some community submissions raised concerns about the potential visual impact on the township of Berrima.

The centre of the township of Berrima is over 3 km from the proposed Hume Coal surface infrastructure area and is located in a low lying land to the north of the Wingecarribee River and east of the Hume Highway. The intervening topography (including the berm formed by the Hume Highway) means that the project will have a negligible impact on the visual amenity of Berrima township. Tree screens have been planted along the Hume Highway, south of the overpass over Medway road, which also directly intersect the line of sight from land to the north-east of the project area.

18.9 Visual impacts relating to specific rail infrastructure

Many submissions from special interest groups and community members, as well as WSC, raised concerns that the rail infrastructure will be visually prominent within the rural landscape and have significant impacts on public and private views.

Construction of the Berrima Rail Project will result in some changes to the rural landscape, particularly in the early stages prior to maturation of screen landscaping. However, Hume Coal has already undertaken an extensive tree planting program that will provide a visual screen to the rail line and associated infrastructure (including the maintenance sidings, provisioning facility and balloon loop) along areas where public views will be possible; in particular along sections of Medway Road and the Hume Highway.

As highlighted in the Berrima Rail Project EIS, the project will not result in significant visual impacts for viewers across the project area as a result of the tree screening and the rail line being predominantly at or near grade. Further, due to the relatively intermittent frequency of trains travelling along the railway line the overall visual impact is minimised. It is also important to note that a railway line already exists within the landscape in the eastern extent of the project area at present so viewers will not experience significant alterations to existing views in the locality. Furthermore a historical railway formation exists in the landscape in the western extent of the project area.

Once operational, land use within the rail loop will continue to be agricultural, as it is now and grazing of livestock will continue to occur.

18.10 Effectiveness and impacts of the mitigation measures

A number of submissions from community members and special interest groups raised concerns about the tree planting undertaken by Hume Coal to screen the surface infrastructure, submitting that the trees will block existing views across the landscape. Conversely, other community submissions submitted that the trees would not effectively screen views of the surface infrastructure, and some claimed that the trees would not mature to adequately screen the above ground infrastructure until the end of the 22 year life of the project. The National Trust raised concerns about views across the Mereworth property, and that tree planting will permanently interrupt public rural views and vistas that have been present for several years, negatively impacting the rural character of the area even after the mine has finished its operations.

The Berrima Residents Association and some community submissions submitted that noise attenuation walls will have a significant impact along Medway Road where residents now enjoy sweeping views across the landscape.

The location and extent of tree screens planted were specifically targeted to small areas adjacent to surface infrastructure, and were chosen to mitigate potential public views of the project-related surface infrastructure; in particular from Medway Road and the Hume Highway. With extensive planting already completed in April/May 2016 there will be sufficient time for many species to reach maturity, or be well progressed towards maturity, by the time construction commences on both projects. A variety of species have been planted, with the age of maturity varying from 5 to 15 years, and ranging in height from 4 m to 30 m at full maturity. As shown in photographs 21.1-21.4 in Chapter 21 many of the trees are already well established.

It is considered that rather than having a negative impact, the screens will add to the rural nature of the landscape. Further, in relation to the Mereworth property, the existing views across Mereworth heading south along the Hume Highway are fleeting and substantially blocked by dense plantings already in place. Views travelling north are interrupted by plantings on Mereworth and the cutting through the hill north-east of the main building and gardens within Mereworth house.

In relation to the proposed noise mitigation wall, as outlined in the Berrima Rail Project EIS, three houses north of Medway Road will overlook the noise wall (refer to Table 18.2, viewpoints 1 and 2). It is acknowledged that the noise wall with tree screening will be seen along the project's frontage to Medway Road. Further, views will change as there is no existing railway, built structures or screening plantings in these views. Motorists travelling along Medway Road will experience loss of views across the rural landscape.

The noise wall is an important mitigation measure to be implemented as part of the Berrima Rail Project to attenuate noise levels from the loading and rail activities to residents located on the northern side of Medway Road. It will be constructed to reflect the character of the rural surroundings through the use of appropriate colours, materials and surface treatments. On maturity, the tree planting along Medway Road will also provide substantial screening of the noise wall.

19 Closure and rehabilitation

This chapter responds to matters raised in the submissions relating to rehabilitation and closure of the mine.

19.1 Post-mining land and soil capability

The Division of Resources and Geoscience (DRG) notes that the Hume Coal Project's rehabilitation outcome currently results in a lower status land value, for 58 ha, than that of pre-mining. The DRG requested further justification for this proposed reduction in land and soil capability and consideration of mitigation options. Concerns relating to the reduction in post-mining land use were also raised in a community submission.

Further discussion and justification of the post-mining LSC class is provided in Chapter 12. As explained in Section 12.1, the LSC class assigned to the rehabilitation area has been based on an assessment in accordance with the requirements of *The Land and Soil Capability Assessment Scheme, Second approximation* (OEH 2012). It is a highly conservative assessment and assumes that the LSC class over 58 ha in the surface infrastructure area (totalling 117 ha) will reduce post-mining to Class 6 as a result of the soil depth being less than the original soil profile in the rehabilitated landform. This is primarily due to the anticipated post-mining condition of the underlying subsoil, which may be highly saline or equivalent to a C horizon of weathered rock.

Rehabilitation activities in the project area will involve the application of stockpiled soil to the final landform to a depth of 0.3 m. As described in Chapter 12, it is expected that there will be a slight deficit in suitable soil for use in rehabilitation as the small areas of hydrosols in the disturbance footprint, which are sodic and highly erosive, are unlikely to be useful in rehabilitation works. In order to amend the rehabilitated LSC class to a higher class than class 6, according to Table 15 of the LSC scheme the soil depth would need to be at least 0.5 m in soil profile with a rockiness of <30% (localised). This would result in a LSC class 4 being applied to the soil. To achieve this, at least 116,000 cubic metres (m³) of ameliorant would be required over 58 ha to provide the additional 200 mm of soil depth. While additional materials such as biosolids, mulch or topsoil alternatives may provide additional amelioration where testing shows these materials are physically and chemically suitable, the volume required would be expected to exceed the NSW guidelines for biosolids reuse based on nutrient and contaminant loadings. Sourcing and transporting materials is both cost prohibitive and introduces significant risks to both the rehabilitation and the final LSC class if found to be unsuitable.

Importantly, the 58 ha of land that is anticipated to be returned to Class 6 land will still be capable of supporting the post-mining land use of grazing on improved pasture (which is the primary 'pre-disturbance' land use and the same landuse as surrounding higher classes of land). It is also noted that this 58 ha represents just 1% of the project area. The LSC class of the majority of the project area will not be affected by the project.

19.2 Decommissioning and closure

19.2.1 Closure planning and execution

A number of submissions from business groups and the community raised concerns in relation to the rehabilitation of the mine, submitting that there are risks of serious and irreversible environmental damage, and that remediation of the site cannot be guaranteed. Many community submissions raised concerns over the ability of Hume Coal/POSCO to rehabilitate the mine site. The Southern Highland Greens submitted that the remediation effort and expense would be enormous (117 ha of surface infrastructure, stockpiles extending 800 m and six storeys high, large reserves of polluted water and extensive handling infrastructure (both rail and road)). Issues raised include how the void would be filled, concerns over the mine being left to pollute for generations, and some questioned leaving preparation of a detailed closure plan to five years prior to closure. A special interest group submission suggested the Hume Coal Project would leave a negative legacy for future generations.

A number of community submissions also claimed that the mining industry has a poor record in relation to rehabilitation, and that prime agricultural land will not be re-instated.

Undertaking rehabilitation so that land affected by mining is left in a safe and stable condition is a statutory requirement in NSW, enforced through a number of mechanisms to ensure that mining companies appropriately rehabilitate mining affected land. Rehabilitation commitments that a mining company must implement and comply with are established as part of the development consent issued under the EP&A Act, and associated conditions of the relevant mining authority issued under the NSW *Mining Act 1992* (Mining Act). Holders of an authority such as a mining lease, are required to lodge a security deposit with the NSW Government, in accordance with the provisions of Division 4 Part 12A of the Mining Act, that covers the full cost of rehabilitation in the event that the authority holder becomes insolvent or does not adequately rehabilitate the site. Authority holders are also required to develop and submit a Rehabilitation Management Plan that outlines and commits to rehabilitation activities, generally within 12 months of obtaining development consent. This management plan also describes completion criteria which are used to measure the success of rehabilitation. Delivery of rehabilitation will occur progressively, where possible, and will be reported in the Annual Review.

Further, the Hume Coal Project will also be required to hold an Environment Protection Licence (EPL) issued by the EPA under the NSW *Protection of the Environment Operations Act 1997* (POEO Act). At closure, this EPL will not be able to be relinquished until evidence can be provided that the site is safe, stable and non-polluting.

The above requirements and regulation will be applied to Hume Coal should development consent be granted for the Hume Coal Project and the Berrima Rail Project. It is also noted that the anticipated costs of rehabilitating the site have been accounted for in the economic assessment and financial model for project, as stated in Section 2.3.1 of the Economic Impact Assessment of the Hume Coal Project (BAEconomics 2017). This section explains that the estimated project expenditure required will be \$860 million (undiscounted) in total capital expenditures, including for sustaining capital expenditures and *rehabilitation*.

The Closure and Rehabilitation Strategy presented in the Hume Coal Project EIS and Berrima Rail Project EIS (EMM 2017a and 2017b) was prepared in accordance with applicable regulatory requirements, guidelines and industry best standards to ensure that the measures proposed are ones that have proven outcomes. The methods proposed are based on widely accepted rehabilitation techniques aimed at successfully returning the project area to pre-existing land uses. In addition to the Closure and Rehabilitation Strategy presented in the EISs, rehabilitation methods will be further described in the RMP, and will also be re-assessed in the detailed project closure planning stage. A detailed closure plan will be produced five years prior to planned closure and therefore well before rehabilitation activities commence. This plan will consider any advances in technologies, rehabilitation methods and outcomes from rehabilitation trials at the time to ensure that the methods applied on site will achieve the desired results.

The overarching rehabilitation objective of both the Hume Coal Project and Berrima Rail Project is to restore the land to its pre-mining land use. As stated above, the delivery of rehabilitation will occur progressively, where possible, and will be reported in the AEMR. Rehabilitation upon cessation of mining will remove all project-related infrastructure, reinstate the soil profile and function, and establish a landscape that permits livestock grazing on improved pasture. The mine design has minimised the surface area which will be disturbed by operational activities, limiting it to 2% of the Hume Coal Project area. This also minimises the area which will require rehabilitation works, making the commitment to successful rehabilitation achievable. Further, the disturbance area and rehabilitation requirements are small in comparison to alternative mining methods, such as those employing secondary extraction techniques resulting in subsidence effects, those involving permanent out-of-pit waste emplacements, and open cut mines.

The following methods will contribute to successful rehabilitation of the Hume Coal Project and Berrima Rail Project:

- topsoil stockpiling techniques and the application of ameliorants will result in a reinstated soil profile that supports improved pastures;
- disturbed land will be re-profiled once surface structures are removed by reinstating depressions;
- underground voids will be progressively partially backfilled as mining progresses; and
- pasture grass species will be chosen to suit the grazing strategy.

In relation to the 'large reserves of polluted water', all water management structures (primary water dam, stormwater dams, sediment dams) and associated infrastructure (pipes, pumps, discharge points, sediment control dams and diversion drains) will be rehabilitated once no longer required. Decommissioning and rehabilitation will include:

- any remaining water in storages will be tested to determine if water quality criteria are met, and if not, then treated to remove any contaminants before discharging, or pumped into the underground voids;
- pushing down the dam walls and re-shaping the area generally consistent with the surface of the surrounding land as practicable;
- deep ripping the compacted base of the dams to facilitate infiltration and minimise the potential effects of compaction; and
- spreading soil and seeding.

Further discussion on the proposed reject emplacement in the underground voids is provided in Chapter 10.

In relation to claims about the re-instatement of prime agricultural land, this is also addressed in Chapter 12. As noted in Section 12.5.2 the project areas for the Hume Coal Project and the Berrima Rail Project are not located on BSAL as the land does not meet the requirements for high value rural land. The LSC class across the Hume Coal Project area ranges from predominately Class 4, with smaller areas of Class 3, Class 6 and Class 7, all of which are not classed as high value. Nevertheless, the project area is capable of sustaining agricultural land uses, which can successfully continue during operations, and will continue to do so post-mining.

19.2.2 Rehabilitation costs and security bond

A number of issues were raised in relation to rehabilitation costs:

- i. Decommissioning and rehabilitation costs: The EPA submitted that the decommissioning and rehabilitation costs at the end of the project's life have not been defined. This includes the method of treatment and disposal of water and sludges in the Primary Water Dam.
- ii. Risks associated with rehabilitation costs: A number of special interest groups raised concerns about the scenario where impacts are much greater than predicted and therefore rehabilitation costs are subsequently much higher than expected.
- iii. Security bond system: Concerns about the cost of this rehabilitation were raised in numerous community submissions, in particular as to what guarantees are in place to ensure that Hume Coal rehabilitate the mine appropriately upon closure. Questions were also raised about the adequacy of the current security bond system. Many community submissions made the claim that Hume Coal could 'walk away' and not rehabilitate the site, and the cleanup bill would be left with the NSW taxpayer. Similarly, questions were raised in relation to the scenario where the mine is sold and the new owners claim they are not responsible for the rehabilitation costs, or where operations at the mine are terminated without proceeding to final rehabilitation stage, for example where the mine is not financially viable to continue or the mine is flooded and mining must cease.

i Decommissioning and rehabilitation costs

As explained in the response in section 19.2.1, the anticipated costs of rehabilitating the site have been accounted for in the economic assessment and financial model for project. This includes all anticipated rehabilitation costs, such as the cost of treatment and disposal of water and sludge from the Primary Water Dam.

Further, and as described in the response in Section 19.2.1, financial assurance is provided in the form of a security deposit to ensure land affected by mining can be rehabilitated in the event that the company responsible becomes insolvent or does not complete rehabilitation satisfactorily. The security bond is based on third party costs and therefore allows sufficient funds to be available to rehabilitate the site should the mining company not fulfil its rehabilitation obligations. However, in accordance with the provisions of the Mining Act, a mining lease cannot be relinquished until successful rehabilitation has been completed in compliance with the relevant conditions on the title. Importantly, the rehabilitation liability remains with the title if it is transferred; therefore if the mine was to be sold in the future and the title transferred, the rehabilitation liability would become the responsibility of the new owners.

Calculation of the security deposit is not required at the development application stage. Mining companies must prepare a rehabilitation cost estimate in accordance with the DRG's Rehabilitation Cost Estimate Tool and lodge the required security deposit prior to the grant, renewal or transfer of a title. Hume coal will therefore be required to lodge the security deposit prior to the grant of the required mining leases.

ii Risks associated with rehabilitation costs

A review of the security deposit is required by the Authority holder annually as part of the submission of the Annual Review, and whenever there is change in the rehabilitation liability, such as when a modification of development consent is approved. As part of the preparation of the Annual Review, the authority holder is required to review predicted versus actual impacts. This annual review of the rehabilitation liability therefore accounts for the situation where impacts are greater than predicted, and ensures that the security deposit remains an accurate reflection of the works required to rehabilitate mining affected land as the mine progresses.

iii Security bond system

The security bond system is in force so that if a mining company were to 'walk away' the NSW Government would have sufficient funds to effectively rehabilitate the mine site. The security bond system has been reviewed extensively over the last decade, resulting in a more accurate and comprehensive estimate of the costs to rehabilitate a mine site. Notwithstanding, before the use of the security deposit, the NSW Government would use its enforcement powers under the Mining Act and EP&A Act to require a mining company to fulfil its rehabilitation obligations required by the relevant development consent and mining titles.

Hume Coal understands it has a statutory obligation, as well as an obligation as a socially responsible, local business, to rehabilitate the mine once mining is ceased, so that the area is left in a safe, stable and non-polluting state. The costs to do so have been accounted for in the project's financial model, and Hume Coal are committed to rehabilitating the site adopting best practice methods, consistent with the leading practice design of the project.

19.2.3 Rehabilitation of the rail line

A community submission requested that all rail infrastructure and embankments are removed at the end of operations and the land be rehabilitated to its pre-mining landform, and another questioned what will happen to the rail post-mining.

Upon completion of mining, all Hume Coal infrastructure associated with the Hume Coal Project and Berrima Rail Project that is not to be used as part of the future intended land use will be removed so that the site is safe and does not pose a threat of environmental harm. As described in Section 2.6 of the Berrima Rail Project EIS, decommissioning and rehabilitation works for the rail project will include the removal of the Hume Coal rail track, as well as the maintenance sidings and provisioning facility. The portion of track owned by Boral, including the rail siding to the cement works, will remain indefinitely and continue to be operated as required by Boral and other users, as it is now.

Where the Hume Coal rail infrastructure is removed, compacted areas will be deep ripped as required, and the topsoil that was stripped during construction and stockpiled at various locations within the project area will be returned to the disturbed land. After the topsoil has been replaced and contour ripped, pasture grass species will be spread onto the prepared soil. Fertilisers may also be spread onto the soil at this time. The pasture grass species will include species that are suitable for fast establishment of an initial cover crop, and species that will suit the final land use of grazing.

20 Economic assessment

This chapter responds to matters raised in submissions relating to the economic impacts and benefits of the Hume Coal Project and the Berrima Rail Project.

Many of the submissions in support of the two projects noted the significant employment and economic benefits that the projects will provide as a reason for their support. If approved, the NSW DPE – Division of Resources and Geoscience (DRG) noted that the additional anticipated 50 Mt of ROM coal to be produced over 20 years from the Hume Coal Project would assist in ensuring the NSW Southern Coalfield remains a part of the NSW coal industry.

20.1 Adequacy of assessment

20.1.1 Representation of local and regional impacts

Community and interest groups raised concerns and objections to the outcomes of the economic assessment on the basis that the economy of the Southern Highlands region has been misrepresented, and that the value of and/or impacts to certain existing industries have not been represented or are understated, including:

- i. Misrepresentation of the local economy - the assessment misrepresents the local economy of the Southern Highlands, provides no recognition of local commercial organisations, and under-represents negative economic impacts on local business, networks and agriculture. Further, it was submitted that the value of many industries has been ignored, such as tourism (including including farm stays and agri-tourism), the historic value of Berrima and the value of prime agricultural land. In particular, the importance of agriculture and tourism for the economy of the Southern Highlands is claimed to be understated.
- ii. Economic benefits (or detriments) to local landholders – it was claimed this has not been estimated on the basis that ‘the net benefit accruing to landholders is insignificant relative to the overall net benefit to NSW generated by the project’. Consideration of a development application includes the public interest, which includes the landholders and local stakeholders and should be considered.
- iii. Scope of the cost benefit analysis - the EIS limits its assessment to a very narrow cost/benefit analysis based on the benefits to government from royalties and employment in the mine, ignoring the other costs borne by individual landowners and the community in general.

The Economic Impact Assessment (BAEconomics 2017) was prepared by suitably qualified experts in the field, in accordance with the SEARs and consistent with relevant guidelines published by the NSW Government; notably the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* published in 2015 (the Guidelines). The peer review undertaken by BIS Oxford Economics, who were commissioned by DPE to review the assessment found that:

This review finds that the CBA is well-researched and (with some exceptions) well presented. The work is obviously the product of considerable effort and much of the approach is reasonable.

Responses to the specific issues raised in the submissions are provided below.

The characterisation of the local economy and the estimate of flow-on benefits were undertaken in the economic assessment in accordance with the Guidelines. In addition to the economic assessment, the social impact assessment (SIA) (EMM 2017h) prepared for the EIS also characterised and considered the local economy of the Southern Highlands (as detailed in Chapter 4 of the SIA (EMM 2017h).

There is no evidence that there will be negative flow on effects on other businesses that would materially offset the secondary employment and income benefits to the region that have been estimated in the economic assessment, which will be significant. As reported in the economic assessment (BAE 2017), the incremental disposable income flow-on benefits of the project have been calculated at \$44 million in NPV terms or \$4 million per annum, and incremental employment flow-on benefits of 34 FTE jobs (BAE 2017). Further discussion on the specific industries mentioned in many of the submissions; agriculture and tourism, is provided below.

Agriculture and tourism

In relation to agriculture, full account was taken of any likely impacts on agriculture, both direct and indirect. The potential impact of the proposed mine on agriculture was investigated in detail in the Economic Impact Assessment (BAE 2017) and the Agricultural Impact Statement (AIS) (EMM 2017k), which included a detailed characterisation of the existing agricultural industry in the LGA. As reported in the AIS, the agricultural industry within the Wingecarribee LGA directly employs approximately 630 people (ABS 2012) which accounts for 3.3% of total employment in the Wingecarribee LGA. Further, as also discussed in AIS, the area of land in the Wingecarribee LGA that is suitable for agriculture is estimated to be approximately 73,000 ha (ABS 2011), or 27% of the LGA (which covers around 270,000 ha). However, farms with an estimated value of agricultural operations greater than \$5,000 per year (the target population for the ABS agricultural census and surveys), cover a combined area of only about 16,900 ha, or 7% of the LGA. Within the actively productive land:

- approximately 1,900 ha is cropped, with less than approximately 1,000 ha cultivated; and
- approximately 15,000 ha is managed for grazing.

While the beef cattle industry is the largest agricultural industry in the Wingecarribee LGA, it represents less than 1% of the beef cattle industry in NSW. Horse studs account for a little under 2.5% of horse studs in NSW.

The gross value of the agricultural production (GVP) for the Wingecarribee LGA was \$44.8 million in 2010-2011 (ABS 2011). This represents 0.38% of the gross value of agricultural production in NSW. In terms of the value of GVP in 2011, there were only five substantive agricultural subsectors in the Wingecarribee LGA: cattle; milk; nurseries and cut flowers; vegetables; and hay.

The land on which the mine is located is not biophysical strategic agricultural land (BSAL). Detailed site surveys and analysis was undertaken in accordance with the NSW Government (2013) *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (Interim Protocol), to confirm whether or not any land within Hume Coal's proposed mining lease areas is BSAL. The assessment found that there is no BSAL in the mining lease areas. DP&E issued a Site Verification Certificate in April 2016 which stated that: "*having regard to the criteria in the Interim Protocol for site verification and mapping of biophysical strategic agricultural land, the land specified as the 'Assessment area' in Schedule 1 is not Biophysical Strategic Agricultural Land*".

Most areas and/or soils failed multiple criteria that were required to be satisfied for land to be classified as BSAL. The principal criteria that were failed across the assessment area are as follows:

- steep slopes (slopes greater than 10%) occur in much of the western part of the project area associated with the deep sandstone gorges in Belanglo State Forest, as well as along some elevated ridge lines through the central and eastern parts of the application area; and

- fertility:
 - Dystraphic Yellow Kandosols have moderately low soil fertility;
 - Paralithic Leptic Tenosols have low soil fertility;
 - Kandosolic Redoxic Hydrosols BSAL have moderately low soil fertility;
 - Lithic Leptic Rudosols have low fertility (and typically occur on land which failed BSAL slope criteria); and
- drainage:
 - Eutrophic Grey Dermosols have poor drainage.

Most soils also did not meet other BSAL criteria. For example many of the soils have high acidity (soil pH less than 5), high salinity (EC greater than 4 dS/m and/or chloride greater than or equal to 800 mg/kg), chemical barriers to plant rooting such as sodicity (exchangeable sodium percentage greater than or equal to 15%) and/or physical barriers to plant rooting such as rock. Further detail is provided in the BSAL and verification assessment report (EMM 2015).

The LSC class across the project area ranges from predominately Class 4, with smaller areas of Class 3, Class 6 and Class 7, all of which are not classed as high value land. High value, or prime, rural land is generally Class 1 and Class 2 land. Further discussion on the impacts on agriculture, as detailed in the EIS, is provided in the responses in Section 20.2 below.

Similarly in relation to tourism, the social impact assessment included a characterisation of the regional economy, including tourism. Hume Coal also commissioned Judith Stubbs and Associates (JSA) to analyse the tourism industry in the region and the potential impacts of the Hume Coal Project and Berrima Rail Project on this industry, as a result of the submissions received in relation to this aspect (refer to Appendix 5). This assessment included an investigation of the value of the tourism industry to the region, as well as an assessment of the major industries in the Wingecarribee LGA, which was undertaken by looking at the ABS employment data in the Southern Highlands Statistical Area 3 (SA3). The SA3 area roughly equates to the Wingecarribee LGA boundary. The ABS data shows that the significant employers in the Southern Highlands are in the areas of retail, health care and social assistance, manufacturing, and education and training, with each of these industries equivalent in size or somewhat larger than tourism. The data suggest a mixed economy, rather than an economy dominated by tourism, although noting that tourism is an important employer in the Southern Highlands.

The analysis undertaken by JSA (2017a) estimated there are approximately 1,510 jobs directly related to tourism in the Wingecarribee LGA. This is compared to 2,216 jobs in retail, 2,082 in health care and social assistance, and 1,805 in manufacturing. At a more local level, there are an estimated 196 direct tourism jobs in the Moss Vale-Berrima ABS Statistical Area 2 (SA2) (a large geographic area that extends beyond the primary locality of the mine, but the smallest area at which ABS 'Place of Work'³⁸ data is available).

Further discussion on the results of the JSA (2017a) assessment is provided in the responses in Section 20.2 below.

³⁸ Place of Work data enables a calculation of jobs in the actual area as distinct from the resident work force who may, for example, commute outside the area for work.

Historic value of Berrima

As explained in Chapter 25 (Historic Heritage), the significance of Berrima is acknowledged in the EIS, in that it is an important town from the colonial period. Importantly, the town is not in the project area, and no aspect of the mine infrastructure will be visible or audible from the town, or vice versa. The centre of Berrima is approximately 3 km from the nearest piece of mine related infrastructure in the surface infrastructure area (the train load-out) and 2.5 km from the nearest infrastructure related to the Berrima Rail Project. No impacts are predicted from the mine on the township.

Further, the report by JSA (2017a) considered the potential for impacts to occur as a result of the Hume Coal Project and Berrima Rail Project on the tourism industry in Berrima. This report found there are no accommodation businesses proximate to or likely to be visible from the proposed Hume Coal Project surface infrastructure area, with the closest publicised accommodation service around 5 km away within the cluster of accommodation in Berrima, and Highfield Cottage in Sutton Forest around 7 km away.

ii Economic benefits to local landholders

As noted in the economic assessment in Section 5.5.2, the flow on impacts on agriculture in the Wingecarribee LGA are estimated to be around \$0.2 million in net present value terms associated with foregone agricultural employment of around 0.2 full-time equivalent jobs in the sector. These impacts are insignificant in the context of the total output of the agricultural sector in the LGA. The gross value of the agricultural production (GVP) for the Wingecarribee Shire was \$44.8 million in 2010-2011 (ABS 2011). This represents 0.38% of the gross value of agricultural production in NSW. Further discussion on the public interest is provided in Chapter 6 (legislation).

iii Scope of the cost benefit analysis

As noted above, the economic assessment of the project was completed in accordance with the Guidelines, which state that the assessment should take account of the collective benefits to the households of NSW. For the Hume Coal and Berrima Rail Projects, the net present value of the direct benefits to NSW households is estimated at \$295 million in net present value terms at a 7% discount rate, with an associated direct net employment effect of 56 full-time jobs. As described in the economic assessment, the net present value of the direct net benefits to the Southern Highlands region of NSW is estimated at \$85 million, with an associated net employment effect of 33 full-time jobs.

20.1.2 Assessment methodology and adherence to guidelines

Community and interest groups raised matters relating to the adherence of the economic assessment to the *Guidelines for the economic assessment of mining and coal seam gas proposals* (Department of Planning and Environment 2015), submitting that:

1. the economic assessment uses "input-output" models, despite these having been described as 'biased' by the Australian Bureau of Statistics and 'abused' by the Productivity Commission, which has resulted in the Local Effects Analysis of the project presenting a misleading analysis of the local economy;
2. there has been no cost-benefit analysis to the NSW economy in the submission which compares the economic benefit to the residents of NSW to the environmental and economic impacts of the proposed mine;
3. no analysis has been performed on the alternative scenario of effects on the economy if the Council's strategic plan, the Southern Highlands Development Framework, was to continue to be implemented in the absence of coal mining;
4. the absence of a sensitivity analysis (for example on how much output prices would need to fall for the project to have a zero NPV) because the proponent considers it to be 'commercial in confidence' is unacceptable and does not meet *Guidelines for the economic assessment of mining and coal seam gas proposals* (Department of Planning and Environment 2015); and
5. the economic assessment does not provide any estimate of the costs and benefits of the project at a global level, or any detail on producer surplus and whether the project as proposed would make money for the proponent.

1. As stated in the economic impact assessment (section 5), there are a number of methods that can be used for calculating the flow-on effects for resource projects. They all face a singular issue in that the relative importance of a project increases when moving from a national to a state, and then to a regional perspective. At the same time, the degree of difficulty in estimating flow-on effects increases when moving from the national to the state and the regional level. For the most part, this reflects a general lack of information about the specific composition and source of intermediate inputs used by an industry, as well as about trade at a state and regional level. In addition, there may also be local rigidities in employment, capital assets and other fixed resources that are not consistent with the assumptions that underpin methodologies for measuring flow-on effects.

The methodology used in the case of the Hume Coal Project relies on input-output analysis to derive various multipliers. The primary reasons for selecting this methodology are the simplicity and clarity with which the underlying assumptions can be set out and appropriate caveats made. Further, when compared to more complex methods such as a general equilibrium (GE) analysis, the gross value of the project is small in relation to the Australian and NSW economies. Unlike an input-output analysis, a GE analysis takes into account the price impacts of a project on inputs and outputs. However, given the relatively small size of the project (relative to the NSW economy), material price impacts would not be expected and the difference between the results of a GE and an input-output analysis should also be small.

Given the lack of information about industry structure and trade at a regional and state level, there is no reason for one method to be materially more accurate than another. Both GE and input-output analysis critically depend on accurately modelling flows of production and expenditure.

From a theoretical perspective, the total (Type IIA) multiplier is the appropriate choice for calculating flow-on effects (since this measure takes into account the full adjustment of the economy to a change in economic activity). Total multipliers are calculated in a manner that compounds any measurement errors and breaches in the assumptions that underpin the analysis. For example, total multipliers are calculated as a progression of first, second and successive round effects, with each embodying any errors in earlier effects. From this perspective, a more conservative approach is to rely on multipliers that capture only first-round effects (Type IA multipliers). As stated in the economic assessment, this conservative approach was adopted for the Hume Coal Project.

2. As previously stated, the economic assessment of the Hume Coal Project was completed by BAEconomics (2017) in accordance with the relevant guidelines (NSW Government 2015b). In completing the cost benefit analysis for NSW those guidelines require that account is taken of the cost of any environmental externalities that have not already been offset and that "all costs and benefits should be quantified and monetised if feasible and material" (p. 2). The methodology used for the Hume Coal Project and Berrima Rail Project is presented in detail in Section 3.3 of the economic assessment and Chapter 24 of the Hume Coal Project EIS (EMM 2017a), and provides a summary of the mitigation, management and monitoring measures proposed by Hume Coal. Hume Coal has taken into account residual external costs that are material to the assessment.
3. The claim that no counterfactual is presented which assumes the project does not proceed is not correct. The economic assessment was completed by comparing the estimated net benefits to NSW with what would have occurred under the counterfactual. The relevant counterfactual in this case is the one where it is assumed that development in all regions in NSW, including that in the Southern Highlands, proceeds under current policy, which in this case includes any plans already in place. If the Hume Coal Project proceeds, this will not preclude the continued implementation of Council's Southern Highlands Development Framework, and may, in some respects be complementary to initiatives proposed under that framework, such as the ongoing development of the Moss Vale Enterprise Corridor.
4. As required by the Guidelines, the economic assessment included a sensitivity analysis. The sensitivity analysis appears in Section 3.7 of the economic assessment (BAE 2017). What is relevant to the consent authority, according to the NSW Guidelines, is the net benefit to NSW households. This estimate has been presented in the economic assessment report. The commercial viability of the project is a matter for the project proponent who will have its own investment guidelines, including an investment hurdle rate. Consideration of such parameters is not relevant in calculating the estimated net benefit of the project to NSW households because the project will either proceed (in which case there will be an estimated net benefit to NSW households) or not (in which case there will be a net loss to NSW households but some negative externalities will be avoided).
5. The NSW guidelines do not require a global assessment; they require an assessment of the net impact on NSW households which has been presented. As already stated in response 4 the commercial decisions of the proponent are not relevant to the assessment of the impact on NSW households.

20.1.3 Absence of financial data

Community and interest groups raised matters relating to the absence of key financial information for the project on the basis that it was considered commercial-in-confidence. This information is required to support the justification of the economic viability of the project, as the viability is doubtful based on the available information. It was contended that the taxable profit is unlikely to be achieved during the life of the mine and the project overall will have strongly negative returns.

As described above, economic 'viability' is not a relevant consideration for the consent authority when assessing a project. The matters to be considered by the consent authority when assessing and determining a development application are set out in Section 4.15 of the EP&A Act, and do not include commercial viability. Rather, the viability of a project is a matter for the proponent to consider. The economic assessment considers the costs and benefits of a project at a local and regional scale, and weighs up whether the economic benefits outweigh the costs to the local region and to the state of NSW to assist the consent authority in determining whether the project is in the public interest. Whether the project is in the commercial interests of the proponent is an internal matter for that proponent, and an irrelevant matter in determining whether a project should be approved pursuant to the provisions of Part 4 of the EP&A Act; although also noting that relevant safeguards are in place in NSW to ensure mine closure and rehabilitation costs are met, such as the current rehabilitation bond regime administered by the NSW government.

20.1.4 Adopted assumptions

Community and interest groups raised matters relating to the adequacy and accuracy of certain assumptions adopted in the assessment, including:

1. impacts are based on estimated foregone agricultural production values and flow-on effects, and assumptions that "labour is supplied locally" and that a salary is \$45,000 per annum; however, insufficient information is provided to repeat the calculation described in Section 5.4.1 iii (pp.128-129) to verify the impacts quoted;
2. the capital expenditure assumptions are very conservative and may not reflect the true costs of undertaking the project;
3. the forecasts for coal prices at the year 2040 were criticised;
4. the local effects analysis appears to be based entirely on desktop research with no input from local businesses. The authors have not been to the region or spoken to local business owners. Local businesses intend to reduce or delay investment if the project goes ahead, or remains a possibility;
5. the longer-term rehabilitation costs and negative environmental and social costs have not been accounted for in the economic modelling;
6. the economic assessment considers impacts on agriculture only on the properties owned by Hume, where the surface mine infrastructure would be located. No consideration is made of any potential impact on agriculture through the mine's impacts on groundwater resources that would affect a much wider area; and
7. project costs do not take shipping into account.

1. The full analysis of the impacts on agriculture is set out in Section 3.4 and 5.4.1 of the economic assessment (BAE 2017), and discussed above in the responses in Section 20.1.1.
2. If it were to be the case that the capital costs have been under-estimated (and there is no evidence that they have), then further capital expenditure may be associated with additional local flow on effects thus increasing the net benefits to NSW, making the EIS assessment conservative in this respect.
3. The coal price forecasts used in the economic assessment are estimates of the long run coal prices for relevant coal qualities by the reputable coal market analyst, Wood Mackenzie, in 2016 when the EIS was being written. A wide coal price sensitivity analysis shows that the project will continue to yield a net benefit to NSW households even in a case where coal prices were to fall substantially from the EIS price level in the long run.

The average coking coal price forecast that was used for the EIS economic assessment (US\$110.90 per tonne) is: already far below the current spot price for coking coal (US\$192 per tonne as at 11 April 2018³⁹); well below the five year average historical coking coal price for calendar years 2013-2017 (US\$ 136 per tonne⁴⁰); well below the implied long term coking coal price, based on the March 2018 acquisition of the Hail Creek mine by Glencore, of around \$145 per tonne⁴¹; and well below the long-term price forecast by the Federal Office of the Chief Economist, as discussed below.

The Federal Department of Industry, Innovation and Science's March 2018 publication of the *Resources and Energy Quarterly*, prepared by the Office of the Chief Economist, forecasts a price decrease from current levels, bottoming out in the medium-term (2020) at US\$142 per tonne before rebounding to a long-term coking coal price projection of US\$163⁴². Even the predicted price bottom is some US\$23 per tonne higher than the EIS base-case long-term forecast price. The assumed thermal coal price in the EIS assessment is conservative by a similar margin. The upper range of the sensitivity analysis presented in the assessment is useful for gaining insight into the likely net project benefits if the Federal Government's forecast price levels are realised. A 25% increase in mining revenues, which equates to an average coking coal price of US\$138.62, would result in net direct benefits to NSW of \$364 million (Net Present Value), compared to the base case of \$295 million. The Federal Government's long-term coking coal price forecast is 47% higher than the average coking coal price used for the EIS assessment.

4. The local effects analysis is based on data collected that represent the economic characteristics of the relevant ABS statistical region. Any use of 'hearsay' data that cannot be independently corroborated is not an acceptable practice in conducting economic impact assessments. Furthermore, Hume Coal deals with a range of local businesses on a daily basis, ranging from agricultural suppliers to consultants and potential equipment and consumable suppliers. Typically, these businesses have indicated they support the project and voiced frustration at the lack of new industry and investment being generated in the local area. Some also expressed concern at the ongoing fragmentation of the once large agricultural enterprises in the area into rural lifestyle properties of typically 100 acres or less. It is false to suggest that Hume Coal has not spoken to local businesses, since Hume Coal has been dealing regularly with local businesses since 2011. Hume Coal estimate it has spent around \$165 million in the period 2011-2017; much of this within the local economy, supporting over 100 local businesses and directly employing up to 17 people.
5. This claim is incorrect. The details of how these costs have been accounted for are set out in Section 3.3 of the economic assessment.
6. The Agricultural Impact Statement (AIS) (EMM 2017k) included an assessment of the possible impacts on agriculture as a result of potential project-related impacts on groundwater. As discussed in Chapter 8 (water resources), potential make good measures have been identified for all privately owned bores that are predicted to be affected by groundwater drawdown as a result of mining operations. The cost to implement these make good measures has been included in the economic modelling of the project as a project-related cost, and therefore has been accounted for. Furthermore, the project has now procured nearly all of the peak groundwater licences predicted to be required by the groundwater model. These licences allow the licence owner to extract the volume of groundwater held annually, in perpetuity.
7. This claim is incorrect. The coal prices used in the analysis are calculated on a "Free-On-Board" (FOB) basis and local rail and port costs have been accounted for.

³⁹ Platts daily price report, 11 April 2018

⁴⁰ Platts daily price report, 11 April 2018

⁴¹ Wood Mackenzie, 22 March 2018, "Glencore continues coal acquisition spree in \$1.7 billion deal with Rio Tinto"

⁴² Federal Office of the Chief Economist, March 2018, "*Resources and Energy Quarterly*" pp. 39-44

20.2 Externalities – impacts on other industries/businesses

Community, interest group and business respondents' stated concerns and objections on the basis that the project is not compatible with the local economy, and would have significant impacts on existing industries and businesses. Matters raised included:

1. the project compromises the sustainable economic growth of Berrima and the Southern Highlands region, which should concentrate on sustainable complementary growth and diversity, building on unique and key assets related to the scenic qualities, tourism and agriculture of the area. The economic viability of the tourism industry, and other industries in the region which contribute to the broader tourism industry such as viticulture and hospitality, will be threatened by impacts from coal mining. The EIS implies that tourism in the Southern Highlands is not a significant driver of the local economy and that the mine is needed for jobs, which is both inaccurate and misleading;
2. coal mining threatens the viability of other industries which are underpinned by agricultural and environmental resources, such as cattle raising, equine industry, vineyards, olive groves and other agricultural produce;
3. the prospect of the project (irrespective of the fact it is not yet approved) is reducing business investment in the region (The Australia Institute's submission provides a number of examples), and will impact on choices made by tourists, employers and investors to the detriment of the local and regional economy; and
4. the project is inconsistent with the Wingecarribee Shire Council and the local business community's long term plans for the region's economy, described in the Southern Highlands Development Framework which notably excludes coal and envisages carbon-neutral energy sources. These long term plans would be undermined by the environmental impacts from coal mining.

1. As explained in the responses in Section 20.1.1, the economic assessment found that the Hume Coal Project and Berrima Rail Project will have significant flow on effects to the local economy, which is contrary to the assertion that the project will compromise the sustainable economic growth of the region.

With specific reference to tourism, as discussed in detail in Chapter 23 (tourism) of this RTS report, JSA (2017a) was commissioned to prepare a report on the potential impacts of the Hume Coal Project and Berrima Rail Project on the tourism industry. This assessment also included a review of the value of the tourism industry to the region, as discussed above in Section 20.1.1, which identified that significant employers in the Southern Highlands region are in the areas of health care and social assistance, manufacturing, and education and training, with each of these industries equivalent in size or somewhat larger than tourism. The data suggest a mixed economy, rather than an economy dominated by tourism, although noting that tourism is an important employer in the Southern Highlands. The JSA analysis estimated there are a total of 1,510 direct tourism jobs in the Wingecarribee LGA, and 196 at a more local level (ie closer to the Hume Coal Project and Berrima Rail Project) in the Moss Vale-Berrima ABS Statistical Area Level 2 (SA2). By comparison, the Hume Coal Project is expected to provide 300 full time equivalent jobs. These mining jobs are likely to be of higher value, with median individual weekly income in coal mining more than \$2,000 per week compared to \$400-\$599 in tourism industries (JSA 2017a).

Further, the JSA report also investigated the impacts of mining more broadly on the tourism industry, finding that at a national scale, there is little evidence that the presence of coal mining is related to either increases or decreases in employment in tourism industries. Using a cross-sectional data set for all LGAs in Australia, the analysis conducted by JSA found that at the LGA scale, there is no discernible relationship between coal mining and employment in tourism, either positive or negative.

There is also no credible mechanism for tourism in the region to be materially adversely impacted by the proposed mine. The mine will operate underground with minimal surface disturbance. The surface infrastructure will be located on land already owned by the proponent and in an area where it will be minimally visible from public vantage points. Noise, air quality, traffic and visual impacts are all predicted to be low and/or manageable. The mine has proposed to use a construction accommodation camp to avoid adversely impacting on tourist accommodation availability by those workers who cannot be sourced locally. Further discussion on this point is provided in Chapter 23 (tourism).

2. The potential impact of the proposed mine on agriculture was investigated in detail in the Economic Impact Assessment (BAE 2017) and the Agricultural Impact Statement (AIS) (EMM 2017k), as also discussed in detail in Chapter 12 of this RTS report. As noted above, the gross value of the agricultural production for the Wingecarribee LGA was \$44.8 million in 2010-2011 (ABS 2011). This represents 0.38% of the gross value of agricultural production in NSW. Notwithstanding the size of the agricultural industry in the Southern Highlands, a comprehensive AIS was prepared for the Hume Coal Project which assessed the potential impacts of the project on agriculture. There will be some agricultural production losses during the construction and operation of the project, estimated at approximately \$2 million in net present value over the 23 year life of the project. These losses will be somewhat offset by the increase in productivity on other properties Hume Coal owns by the application of more productive farm management techniques by the licensee, Princess Pastoral, when compared to the previous management regime.

As described in the AIS, direct impacts will be limited to the surface infrastructure area which, with the exception of the downcast ventilation shaft location in the Belanglo State Forest, is on land owned by Hume Coal. After mining is complete and the land rehabilitated, it will be returned to agricultural use for livestock production on improved pasture. The highest potential risk to agriculture was identified as the potential loss of groundwater for agricultural users, resulting from groundwater drawdown. However, Hume Coal will implement the necessary 'make good' arrangements with reference to the NSW *Aquifer Interference Policy* to effectively compensate landholders for drawdown related impacts. Furthermore, the project has now procured over 90% of the peak groundwater licence requirement predicted using the groundwater model. These licences allow the licence owner to extract the volume of groundwater held annually, in perpetuity. Therefore, no uncompensated (financial or otherwise) loss of water availability for agriculture will occur. Further discussion on the potential groundwater related impacts and 'make good' measures is provided in Chapter 8 of this RTS report.

3. In 2011, the Gross Regional Product of the Wingecarribee LGA was \$2,157 million. In 2016, this increased to \$2,410 million, showing that the economy of the Wingecarribee LGA continues to grow. Further, in relation to tourism and as already described above, there is no evidence that the presence of coal mining has a negative or positive effect on the tourism industry (JSA 2017a).
4. The views regarding the exclusion of coal in the long term in the Wingecarribee LGA are noted. However, it is also noted that coal mining developments, as proposed by the Hume Coal Project, are permissible developments in the Wingecarribee Shire LGA. Permissibility is discussed in Section 6.2 of this RTS report.

The primary product produced by the Hume Coal Project will be coking coal for the purpose of steel production. Demand for steel continues to rise, with the World Steel Association estimating demand will grow by 50 per cent above current levels by 2050 (World Steel Association 2015). There is currently no viable, commercially available method of making new steel which does not involve the use of coal in a blast furnace. Approximately 70% of steel produced worldwide is new steel and 30% is recycled. If steel is to continue to be manufactured and used in our daily lives, the mining of coal is essential. It is also widely acknowledged that a broad energy mix is required to sustain Australia's energy demand now, and will be into the future. This energy mix includes coal, which will continue to play an important part in this mix if energy demands are to be met. Further discussion on this point is provided in Chapter 26 of this RTS report.

Further, a number of coal mines continue to operate with active mining leases within the broader Wingecarribee Shire LGA today. The CCL 747 of Tahmoor Colliery, which is an underground longwall mine operating in the Bulli Seam, extends into the northern end of the LGA. The mining leases associated with Dendrobium and Wongawilli Collieries also extend into the north-west of the LGA, with Dendrobium extracting longwall panels within the shire.

The project has been carefully designed in consideration of the site and context of the area and broader LGA, with some specific project design elements adopted as a result and setting a new benchmark for underground coal mining in NSW. These include the following:

- the rail wagons that will transport product coal will be covered, both when full of coal and on the return route when empty. The mine will be the first to do so in NSW;
- all coal reject material will be returned underground to partially backfill the mined-out void, reducing potential visual and other environmental impacts that could be associated with a permanent surface emplacement area; and
- a mining system will be used that will specifically avoid subsidence impacts across the project area. This mining method leaves pillars of coal in place so that the overlying strata is supported, rather than collapsing into the mined-out void, and therefore surface subsidence impacts will be negligible.

20.3 Economic benefit of the project

Community and special interest group respondents' stated concerns and objections regarding the cost-benefit ratio of the project, largely centred on the poor economic return and associated lack of benefits for NSW compared to the loss of direct and indirect benefits from other sectors (such as tourism and agriculture) and the overall adverse environmental impacts that would result from the project. Specific matters raised include:

1. the stated economic benefits of the proposal are minor, temporary and not directed to appropriate sustainable development of the regional and State economies;
2. the employment generated by the project is a poor return compared to the level of risk generated by the project, and likely job losses in both tourism and agriculture resulting in a negative net effect for the region;
3. the project would be of no economic benefit to the region, while the state government will receive very marginal revenue from the project. Economic gain from the mine is far less than what the Southern Highlands produces currently; and
4. The economic benefit of the project for the local economy and NSW government is far outweighed by its adverse impacts and represents a very poor economic return for the level of environmental impacts that will result.

1. The benefits of the project will not be minor or temporary, as shown by the economic assessment of the project (BAE 2017). The estimated net benefit to NSW households will be \$295 million over the 19 year life of the project in net present value terms at an average coking coal price of US\$110 per tonne, which is significantly lower than current market pricing as discussed earlier, and therefore a conservative estimate of the benefits of the project. In other words, from a NSW perspective the benefit cost ratio of the project is greater than one (and significantly so) and therefore the project will make a positive contribution to NSW. Furthermore, the project is likely to result in the accumulation of significant and lasting human, social and economic capital some of which may persist well beyond the life of the project.

2. As already demonstrated in this RTS report, the project is unlikely to result in any job losses in tourism (refer to the response in Section 20.2 and Chapter 23).

In relation to agriculture, the AIS (EMM 2017k) concluded that the foregone agricultural values and flow on impacts of lost production associated with the project would equate to 0.2 FTE applying the DPI (2016) stocking rates and 0.4 FTE applying the stocking rates achieved under Hume Coal's ownership. There would also be minor flow-on effects of 0.14 FTE and 0.28 FTE applying the DPI (2016) stocking rates and stocking rates achieved under Hume Coal's ownership, respectively. This compares to a peak workforce of approximately 400 FTEs during the construction phase and, initially, an operations workforce of approximately 100 workers, which will grow to a peak of approximately 300 workers in Year 5 of the 19 year operations phase. The net effect will therefore be positive.

3. The assertion that the mine will provide no economic benefits to the region is not correct. The economic assessment, which was produced by suitably qualified experts in the field and in accordance with the NSW Government (2015) *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*, and peer reviewed by BIS Oxford Economics, found that the project will have a significant net direct benefit of \$295 million over the life of the project, in net present value terms discounted at 7% compounded annually. This includes a royalty contribution to NSW of \$114 million in present value terms discounted at 7% compounded annually or \$266 million in real 2016 dollars.
4. In accordance with the Guidelines, the economic assessment calculated the net economic benefits of the project, taking into account the costs associated with the predicted residual environmental impacts. The impacts were accounted for as follows:
 - a) Noise impacts: noise will affect 10 properties (or 11 residential dwellings) owned by external parties, of which two are in the voluntary acquisition zone and nine in the voluntary mitigation zone. The expenditure on mitigation measures to address these impacts is included as a cost in the Cost-benefit analysis (CBA).
 - b) Visual amenity impacts: visual amenity will be affected from two viewpoints. Hume Coal is undertaking mitigation works and the costs of screen planting, associated fencing, labour and ongoing maintenance were used in the CBA.
 - c) Aboriginal heritage impacts: a range of active (eg fencing) and passive (eg avoidance) measures will be used and the amount was incorporated as a cost in the CBA.
 - d) Biodiversity: The identified ecological impacts will be offset to achieve an outcome deemed to be as good as or better than the status quo by the relevant NSW authorities. The ecological impacts associated with the project were therefore valued at the cost of implementing the offsets and associated initiatives.
 - e) Groundwater: Where groundwater impacts are concerned, the modelling indicates that the NSW *Aquifer Interference Policy* minimal impact criteria will be exceeded at 94 privately owned bores. Hume Coal will apply a range of 'make-good' measures so that landholders will continue to have access to a reasonable quantity and quality of water that fits with the bores' authorised use. The cost of estimated make good measures was accounted for in the costs of the project in the economic model. Hume Coal has procured in excess of 90% of the predicted water licences to be required for the project.
 - f) Surface water: Hume Coal owns 31 ML of surface water licence. No additional surface water licences will be required over the life of the mine.

- g) Greenhouse gas emissions: The project will give rise to GHG emissions. The additional Scope 1, 2 and 3 GHG emissions have been valued in accordance with the NSW Government's 'Greenhouse Gas Emissions Valuation Workbook' using the social cost of carbon determined by the US EPA. Alternative valuations using the forecast European Union Emission Allowance Units price and the carbon price applied in the Australian Treasury Clean Energy Future Policy Scenario were also applied as part of the sensitivity testing; the results are given in the Economic Impact Assessment (BAE 2017).

Once these environmental costs were taken into account in the economic model, the result (ie the net economic benefit) is still positive, meaning that the economic benefits of the project far outweigh the costs.

20.4 Property values

Some concern was raised over the negative impact the mine could have on property values. It was submitted that the prospect of the development of the Hume Coal Project has led to lowered property values in the area and/or that the development of the coal mine will lead to lowered property values in the area.

Judith Stubbs and Associates (JSA) were commissioned to prepare a report on the potential impacts of the Hume Coal Project on property values in the Wingecarribee LGA. The full technical report is included in Appendix 6, and a summary of the key findings provided below.

JSA (2017b) investigated two aspects:

1. the relationship between coal mining and property values, and whether increased levels of coal mining is associated with a decline in property values; and
2. the impact of the Hume Coal Project on property values to date, and whether there has been a decrease in property values in the locality in recent times.

i Relationship between coal mining and property values

A statistical analysis was undertaken by JSA (2017b) to understand the relationship between increases in coal mining employment and changes in median property prices over time for LGAs in NSW where an active coal mining industry operates. These LGAs include Singleton, Muswellbrook, Wollongong, Lake Macquarie, Wollondilly, Mid-Western Regional Council, Lithgow, Cessnock, Narrabri, Gunnedah, Liverpool Plains, Gloucester and Great Lakes. A data set was compiled of median prices for dwellings and rural properties in these LGAs from the EAC RedSquare Database for the years 2001, 2006 and 2011.

The data was further analysed to obtain the absolute change in coal employment and percentage change in median prices for the periods 2001-2006 and 2006-2011. A factor was also included for the year to account for the rapid price growth between 2001 and 2006 compared to the more moderate growth between 2006 and 2011.

The analysis found no statistically significant adverse or positive impact of a change in coal mining employment on property prices at the 95% confidence level.

ii Property values in the Wingecarribee LGA

A statistical analysis was undertaken to compare the price growth of dwellings and rural properties in both the Wingecarribee LGA and for the combined suburbs of Berrima, New Berrima, Medway and Sutton Forest.

To understand trends in sales prices in the locality and the impact of the proposed mine on prices, data sets were compiled for the sale price of dwellings and rural properties in Wingecarribee LGA generally (as a control) and for the combined suburbs of Berrima, New Berrima, Medway and Sutton Forest for the period 1 January 2015 to September 2017. The combined suburbs reflect the area of the mine lease and the likely impacts on groundwater and other matters stated in submissions to affect prices; while the period includes the sale of a property in Golden Vale Road, which was claimed in one submission to have been adversely affected by the proposed coal mine.

Two methods were used to investigate the potential impact of the proposed mine on property prices; analysis by examining median sale prices, and analysis by linear regression.

Median sales prices were calculated for the period 1 January 2015 to September 2017 (the request for SEARs for the Hume Coal Project was made in July 2015, and therefore this study period was chosen to cover the period before significant information about the project was publicly available). The value of both rural properties and dwellings were investigated; properties described in square metres in the EAC RedSquare Database were defined as residential dwellings by JSA, and properties described in hectares were defined as rural properties.

In both the Wingecarribee LGA and the selected suburbs closest to the project area, median house prices experienced a significant increase over this period. Rural property prices increased by 41% and 63% in the Wingecarribee LGA and selected suburbs respectively, whilst house prices increased by 33% in the Wingecarribee LGA and 42% in selected suburbs over the same period. Notably, growth in median price in the areas closest to the project area, including Berrima, New Berrima, Medway and Sutton Forest, exceeded growth in median prices more generally in Wingecarribee LGA. This finding does not support the hypothesis that prices in the locality have been depressed or adversely affected by the development application for the coal mine and the publicity surrounding the proposed development.

20.5 Economic viability

Community and special interest group respondents' stated concerns and objections on the basis that the project would not be economically viable, for reasons including:

1. the project would be a small and costly mine to operate, relying on an unproven method of extraction which has no competitive advantage, yielding an average-grade mix of thermal and metallurgical coal, in a market trending away from fossil fuels;
2. the revenue predicted to be generated by the project for the State is insignificant compared to other sources, and further to this, independent economic analysis shows that the mine is likely to operate at a loss, further diminishing revenue from royalties for the NSW Government, and nationally in the form of company tax;
3. extraction of only 35% of the available resource makes the project particularly vulnerable to weak market conditions for steel production, further increasing the risk of diminished economic benefits in the form of royalties and tax;
4. there is no need for new coal mines, which is recognised by several countries announcing a shift away from coal to renewable energy sources. The only imperative for the project is financial gain for Hume Coal/POSCO;
5. investment in a declining coal mining industry is a risky venture, as is evidenced by the reluctance of banks and other large financial institutions to fund such projects. There is a risk that the venture and its owner will collapse in the foreseeable future, thereby raising the prospect that there will be no rehabilitation of the site, leaving a burden for taxpayers;
6. the stated economic benefits of the project will be greatly diminished through the foreign owner of the mine exporting the coal to offshore related companies; and

7. the project will not be economically viable unless it is expanded considerably beyond the current approval being sought. Given the limited economic viability, there is concern that the proponent will secure approval for the project and hold off on development for an extended period, or attempt to sell an approved mine to another party, both of which are perceived as a poor outcome for the region. The proponent should consider acquiring an existing brownfield mine with similar or better quality coal, which would reduce capital costs to improve the net present value of the project.

1. Extensive discussion on the mining method proposed is provided in Chapter 16. Further, and as noted below in response to issue number 4, the demand for coal continues to rise, and in particular for metallurgical coal.
2. The claim that the mine is likely to operate at a loss is based on a flawed and simplistic economic analysis by others which does not adhere to an established code of practice relating to the valuation, or reserve determination of mineral deposits (such as the VALMIN Code, or the Joint Ore Reserves Committee (JORC) Code). The analysis on which these claims are based consists of a highly simplified spreadsheet, with cost data inappropriately benchmarked against two highly dissimilar mines, having no regard to the significant differences in the geology, mining method, depth of cover, seam gas content, labour requirements, location, mining equipment or any other relevant difference between these mines and the Hume Coal Project. The individuals who prepared these analyses are not appropriately qualified individuals to undertake valuations of mineral deposits for public reporting, under the relevant codes of practice.

An individual who is appropriately qualified to prepare a public valuation of a proposed coal mine would meet the following criteria (VALMIN Code 2015):

- a) be competent in, and have had at least five years of recent and relevant industry experience in relation to, the specific Mineral Asset to be reported upon;
- b) have at least five years of recent and relevant experience in Technical Assessment,
- c) where a valuation is being prepared, have at least an additional five years (totalling a minimum of ten years) of recent and relevant experience in the valuation of Mineral Assets;
- d) be a member of a professional organisation with an enforceable professional Code of Ethics and understand that a violation of the VALMIN Code may result in an investigation in accordance with the rules of the professional organisation; and
- e) be familiar with the VALMIN Code, the JORC Code, the relevant requirements of the Commonwealth *Corporations Act 2001*, the public policies of the Australian Securities and Investments Commission (ASIC), the Australian Securities Exchange (ASX) or other recognised securities exchanges, and court decisions that may be relevant to the public report being prepared.

The implications of the criteria specified above are that even if a person is very experienced in mining but has spent the latter part of their career working in a different commodity, mining jurisdiction or style of mining (for example, open cut gold mines in Indonesia) then they are not suitably qualified to value an underground coal mine in NSW, Australia.

Hume Coal has never prepared a public report containing a valuation of the project because the project does not meet the materiality test for the parent company. Therefore, Hume Coal is not required to meet this standard. Nonetheless, a number of the people who have contributed to the project are suitably qualified to do so. The project's engineering team has also drawn from a wide range of expertise and experience. A summary of the expertise of some of the project team members is provided below. The list is far from exhaustive:

Table 20.1 Hume Coal Project engineering team experience

Name	Role on project	Experience	Summary
Mick Barker	Project Director / Mining Engineer and Competent Person for JORC Reserves	21	Michael Barker has 21 years of experience in high productivity underground coal mine design from exploration through to the preparation plant. His work has led to major operational improvements in both safety and productivity at Newlands and Mandalong.
Mick Bevan	Study Manager / Senior Mining Engineer	30	Michael has worked in the underground coal mining industry for a period of more than 30 years in operational and senior management roles. Throughout his career in the industry he has been responsible for the introduction of revised mining systems that improved productivity and overall mining costs with improved safety and roof control.
Joey Stam	Senior Mining Engineer	14	Joey has spent the past 14 years in the mining industry, predominantly in Australian underground coal mining. He has had a diverse range of technical roles including operations, business improvement, technical services, mine planning, reserve estimation, corporate/strategic planning, optimisation and studies. He is familiar with various types of software including Deswik, XPAC, XAct and AutoCAD.
Heath Shepherd	Mine Planner / Scheduler / Mining Analyst	10	Heath has 10 years' experience in the exploration, planning, technical and economic evaluation of mining assets within Australia and internationally. He holds qualifications in geology and mining engineering and specific skills gained in geological modelling, underground mine planning, project evaluation, financial modelling and JORC compliant resource and reserve estimation.
Dan Long	Mine Planner / Scheduler	10	Daniel has almost 10 years of experience in the resource industry across the public and private sectors, working on projects both in Australia and internationally. He has contributed to mining studies from scoping to feasibility level where he has utilised skills in coal exploration and geology, resource estimation and evaluation, underground mine design and scheduling, gas reservoir characterisation, and mine gas management.
Brad Willis	Resource Geologist	19	Brad is currently Principal Geologist at Palaris and his career spans 19 years in the resources sector. During his career, Brad has been involved in JORC resources and reserve reporting, opportunity assessments, feasibility studies and audits. He has also been responsible for construction of geological databases and models, exploration program design and management of exploration programs. Brad has joined Palaris Financial Services team on more than 30 technical due diligence projects, and recently completed post-graduate study in Finance.
Mark Blanch	Ventilation Engineer	30	Mark has more than 30yrs experience in the coal mining industry including practical onsite experience in ventilation, gas drainage and outburst management. Mark has significant experience in the Illawarra, Hunter and Central Queensland
Steve Peart	Environmental Advisor	7	Steve Peart is an environment and approvals manager with over 7 years' experience in environmental management in the NSW and QLD coal mining industries.
Richard Prouse	Senior Mechanical Engineer	11	Richard has spent the last 11 years working within the underground coal mining industry. The majority of this time has been spent in the NSW Southern coalfields on numerous engineering projects in various roles including project management, asset management, risk management, reliability improvement, process improvement, strategic planning, technical specifications, major equipment acquisition and overhaul, fluid power system design and coaching/mentoring.

Table 20.1 Hume Coal Project engineering team experience

Name	Role on project	Experience	Summary
Brad Williams	Senior Electrical Engineer	30	Brad has a total of over 30 years' experience in the coal mining industry across a variety of management, engineering, maintenance and operational roles. He has worked at numerous sites in both NSW and Queensland. He has extensive experience with mining plant including both continuous miners and longwall equipment and the specialist area of minesite automation systems with the development and implementation of longwall automation including LASC and Longwall Top Coal Caving technology and monitoring and visualisation systems.
Matthew Pilgrim	Senior Electrical Engineer	9	Matthew has over nine years of experience in the mining industry and has managed a variety of statutory, engineering and maintenance roles within the coal and metalliferous mining sectors. With operations experience as Statutory Electrical Engineer, project engineer, maintenance engineer, breakdown supervisor and maintenance planner, as well as tertiary qualifications in electrical engineering, He has significant experience with high voltage electrical infrastructure, heavy mining equipment and management of electrical engineering systems, which drives safe and efficient mining practices. Matthew provides a range of specialist power systems engineering services including modelling, load flow studies, fault studies, protection grading, arc flash studies, transient motor starting, earthing and lightning protection.
Graeme Brown	Senior Electrical Engineer	25	Graeme has had extensive experience in the coal mining industry across a variety of roles within several different coalfields. His strengths are within project management, assessments, auditing and training.
Bram Tibbs	Electrical Engineer	21	Bram has a total of 21 years heavy industry experience in the Mining Industry, Oil and Gas Industry and Steel Industry. He has been involved in a variety of management, engineering, projects, product development, commissioning, maintenance and reliability roles. Bram has worked in Europe, Asia and Australia. Bram has an honours degree in mechanical engineering and trade qualifications in fitting and machining. Bram has extensive experience with a broad range of equipment including deep water oil rigs, mining equipment, complex hydraulic systems, power generation equipment, cooling systems, steel making equipment, rolling mills and steel coating lines. Bram has an excellent combination of practical and theoretical experience.
Martin Hibberd	Senior Financial Analyst / Lead Estimator	16	Martin has over 16 years of experience in the resources industry across a broad range of mining operations, projects and corporate transactions. He holds qualifications in mining engineering, finance and mine management. Martin held various leadership and technical positions with BHPB over his eight years of service with the company
Steve Robinson	Risk Management Facilitator	18	Steve has over 18 years of experience in risk management and safety. He holds qualifications in Behavioural Science (Work, Health and Human Error), Global Minerals Industry Risk Management (G-MIRM) - Managers Program and is a Certified Management Systems Auditor (RABQSA-AU, TL)
Wes MacKinnon	Coal Processing / CHPP	20	Wes has over 20 years' experience in the coal industry covering the fields of process design and optimisation, practical yield modelling, resource evaluation, feasibility studies, financial assessment, mine site operating strategies and coal quality investigations. Over the last 10 years, he has participated in the establishment of several CHPP projects and has been involved in 20 due diligence reviews
Ross Souter	Chief Design Engineer	40	Ross has over 40 years experience in the manufacturing industry and coal preparation, in which he has held a range of technical and middle management roles. He has provided consulting and engineering services in a broad field of industries, including high pressure gas, water treatment and coal preparation plants.

Table 20.1 Hume Coal Project engineering team experience

Name	Role on project	Experience	Summary
Andrew Swanson	Executive General Manager Strategic Consulting and Business Development	35	Andrew has over 35 years experience in coal preparation, and has held a range of technical, business development and senior management roles. He has provided consulting and engineering services in the broad field of coal preparation, technology and quality.
Les Geczy	Executive General Manager - QCC Resources	39	Les has over 39 years of post graduate experience of which 20 years were in operational roles at various coal mines. During the subsequent 13 years, he has used his operational experience to lead the engineering and design functions within the offices of QCC Resources.
Martin Densham	Study Manager	22	Martin is a mechanical engineer with project management experience in mining, rail, materials handling, building automation systems, electronic security systems, design and manufacturing of business equipment.
Bradley Allsopp	Infrastructure Manager / Materials Handling Engineer	23	Brad's experience includes primarily in design, supply, installation and commissioning of heavy industrial plant and equipment. He specialises in studies, detailed design, construction supervision, commissioning and performance improvement of bulk materials-handling systems, especially belt conveyors.
Jamie Anderson	Engineering Geologist	10	Jamie is experienced in the fields of geotechnical engineering and engineering geology.
Darren Morgan	Senior Project and Design Manager, Civil and Structural Engineer	11	Darren is experienced in project management, design management, structural design and civil design across a variety of engineering projects in the mining, power, water and transport sectors.
Dean Baker	Senior Mechanical Engineer	16	Dean has experience in manufacturing, installation, commissioning, research and development, design, estimating and project management, including materials handling, open-cut and underground mining infrastructure, improving efficiency, compressed air, hydrocarbon storage and reticulation systems, heating, ventilation and airconditioning (HVAC), and occupational hygiene through the control of airborne contaminants.
Peter Wells	Mechanical Team Manager / Principal Engineer	26	Peter has project and design management experience for small to medium projects in the mechanical, mechatronics and civil/structural areas. His technical experience includes expertise in slurry, chemical and water handling for the mining and power industries. He also has experience in bulk materials handling and heavy manufacturing operations (including foundry, rubber shop, machine shop, fabrication shop and logistics).
Lance Brichard	Principal Electrical Engineer	24	Lance is a principal electrical engineer with experience in mining industries, water and wastewater, and transportation.
Samit Bhakta	Principal Electrical Engineer	22	Samit is an experienced electrical engineer with specialisation in the water, mining and transportation industries.
Richard Mitchell	Senior Communications Systems Engineer	21	Richard specialises in large communications projects including a digital radio upgrades for a rail networks, communications mining infrastructure including fibre, copper and digital radio systems, data centre relocation and planned new systems or upgrades to existing live systems.
Dan Collison	Senior Permanent Way Engineer	20	Dan is a professional permanent way design engineer with extensive knowledge of the railway industry. He has extensive track design experience completing complex switch & crossing and plain line designs.
Steve Clarke	Chartered Civil Engineer	35	Steve Clarke is an experienced study manager with a solid practical background both in construction and mine operations.
Mark Smith	Principal Engineer	29	Mark has 29 years' experience in civil engineering design specialising in designing coal mine sites
Dr Russell Frith	Senior Principal Geotechnical Engineer	37	Dr Frith is a practicing geotechnical engineer who specialises in underground coal mining.

Table 20.1 Hume Coal Project engineering team experience

Name	Role on project	Experience	Summary
Professor Bruce Hebblewhite	Mining Engineering Peer Reviewer	40	Professor Hebblewhite is a mining consultant with expertise in geotechnical engineering.
Phil Imrie	Civil Engineer, and internal peer review	>25	Phil has decades of experience in railway design, construction and operations in NSW.
Darren Mathewson	Principal Process Engineer, and internal peer review	>25	Darren has decades of experience in the design, construction and operation of coal processing plants including expertise in materials handling and coal reject systems.

In addition, the experience of key members of Hume Coal's internal project team is provided below.

- Greig Duncan - 40 years' experience in coal mining operations, coal mine management and project management.
- Rod Doyle - 40 years' experience in coal geology and underground coal mining operations
- Alex Pauza - 19 years' experience in underground coal mining, mining studies and mining finance.

The Hume Coal Project has a defined mineral reserve that has been determined by a Competent Person in accordance with the JORC Code, and this has been provided to the NSW Resource Regulator for review as part of the assessment process. In determining a mineral reserve, the Competent Person must be satisfied that the coal is economically viable to extract. This requires a detailed production schedule and project financial model to have been developed.

The underlying production schedule has been developed using a specialist mine scheduling software package called Deswik, and includes geological data from the project's geological model, as well as additional modifying factors to allow appropriate conservatism for geological uncertainty. Production rates have been worked up from first-principles and then checked through benchmarking to mines operating similar types of equipment in similar geological conditions. The production schedule, which includes year by year information on tonnages, yield and grade then feeds into a mine financial model.

Inputs into the financial model are generally of pre-feasibility or bankable feasibility level of confidence. This generally requires that material cost estimates are based on prices supplied via budget quotation from equipment and consumable suppliers, or to an equivalent of higher level of confidence. Construction quantities such as earthworks volumes have been estimated from engineering drawings by qualified engineers. Operating costs have generally been worked up from first-principles based on the relevant cost-drivers from the production or mining schedule and known or quoted cost estimates for consumables, labour and equipment. Labour rates were calculated based on relevant recent enterprise bargaining agreements.

Ultimately, this information formed the basis for the economic impact assessment prepared for the project. The economic impact assessment was undertaken by a suitably qualified economist in accordance with the NSW Guidelines, and shows that the proposed mine will be beneficial to NSW with \$295 million in direct net benefits flowing to the state. This is stated in net-present-value terms using a 7% real discount rate.

3. The percentage extraction is irrelevant to the economic viability of the mine. The factors that drive the economic viability are the coal type and yield (and therefore the revenue), the productivity of the workforce, and the cost of production, processing and transportation. As described above, the mine's revenue and costs have not been guessed at, but have been estimated methodically and systematically using real cost data from suppliers and other sources, and coal price assumptions that are very conservative. There are numerous examples of high extraction ratio mines (i.e. longwall operations) being uneconomic due to low productivity and high costs, as are there many examples worldwide of low extraction ratio mines in good geological conditions being economically viable. For example many of the mines owned by Centennial Coal in NSW are low extraction ratio bord and pillar operations, and these mines remained open and viable during the recent downturn. Hume Coal has the added advantage of being close to an underutilised port and other existing infrastructure which will help to keep capital, transportation and operating costs low.
4. As reported in the Hume Coal Project EIS, the global demand for steel is forecast to continue to increase in the future. The World Steel Association estimates that demand will grow by 50 per cent above current levels by 2050 (World Steel Association 2015). Global per capita steel use increased from 150 kg in 2001 to 217 kg in 2014. This occurred despite development of stronger steel alloys which reduced requirements for individual structures. Further discussion on this matter, including discussion on energy policy and renewables, is provided in Chapter 26, as well as previous comments about price forecasts.
5. As explained in Chapter 19, financial assurance is provided in the form of a security deposit to ensure land affected by mining can be rehabilitated in the event that the company responsible becomes insolvent or does not complete rehabilitation satisfactorily. The security bond is based on third party costs and therefore allows sufficient funds to be available to rehabilitate the site should the mining company not fulfil its rehabilitation obligations.
6. The estimated net economic benefit to NSW households will not be negatively affected by the potential for the export of the coal to Korea because the cost benefit analysis already assumes that the product coal will be exported.
7. A project is economically beneficial if its benefits exceed its costs measured in today's values (known as net present value or NPV). The net direct economic benefit of the project for NSW is estimated at \$295 million in NPV terms. Further, and as explained above, the economic viability of a project is not a consideration for the consent authority in determining a project, but a matter for the proponent. Irrespective of this, the project is economically viable at current and forecast coal prices, with a wide tolerance for price decreases, and has a marketable coal reserve determined in accordance with the JORC Code. Importantly, the economic impact assessment found there will be a net benefit of the project to NSW.

20.6 Externalities – valuation methodologies

Community and special interest group respondents' stated concerns and objections regarding the method used to value external costs against the value of the project, including:

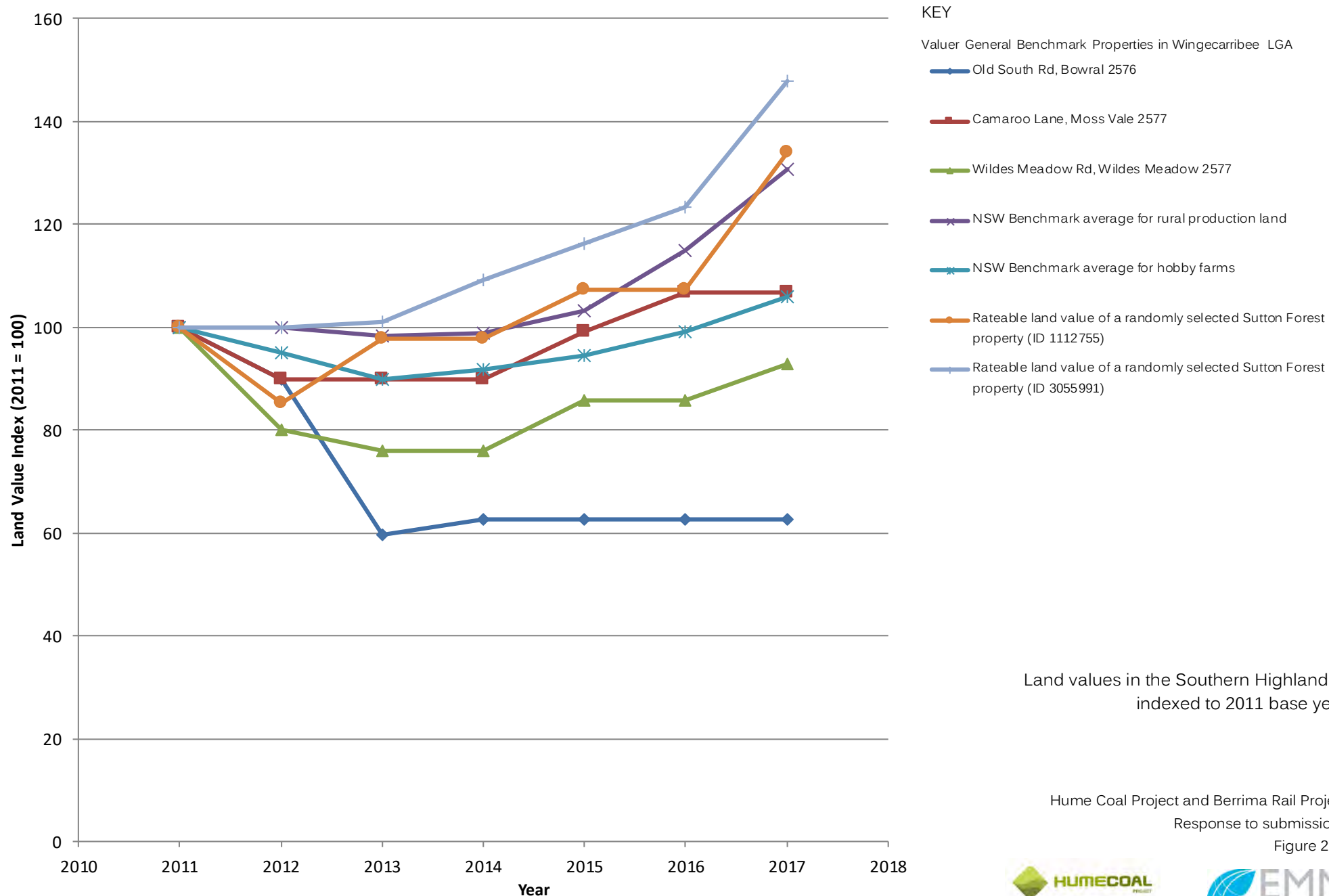
1. the economic case should take into consideration costs to private landholders (which are already acknowledged by Valuer General as considerable), the losses to the council in foregone rates, and losses to the state in forgone stamp duty;
 - a. delays arising from the proposal rail line and level crossings also appear not to have been factored in economic modelling, despite the opposite (improved travel times) commonly being used as a measurable and quantifiable benefit;
 - b. opportunity costs such as the alternative investment and use of water rights (and potential future users), and indeed an alternative mine proposal, are not considered, which would have greater economic and long term benefits;
2. royalties to the state and local jobs are not sufficient justification for the project. Long term and legacy effects on people, economics and the environment across the region, nationally and globally, are well understood by the modern public and need to be considered and publically reflected in any decision; and
3. the environmental costs are rarely accounted for properly and are normally paid by the tax payer.

1. There is no publically available evidence to support the assertion that land valuations undertaken by the Valuer General have decreased as a result of the Hume Coal Project. An analysis of information available from the Valuer General's website shows that properties in the Wingecarribee LGA that are proximate to or within the project area have not fared worse in terms of their land values than properties farther afield in the LGA, or in NSW generally, over the period from 2011 to 2017, as shown in Figure 20.1 (Valuer General 2017). Two properties in Sutton Forest were selected at random for analysis, and compared to the benchmark rural properties provided for the Wingecarribee LGA on the Valuer General's website, as well as to the NSW averages for hobby farms and rural production land. These valuations were indexed to a base year of 2011 to allow for a direct comparison, over the full period since Hume Coal acquired the exploration lease. The two Sutton Forest properties increased to an index value of 132 and 148 over the period, whilst the benchmark properties varied from a decrease to 63 and an increase to 107. The benchmark for hobby farms in NSW generally increased to an index value of 106 over the period and rural production land increased to 131 over the period. There are no rural production land benchmark properties listed on the Valuer General website for the Wingecarribee LGA.

The economic assessment takes into account all impacts on private landholders and any projected changes in council rates that are material to the overall outcomes of the impact assessment. Hume Coal continues to pay such rates and any other duties levied in NSW as a result of property transfers. In the economic assessment the mine and rail projects were considered as a single project and all costs and benefits have been accounted for in the analysis. Traffic delays at level crossings, whilst acknowledged to be a nuisance, are not considered to be material to the overall outcomes of the economic impact assessment. For example, if an opportunity cost of \$100 per hour is applied to each vehicle delayed, and it is assumed that five vehicles are delayed at each of the two main level crossings, for an average of one minute each train, then the total extremal cost would equate to about \$84 per day, assuming an average of five train movements per day. Most of the potential additional coal train operating times for the Hume Coal trains at Robertson and Moss Vale are either after 7 pm in the evening or before 6 am in the morning, and the number of vehicles that would be delayed at these times is likely to be significantly lower than this.

In addition, Hume Coal has already purchased on-market a high proportion of the necessary water access licences to cover its peak requirements. Given that these licences are tradable on a free market and were purchased by Hume Coal on that market it follows that there is no externality associated with the mine's purchased water requirements. Further, Hume Coal is required by its undertakings to compensate any local landholder for any additional water pumping costs (or if necessary to construct new bores) in circumstances where groundwater levels fall below impact thresholds set out in accordance with the NSW *Aquifer Interference Policy*. Hume Coal intends to purchase any further water licences that it may require on market or via controlled allocation, which is undertaken as a blind auction. Taking all these points into account implies that there is no water externality associated with the project that has not been internalised, and in that way taken into account by the economic assessment.

2. The economic assessment shows that there is a net economic benefit to NSW households from the proposed project. The long term effect of not proceeding with the project would be a net loss (in net present value terms) to NSW households of \$295 million. As already set out in section 20.1.3 above, any national and global effects (be they positive or negative) are irrelevant in determining whether a project should be approved pursuant to the provisions of Part 4 of the EP&A Act.
3. In the case of the Hume Coal Project, all material environmental externalities have been accounted for in the economic impact assessment and environmental offsets have been documented in Section 3.3 of the economic assessment report (BAE 2017).



Land values in the Southern Highlands - indexed to 2011 base year

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 20.1



20.7 Royalties payments/VPA

Community and special interest group respondents' stated concerns and objections regarding the quantum of state revenue generated in the form of royalties, including:

1. the project would result insignificant royalties compared to the environmental and economic impacts that would result from the project, and would comprise a negligible value compared to gross income for the State government – the risks of the project far outweigh the return on investment;
2. the predicted State revenue contributions in the form of royalties are so inconsequential that they are unlikely to cover the salaries of government staff involved in past and future decision-making on the project, and of the costs associated with regulatory compliance monitoring over the life of the mine;
3. it was claimed the financial feasibility of the project is negative, with royalties to NSW projected to be \$118 million, offset by an estimated cost of \$131 million for groundwater impacts. The project is likely to result in a net loss of \$12.5 million to the State;
4. the project represents a poor economic return for the state of NSW, generating around \$118 million over the 19-year life of the mine, averaged at \$6 million per annum. This is compared to \$261 million generated annually by visitors to the Southern Highlands that would also be put at risk due to the project; and
5. the royalties generated will be consolidated into State revenues and will diminish benefits for the local community.

1. The estimated net benefit to NSW households is \$295 million over the life of the project in net present value terms. In other words, from a NSW perspective the benefit cost ratio of the project is greater than one and therefore the project will make a positive contribution to NSW.
2. The estimated net present value of the royalty contribution to NSW is \$114 million. This figure is a discounted cash flow, which is the equivalent to the State of NSW receiving all of the future royalty payments up front as a lump-sum. If the series of future cash flows are simply summed, the total royalty to NSW is estimated to be \$266 million in 2016 dollars. To put this in perspective, the present value (lump-sum equivalent) of the project's estimated royalty stream represents an amount approximately equivalent to the cost of the Goulburn Hospital Redevelopment, which was announced in the 2017-18 NSW State Infrastructure Plan. In addition, even if this submission was correct in that the royalties would not cover public servant salaries, there is no sense in which the royalties from a single project are meant to offset the costs of the salaries of public servants. Those public servants provide planning and regulatory services for all projects in NSW and royalties from projects are not hypothecated to cover salaries.
3. The numbers quoted in this submission are based on the respondents own estimates. The economic assessment prepared for the Hume Coal Project was prepared by a suitably qualified expert economist in accordance with the relevant guidelines and was peer reviewed by BIS Oxford Economics, and clearly shows the project will result in a net economic benefit to the state of NSW.
4. The net benefit of the project to NSW households is estimated to be \$295 million in net present value terms. As already stated in the response to submissions in section 20.1.1, there is no evidence to suggest that the effect of the project will be negative and hence the net benefit of the project will flow in addition to benefits from the existing tourism industry.
5. Royalties are not pledged to particular uses in NSW. This is a choice made by the democratically elected NSW Government.

20.8 Employment

Community and special interest group respondents' stated concerns and objections regarding the quantum of local employment generated by the project:

1. the notion that 80 per cent of construction workers will be housed on site conflicts with statements about economic benefits to the community from the employment of local workers;
2. existing employment in the tourism, hospitality and agri-tourism industries (2578 jobs) will be threatened by the project; and
3. employment demands will be met by workers from other parts of Australia and overseas, with only a small number employed locally.

1. The economic assessment has taken a conservative view on the origin of the construction workforce. Locally sourced construction employees are highly desirable, where relevant skills are available, since these employees will avoid the costs associated with the provision of transportation, meals and accommodation that are associated with non-local workers. Where the construction workforce is concerned, the Social Impact Assessment (EMM 2017h) assumed conservatively that 90 per cent of construction personnel will temporarily relocate to the local region, so that only 10 per cent of the workforce would be recruited locally. The local income benefits attributable to the construction workforce in the economic assessment were therefore derived on the assumption that 10 per cent of the construction workforce would reside in the SA3 Region. This is explained in Section 4.1.1 of the economic assessment (BAE 2017), and makes the assessment of local benefits conservative.
2. As discussed in detail in Chapter 12 (agricultural resources) and Chapter 23 (tourism), existing employment in these industries will not be threatened by the proposed mine. To the contrary and as explained in Chapter 23, at a national scale there is little evidence that the presence of coal mining is related to either significant decreases or increases in employment in tourism industries.
3. During the 19 year operational phase of the mine, Hume Coal will implement training and recruitment programs aimed at maximising local employment. During operations, a workforce of around 100 full time equivalent (FTE) employees will be required during the first year of operations, rapidly building up to around 300 FTE at peak production. As reported in Chapter 20 of the EIS and in the SIA, during the peak of operations it has been assumed that 70% of the workforce will be sourced from the Wingecarribee LGA and immediately adjacent areas, with the balance relocating to the area for employment. However, the SIA conducted a sensitivity analysis on this number to account for some uncertainty around this assumption, assessing an alternative scenario based on 50% (conservative case) local recruitment over the life of the project.

The operations workforce will consist of both semi-skilled and skilled mine operators and maintenance staff, engineers and managers requiring varying levels of experience and will total 300 workers after five years of operations. In the early commissioning and build-up phases, a core of experienced workers will be needed. However, over time there will be more opportunity to introduce effective training programs for workers without the necessary experience and to recruit less experienced workers. It will take around six to nine months to train an inexperienced person to work competently in an underground mine. Thus, as training programs become established the potential to recruit local workers will increase and, given the reasonably large pool of suitable local workers, 70% of workers sourced locally over the life of the project is considered a reasonable estimate of local employment.

Hume Coal has already received expressions of interest from more than 500 people who are interested in working at the mine, if approved.

20.9 Foreign ownership

Community and special interest group respondents' raised concerns over the foreign ownership of the project, largely focussed around the extraction and export of local resources for profit by a foreign country, with a high cost imposed on the local community, environment and economy, and minimal benefits to the State and Australia in the form of royalties and company taxes.

In completing the economic assessment full account has been taken of the foreign ownership structure of the project, as required by the Guidelines (NSW Government 2015b).

The net benefits of \$295 million from the proposed mine will flow entirely to NSW households. Included in this estimate is the share of any corporate taxes paid in Australia that can be attributed to NSW. Australia has a strict regime governing foreign investment in Australia which is overseen by the Foreign Investment Review Board. The operation of the Board, together with relevant State planning regulations are designed to ensure that foreign owned projects operating in Australia contribute a net benefit to Australians.

All Australians had the opportunity to own a portion of the project when it was owned by the publically listed company, Cockatoo Coal. Ultimately, Cockatoo Coal had to sell its stake in the project to raise funds to meet its ongoing financial needs at a period when the investor appetite for its stock significantly waned. All Australians have the opportunity to own shares in Hume Coal's ultimate parent company, POSCO, which is listed on international stock exchanges. Many Australians may own shares in POSCO indirectly via their superannuation.

21 Social assessment

This chapter responds to issues raised in the submissions relating to the social impact assessment (SIA) (EMM 2017h), including issues relating to the scope of the assessment, employment, and community concerns about the proposed mine.

21.1 Methodology and approach to the SIA

Wingecarribee Shire Council (WSC) raised a number of questions in their submission regarding the Hume Coal Project SIA methodology and the findings of the assessment. WSC disagrees with the findings of the assessment, submitting that:

1. Scope and accuracy of the assessment - some impacts, both positive and negative, have not been considered. WSC also contend the Hume Coal Project is already having a negative social impact on the local community, with respondents describing anxiety and fear over the mine. WSC contends this impact is largely ignored in the EIS.
2. Significance weighting tools - the tools used do not always accurately reflect the actual significance of the impact being assessed. For example, WSC submitted that:
 - a. in Section 20.6 of the EIS (Tables 20.11, 20.12, 20.13, and 20.14) there are at least 15 impacts (both positive and negative) where the calculated level of significance does not appear to accurately reflect the actual significance of the impact;
 - b. at least two impacts haven't been considered;
 - c. there are at least nine impacts (both positive and negative) that appear to be 'insignificant', and do not warrant inclusion in the balance calculation process; and
 - d. two impacts where the benefits are likely to be beyond the regional scale and therefore should not be included.
3. Positive impacts - some listed 'positive' impacts should not be included as they relate to mitigation measures being put in place to reduce a negative impact (eg tree screening).

21.1.1 Scope and accuracy of the SIA

The SIA was conducted in accordance with accepted standards and guidelines from both Australia and internationally, and in accordance with the SEARs. Leading practice guidelines or policies that were reviewed and considered in the preparation of the SIA include:

- Community Development Toolkit (Energy Sector Management Assistance Program, the World Bank and the International Council on Mining and Metals 2012);
- Leading Practice Strategies for Addressing the Social Impacts of Resource Development (Centre for Social Responsibility in Mining, Sustainable Minerals Institute, University of Queensland 2009);
- Cumulative Impacts – A Good Practice Guide for the Australian Coal Mining Industry (Centre for Social Responsibility in Mining, Sustainable Minerals Institute, University of Queensland 2010);
- Social Impact Assessment of Resource Projects (International Mining for Development Centre 2012); and

- Approaches to Understanding Development Outcomes from Mining (International Council on Mining and Metals 2013).

The SIA was prepared using a comprehensive and systematic eleven step process, as documented in Chapter 2 of the SIA, and summarised below:

1. documenting the social aspects of the project;
2. defining the workforce catchment;
3. estimating the residential distribution and population change;
4. describing the community characteristics;
5. determining the community impacts and opportunities;
6. identifying land use change;
7. devising mitigation measures to address adverse impacts;
8. identifying project activities that will add value and result in community enhancement;
9. documenting monitoring and reporting processes;
10. providing a social balance sheet that compares all of the project's positive and negative impacts; and
11. documenting all of the above in the SIA report.

The SIA addresses the potential social impacts of the Hume Coal Project across all phases of the project, from the planning and assessment phase, through to operations, closure and rehabilitation. The SIA applied accepted methodologies with reference to a number of leading practice guidelines and policies as described above to present a robust, objective assessment of the potential social impacts and benefits of the project.

WSC claim that some social impacts of the project were not considered in the SIA, although do not state what these are. A comprehensive analysis was undertaken in the SIA to determine the potential social impacts across all project phases. A detailed discussion of what these potential impacts are, including an explanation of the impact criteria used against which the impacts were assessed, is provided in Appendix A of the SIA. The information and analysis presented in Appendix A does not support the assertion by WSC that some aspects were not considered.

With regard to the claim that the project is already having a negative social impact, Section 3.2 of the SIA specifically discusses the social aspects and changes relating to the project during the planning, feasibility and approvals phase. Section 7.2 then presents an assessment of the social impacts during this initial stage. The social impacts that may already be occurring during the assessment stage were therefore considered and documented, including both positive and negative impacts.

Table 7.4 from the SIA is replicated below, which presents the identified social impacts and opportunities that could occur during the project's planning and approval phase.

Table 21.1 Hume Coal Project planning, feasibility and approvals phase impacts

Potential social impact or opportunity	Potential outcome	Duration	Extent	Magnitude	Overall significance	Potential to mitigate or enhance?
1. Population and demographics						
Change in the number of residents within the project area due to project-related property acquisitions and subsequent tenancy agreements.	Direct, positive	Medium	Site specific	Minor	Low	Yes
2. Labour market						
Create 17 direct employment opportunities.	Direct, positive	Short	Regional	Minor	Medium	Yes
Improve workforce skills through sponsoring around two trainees and four apprentices.	Direct, positive	Long	Regional	Minor	Medium	Yes
3. Economic change						
Provide economic stimulus to local economy through engaging local consultants and contracting companies for preliminary works and to provide services.	Indirect, positive	Short	Regional	Minor	Medium	Yes
4. Community services and facilities						
Improve community facilities and services through sponsoring local organisations through the Hume Coal Charitable Foundation.	Direct, positive	Short	Regional	Moderate	Medium	Yes
5. Housing and accommodation						
Small increase in demand for housing by direct employees.	Direct, positive	Short	Regional	Minor	Medium	Yes
6. Community liveability						
Create uncertainty about the type, location, timing and potential impacts of future coal mining on the local area.	Direct, negative	Short / Medium	Local	Minor	Medium	Yes
Improve amenity and rural character of project area by improving agricultural practices and output.	Direct, positive	Long	Local	Minor	Medium	Yes

As evident in Table 21.1, the positive benefits of the project in the planning phase outweigh the identified negative impacts. As shown, the negative impact relating to the uncertainty of impacts of the project, and the stress and anxiety this can cause, as raised in the WSC submission was identified and considered in the SIA. Prior to the operation of the project, a Social Impact Management Plan will be developed. This plan will be developed in consultation with all relevant stakeholders, including the local community, where there will be an opportunity for further input into the appropriate mitigation and management measures to address any potential residual social impacts of the mine. Further discussion on this aspect is provided in the response in Section 21.2.

21.1.2 Significance weighting tools

WSC refer to 15 impacts where the calculated level of significance does not reflect the actual level of significance (although WSC do not state what these 15 impacts are). As mentioned in the response in Section 21.1.1, a detailed explanation of the six criteria which were assessed for the three project stages is provided in Appendix A of the SIA. These six criteria are:

- population and demographics;

- labour market;
- economic change;
- community services and facilities;
- housing and accommodation; and
- community liveability.

These criteria were assessed consistently and objectively across all of the project phases. The significance of potential impacts of the project on the six criteria was determined based on a combination of the duration of impact, extent of the impact, and the magnitude. This approach is widely used and conforms with ISO 31000 (Risk management standard); the outcomes of which are transparently presented in the SIA.

The WSC submission refers to two impacts where the benefits are likely to be beyond the site specific, local or regional scale assessed, and therefore submit they should not be considered. The one example of this provided by WSC is the labour market considerations in Table 20.12 of the EIS, and specifically the creation of 414 jobs during the construction phase of the project. The extent of this impact/opportunity was assigned a regional category (ie across the Southern Highlands) which WSC disputes given many workers will come from outside the Southern Highlands. However, the magnitude of the impact/opportunity was assessed as minor, in recognition of the fact that the majority of construction workers will come from outside the Southern Highlands. Notwithstanding, there will be some economic flow-on effects of these construction workers living and working in the Southern Highlands. Therefore, the assessment recognises there will be some regional benefit of the creation of construction jobs; however also recognises this will be a minor benefit of the project.

21.1.3 Positive impacts

WSC refer to some of the identified positive impacts of the project, contending that as they are mitigation measures for potential negative impacts, they should not be 'counted' as benefits of the project. An example used by WSC is the planting of trees as visual screens, submitting this will not improve the visual amenity of the Southern Highlands.

WSC is referring to the benefit identified against the 'community liveability' criteria in the construction phase, which identified a potential social opportunity of the project to 'improve visual amenity due to tree planting *and* better agricultural land use'. As demonstrated below, these are current benefits (or positive impacts) of the Hume Coal Project and are irrespective of whether the project goes ahead or not.

Hume Coal owns around 1,306 ha of land in and around the project area. As described in the EIS, considerable effort has been spent implementing improved management practices on this land, with much success. Princess Pastoral Company leases the Mereworth and Evandale properties from Hume Coal, along with the other Hume Coal affiliated land.

In addition to the improved land management practices, Hume Coal has also planted approximately 2.5 km of tree screens in and around the project area, comprising a total of some 3,995 trees. It is acknowledged the planting of the tree screens has been undertaken to mitigate the future potential visual impacts of the mine; however it is also submitted that the tree planting is currently having a positive effect on the visual amenity of the area during the assessment phase, as reported in the EIS. Many of the trees planted are well established, as shown in the photos below.



Photograph 21.1 Tree screen along the western side of the Old Hume Highway, east of Hume Highway



Photograph 21.2 Tree screen along the western side of the Hume Highway



Photograph 21.3 Tree screen along Medway Road, east of the Hume Highway



Photograph 21.4 Tree screen along Medway Road, east of photograph 21.3

21.2 Social impacts of the mine during the planning and environmental phase

As noted in Section 21.1, WSC contends that the Hume Coal Project is already having a negative social impact on the local community; with respondents describing anxiety and fear over the mine. A number of community and special interest group submissions stated that the potential of a coal mine operating in the area has caused stress and anxiety amongst members of the community.

The opposition to the project within the community was also submitted as an important social factor to be considered.

It is understood that concern exists in some members of the community over the unknown potential impacts that a coal mine would have on their properties. Therefore, Hume Coal has remained committed to an extensive engagement process for the project throughout the planning and environmental phase; aimed at providing the timely provision of factual and relevant information and to create a process that provides opportunities for stakeholders to express their views and enable timely feedback on matters raised. This engagement will continue as reflected by the continued operation of the Berrima community project office, and the dedicated community liaison team that will continue to function during the next phases of the project, should it be approved. Further, a Social Impact Management Plan will be developed for both the construction and operation phases of the project in consultation with relevant stakeholders.

As described above, the SIA addresses the potential social impacts of the Hume Coal Project that may already be occurring during the assessment phase. Both the positive and negative impacts are considered and documented. Section 20.6.1 of the Hume Coal Project EIS summarises these potential impacts as follows:

- Positive benefits:
 - a modest number (17) of new job opportunities (excluding contractors and consultants), as well as further indirect and induced jobs from spending by Hume Coal and its employees, consultants and contractors;
 - a small improvement in the skills base of the local workforce through Hume's apprenticeship and training program;
 - improved community facilities and services from investments by the Hume Coal Charitable Foundation; and
 - increased agricultural output from the project area as a result of Hume Coal actively managing land purchased, which will also benefit local rural services businesses.
- Negative impacts:
 - stress and anxiety caused by uncertainty about aspects of the project and its potential impacts on the local area.

Notably, the SIA concludes that on balance, the positive impacts outlined above outweigh the negative impact during the planning phase, meaning there will be a net benefit to the local community during this phase. In relation to negative social impacts, Chapter 22 (health) of this RTS addresses the generation of stress and anxiety in relation to the project. As noted in Chapter 22 Hume Coal acknowledges the extended approval process that has been, and continues to be, undertaken in seeking development consent for the Hume Coal Project, and the long period of uncertainty necessitated by this process. Hume Coal is seeking approval through the required legal process pursuant to the provisions of the EP&A Act and associated regulations and supporting guidelines. This process involves a number of statutory timeframes which must be followed, and which requires extensive baseline monitoring to be undertaken. Considerable time has subsequently been spent analysing the results and preparing detailed technical studies so as to present a robust and comprehensive EIS for consideration by relevant stakeholders and government agencies. This process is unavoidable and is the same process that the proponent of any development requiring consent under the EP&A Act has to go through.

Social impacts include any intended or unintended changes to a range of factors, including people's concerns and aspirations that translate into opposition to a project. In assessing social impacts, consideration must be given to the foundation or rationale for concerns and aspirations held and expressed as opposition to a development. These concerns and aspirations that translate into opposition require support in objectively assessing evidence before a decision can be made of adverse impact. The SIA for the Hume Coal Project considered the concerns and aspirations that translated into opposition to the project (based on consultation undertaken during the preparation of the SIA and EIS) and these were objectively assessed against the outcomes of the technical studies prepared by the technical specialists. As such, opposition to the project, as expressed through people's concerns and aspirations, were considered as part of the SIA.

In relation to the WSC submission about the community opposition to the project, it is acknowledged that a large number of submissions were received objecting to the project. Notwithstanding, it is also noted that submissions were received in support of the project, particularly from individual (or 'unique') community submissions as graphically shown in Figure 3.1 (refer to Chapter 3). Approximately 30% of the unique individual submissions received were in support of the project.

Further, during the planning and environmental assessment phase, Hume Coal advertised via radio, print and social media for people to express interest in employment. A total of 515 expressions of interest were received, showing the high level of interest and support for the mine on the basis of the employment opportunities it will provide.

21.3 Social impacts of the mine during the construction period

The use of a Construction Accommodation Village was raised in community submissions as one of the primary concerns regarding social impacts during the construction period.

The exclusion of the construction workforce from the surrounding community was raised as an issue, claiming that this will create social division and suspicion, and will contribute to gender imbalance, income inequality and lack of social cohesion. Therefore such a facility will be socially damaging and unnecessary. It was also submitted that some workers will instead choose to live in town, which will put pressure on the availability of accommodation. Given the village will be a "dry zone", submissions surmised that the village will be basic and that workers will seek recreation, alcohol and an "escape" from the compound.

Additionally, given that Hume Coal will be constructing a temporary village on site, a respondent implied that this is evidence that there will not be as many local jobs created.

DPI-Agriculture claimed that Hume Coal does not specifically address whether the temporary construction village or increased housing demand would affect accommodation available for agricultural-related labour.

As described in the Chapter 3 of the SIA, the project's construction will occur over a period of around two years. Initially, about 105 construction workers will be required during early works, building-up to a peak workforce of about 414 construction workers after 11 months. The peak workforce will be deployed to a number of construction sites, including the CPP, rail spur, administration area and underground mine precinct.

Many of the skills required during the construction phase are highly specialised and so specialist firms will be contracted for these tasks. Most of these specialist firms and their employees are located outside of the local area so these workers will require accommodation while rostered on during construction. Hume Coal has conservatively assumed that around 90% of construction personnel will be employees of specialist firms from outside of the local area, with the balance recruited locally. Whilst the local content of the workforce may be higher than this, many key aspects of the project require specialist skills which may not be readily available in the local area. During the much longer operational phase of the project, a significant number of people who already reside locally will be employed; predicted to be between 50% and 70% (150 to 210 positions), with the balance being required to relocate to within the local area, as defined by a 45 minute commute, upon employment.

Due to the high influx of construction workers and the temporary nature of the work, Hume Coal has appropriately included provision of a construction accommodation village in the project design. Whilst the construction phase will run for around two years, many construction workers will be on site for periods far shorter periods than that, depending on the specialist task they are employed to complete. The flexibility of having onsite accommodation means that contractors can be quickly mobilised and accommodated on site as needed, and equally, can de-mobilise as soon as a task is complete. This would be more difficult if workers were committed to rental properties in the area.

The village will be managed by an experienced facility management company and will contain facilities that are of a high standard including a dining hall, gym, and recreation room.

The presence of the construction accommodation village means that non-local construction workers will not place additional pressure on the supply of local housing and short-term accommodation in the region, especially on weekends when demand is particularly high. This is significant as the region's tourism industry relies on the availability of a limited number of beds and means that the construction phase will not affect accommodation available for agricultural-related labour. The village will minimise project-related impacts on rental accommodation and prices for short-term rentals to negligible levels. It will also help Hume Coal to attract skilled construction workers and minimise any risks to the project's development schedule from a potential skills shortage.

Hume Coal acknowledges that temporary construction workers are unlikely to invest in the social capital of the community. Again, it is noted that these workers are highly specialised and therefore the majority of the skills required may not be available locally, particularly for short-duration parcels of work, necessitating this temporary in-migration of construction workers. Further, the workers will only be on site for a short period of time, and the concerns that the village will create social division and suspicion, contribute to gender imbalance, income inequality and lack of social cohesion, and that workers will seek recreation, alcohol and an "escape" from the village are considered to be unfounded. Construction villages like the one proposed are commonly used on major projects, including other major Australian mining developments and this experience has informed the assessment of potential social impacts associated with the village as proposed.

The facility will be a professionally managed village, with numerous facilities for the construction workers to use during their stay. There will also be benefits of the construction workers utilising hospitality businesses such as restaurants, during their time on-site. Importantly, the use of the village will ensure that housing pressure is not placed on the short term rental market during the construction period, as discussed above. By contrast the operational workforce will be employed over the long term of around 19 years, and as such Hume Coal will require operational employees to reside locally throughout the operational mine life. The construction accommodation village will be dismantled when no longer required, as the mine moves from the construction phase into the operations phase.

21.4 Social impacts of the mine during operation

Concerns raised over the social impacts of the mine during operation include:

1. operation of the mine 24 hours per day, seven days per week;
2. impacts on the local community relating to air quality, noise, water resources and traffic;
3. incompatibility of the mine and associated infrastructure with the region;
4. the potential for 'fly-in fly-out' workers;
5. impacts on jobs in other industries such as agriculture and tourism;
6. impacts on social infrastructure such as schools and emergency services, particularly in Berrima;
7. lack of details relating to a Voluntary Planning Agreement (VPA);
8. availability of houses, and possibility for overcrowding in rental properties; and
9. the scale and purpose of this new project amounts to a dramatic change of direction in the economic and social future of the Southern Highlands, noting the small scale coal mining that has historically occurred.

21.4.1 Operation of the mine 24 hours per day, seven days per week

The potential impacts of the mine have been assessed and documented across the full 24 hour period in which operations are proposed. This includes the aspects with the most potential to be impacted during the night-time period such as noise and visual amenity. It is also noted that other industries in the area (such as the Berrima Cement Works) operate 24 hours a day.

Lighting within the project area will be established in accordance with the Australia Standard 4282 (AS4282) *Control of Obtrusive Effects of Outdoor Lighting*, which sets out guidelines for the control of the obtrusive effects of outdoor lighting and gives recommended limits for relevant lighting levels to contain these effects within tolerable levels. Lighting protocols for the project will adopt the following principles:

- mobile lighting plant will be set up so that light is directed away from external private receptors where practicable;
- lighting sources will be directed below the horizontal where practicable to minimise potential light spill;
- light systems will be designed to minimise wastage (ie only set up and used when and where light is required);
- screening of lighting will occur where practicable for viewers internal and external to the project; and
- lighting of light coloured surfaces, which have greater reflectivity, will be avoided where practicable.

These measures will enable avoidance and/or mitigation of any impacts associated with night lighting on the surrounding community.

Importantly, with regards to noise, the noise and vibration assessment concluded that the predicted internal noise levels at the nearest sensitive receptors will be well below those likely to cause sleep disturbance. The potential impacts of noise on the local community are discussed further below in 18.4.2.

21.4.2 Impacts on the local community relating to air quality, noise, water resources and traffic

As noted previously in this RTS, the potential for an exceedance of applicable NSW EPA air quality criteria to occur due to the project is negligible. This criteria is based on the objective of protecting the general amenity of area as well as human health. It follows therefore, that if criteria are met then there will be no significant impact on the local community in relation to dust. The underground nature of the project is a significant avoidance measure in relation to potential air quality impacts as most of the major emissions sources normally associated with mining projects will not be present. Hume Coal train wagons will also be covered, again significantly mitigating potential dust impacts of train movements. Further details on air quality are provided in Chapter 15.

The noise and vibration assessment considered 75 potentially noise sensitive receivers (houses) surrounding the project area, and, in particular, around the proposed surface infrastructure site. The assessment identified that during adverse weather conditions and with feasible and reasonable mitigation applied:

- nine of the 75 dwellings are predicted to experience residual noise levels of between 3 dB and 5 dB above project-specific noise levels (PSNL) and are therefore entitled to voluntary mitigation upon request; and
- two assessment locations are predicted to experience residual noise levels greater than 5 dB above PSNLs and are therefore entitled to voluntary acquisition upon request.

Hume Coal will comply with the above mitigation measures (upon request by landowners), or will enter into amenity agreements with the affected landholders. Therefore, impacts will be appropriately avoided and/or mitigated so that the local community is not significantly impacted by noise. The noise assessment also concluded that the predicted internal noise levels at relevant locations will be well below those likely to cause sleep disturbance.

The impacts relating to water resources on the local community is discussed in detail in Chapter 8. As noted, approximately 94 groundwater bores are predicted to experience a groundwater drawdown of 2 m or more. Make good measures have been identified for each of these bores, and an appropriate make good agreement will be entered into with each affected landowner at their request so that impacts arising from borewater use are fully mitigated or avoided.

The potential impacts relating to project related traffic generation on the community are discussed in detail in Chapter 17. Importantly, during the construction phase where traffic movements have the potential to be greatest with a peak workforce of over 400 persons, traffic related impact will be mitigated by having an on-site accommodation village. This will greatly minimise the extent of the project related peak hourly and daily traffic movements that would otherwise be using the roads in the area at these times.

21.4.3 Incompatibility of the mine and associated infrastructure with the region

The suitability of the site for the proposed mine is discussed in Section 6.7. The suitability of a site is a matter that must be considered by the consent authority in accordance with section 4.15 of the EP&A Act when assessing a development application. As discussed, the Hume Coal Project will efficiently recover an economic coal resource beneath privately owned land where underground mining is permissible. Resources extracted in this way avoid land use conflicts by continuing existing land uses at the surface and minimising impacts to significant environmental, cultural and built features. The site is well served by necessary services and infrastructure, particularly nearby rail infrastructure and Port Kembla. A range of commitments have been made by Hume Coal to mitigate potential impacts on surrounding land uses, as described in the summary of commitments in the Hume Coal Project EIS. When these commitments are applied, the project is unlikely to have a significant land use impacts.

During the project planning phase, a number of options were considered relating to the location and layout of the surface infrastructure. The primary requirements in identifying a suitable location for the project's surface infrastructure were:

- proximity to the underground mining area;
- proximity and access to important services and infrastructure, particularly the rail network;

- land availability, that is Hume Coal must already own or likely be able to purchase the land, or where landowner approval could be negotiated to gain access; and
- a suitably sized area, relatively free from environmental, urban and other constraints, specifically to enable:
 - avoidance of more densely populated areas and areas with fragmented land ownership;
 - avoidance of flood-prone land, defined as land that would be inundated by a 1% annual exceedance probability (AEP) rainfall event, that is, an event that on average occurs once every 100 years;
 - avoidance of large tracts of native vegetation;
 - integration with the existing topography and landform by selecting a relatively flat site where the need for cut and fill is minimised, and with the site surrounded by landforms and/or vegetation that would minimise exposure from the Hume Highway and other sensitive viewing points;
 - minimisation of the number of watercourse and road crossings by new infrastructure; and
 - concealing surface infrastructure from sensitive receptors as much as possible, to minimise the potential for visual, noise, dust and amenity impacts.

The proposed surface infrastructure location on the western side of the Hume Highway was chosen as the option that best met the above criteria. Further amendments were made to the original proposed layout at this location, which covered a bigger area further to the south of where it is now proposed. The final design amalgamated the infrastructure areas to reduce the overall footprint to the 117 ha for which approval is sought. The location of the surface infrastructure also aligns with the existing industrial corridor south of, and parallel to, the Hume Highway; comprising the Berrima Cement Works, the Moss Vale Enterprise Corridor, and the industrial facilities at the junction of the Berrima Branch Line and the Main Southern Rail Line.

Further, the local area has a long history of coal mining, including Berrima Colliery in an adjoining coal lease, which only recently closed after nearly 100 years of continuous operation.

In light of all of the above, the project area is considered suitable for the proposed development, and compatible with the surrounding region.

21.4.4 The potential for 'fly-in fly-out workers

The source and location of the workforce is discussed in Section 21.7.2 below. As noted, Hume Coal is committed to a policy that requires employees reside within a 45-minute commute of the mine during the operational phase of the project. This important measure has been adopted to avoid a 'drive-in-drive-out' or 'fly-in-fly-out' workforce, so that the benefits of employment from the mine flow to the local region in which it will operate, as well as to manage the risk of fatigue during employee's commute to and from the mine. The policy will be enforced through the documentation, communication and implementation of a Fatigue Management Policy and in the relevant Human Resources Policies.

Hume Coal has received 515 expressions of interest to date in seeking employment at the mine.

21.4.5 Impacts on jobs in other industries such as tourism and agriculture

This issue is responded to below in Section 21.7 (Employment). In summary, analysis undertaken as part of the economic impact assessment (EIA) for the project (BAEconomics) and the report completed by JSA on the tourism industry in the region does not support the assertion that jobs in other sectors will be affected by the project, nor will unemployment rise in the region as a result of the Hume Coal mine. To the contrary, the project is likely to generate jobs in the local region and will generate a net economic benefit for the local region and more broadly the state of NSW.

Hume Coal consulted with local business and suppliers throughout the project planning phase, and will continue to do so as the project moves through the assessment phase. 45 local businesses have already expressed interest in working with Hume Coal to supply goods and services, recognising the important economic benefits the project will bring to the region.

21.4.6 Impacts on social infrastructure such as schools and emergency services, particularly in Berrima

A statutory framework is in place to ensure there is the provision or improvement of amenity or services in an area where development occurs.

Pursuant to section 7.11 of the EP&A Act, where a development is likely to require the provision of, or increased demand for, public amenities and services in an area, a consent authority can grant development consent to a development subject to the condition of requiring a development contribution in accordance with any valid section 7.11 development contributions plan. Development contributions are used to fund the design and construction of new infrastructure to support the growth in population and meet the demands of new development as identified in the section 7.11 development contributions plan.

Section 7.4 of the EP&A Act also enables the proponent of a development to enter into a Voluntary Planning Agreement (VPA) or other arrangements with planning authorities in lieu of a Section 7.11 contribution.

Accordingly, Hume Coal proposes to enter into a VPA or similar mechanism with a planning authority, as discussed in Section 6.9.

21.4.7 Availability of houses, and possibility for overcrowding in rental properties

Hume Coal will develop and provide accommodation during the construction phase. The construction accommodation village will have capacity for all non-local construction workers. This will mean the construction workforce's demand for accommodation will not induce inflationary and availability pressures on local housing.

Based on the current availability and forecast future supply of new housing in the region, the operations and closure workforce will also not significantly impact the local housing market. It is probable that there will be adequate capacity to cater for the relocated workers and their families meaning mitigation measures will almost certainly not be needed, as discussed below.

The availability of housing and potential demand as result of the Hume Coal Project and Berrima Rail Project was investigated in the SIA. As reported, the housing stock in the Wingecarribee LGA is characterised by low rates of home rental, high private ownership, a high proportion of freestanding dwellings and lower rates of occupancy compared with NSW's overall housing stock.

Under the maximum (or most conservative) in-migration scenario of 50% local recruitment anticipated during the operations phase, up to 150 people will relocate to the area. This will generate demand for up to 150 dwellings. However, this demand will be spread over a four-year ramp-up period to peak operations. Therefore, the total demand for housing from the start of operations to employment of the peak operations workforce, based on 50% in-migration, is predicted to be as follows:

- 88 dwellings in Year 1;
- 38 dwellings in Year 2;
- 13 dwellings in Year 3; and
- 11 dwellings in Year 4.

The number of building approvals for an area provides an indicator of the capacity of the local building industry to satisfy demand for new housing. In the Wingecarribee LGA, where demand for dwellings associated with the project will be greatest, there were 519 approvals for new residential building approvals in 2014–2015. Under the maximum in-migration scenario (50% local recruitment), there would be a maximum demand for up to 150 dwellings in the Wingecarribee LGA, assuming all migrating workers require their own home and relocate to the Wingecarribee LGA. If current building approval rates continue, the construction industry in the Wingecarribee LGA could accommodate this demand for housing. In the remaining LGAs, the demand for dwellings due to the project is far lower. A comparison of the expected dwelling demand in each of these LGAs with residential building approvals shows each of them could accommodate any future dwelling demand.

Of note is the fact that a large new residential development has recently been approved by the NSW state government for Moss Vale⁴⁴. The development will provide for around 1500 new housing lots, many of which will coincide with the timeframe during which the project would be employing the operational workforce.

21.4.8 Dramatic change of direction in the economic and social future of the Southern Highlands

The Southern Highlands has a long history of coal mining, with coal exploration and mining occurring since the 19th century, as described in detail in the EIS. Notably, the Berrima Colliery mining lease (CCL748) lies immediately north of A349, where the Wongawilli Seam was mined until 2013.

A number of coal mines continue to operate in the broader Wingecarribee LGA today. The Consolidated Coal Lease (CCL) 747 of Tahmoor Colliery, which is an underground longwall mine operating in the Bulli Seam, extends into the northern end of the LGA. The mining leases associated with Dendrobium and Wongawilli Collieries also extend into the north-west of the Wingecarribee LGA, with Dendrobium extracting longwall panels within the shire.

Further, the design of the Hume Coal Project, and specifically the underground mine plan and method of rejects disposal, was designed with consideration of the character of the area to ensure compatibility with surrounding land uses. In addition the size of the mine in comparison to existing business and the population in the area will not 'dramatically' change the direction of the Southern Highlands. Studies such as JSA 2017a have shown that mining and other industries successfully coexist without one significantly affecting the other. Importantly, the Southern Highlands has a relatively diversified economy, and is therefore not reliant on one particular sector for income. The Hume Coal Project will add to this important diversity in the region.

Accordingly, the Hume Coal Project will not result in a dramatic change of direction in the economic and social future of the Southern Highlands.

⁴⁴ <http://www.planning.nsw.gov.au/News/2017/New-homes-and-open-space-set-for-Southern-Highlands-at-Moss-Vale>

21.5 Social impacts of the rail project

Some community respondents raised concerns about the social impacts of the rail project relating to:

- noise and dust emissions - from trains travelling through towns in the local area;
- time of operation – the need for curfews to minimise disruption from noise, vibration and light pollution; and
- level crossings – traffic congestion at level crossings as result of additional trains, and the impact this could have on tourism as the Southern Highlands will no longer be the quiet and peaceful place it is well known for.

Submissions about the potential impacts of the Berrima Rail Project relating to noise and dust emissions are responded to in detail in Chapters 14 and 15, respectively.

The results of the noise assessment of the Berrima Rail Project found that noise from the operation of the trains along the Berrima Branch Line (including both other users and Hume Coal Trains) will satisfy all relevant government criteria at the nearest sensitive receivers, with the exception of one assessment location (28), which is predicted to be impacted by noise from the project above the trigger level for voluntary mitigation rights. Operation of Hume Coal trains on the broader rail network is predicted to only cause a negligible or marginal increase in rail noise levels, which is consistent with the small number of trains (up to four per day) Hume Coal will add to this large rail network. Noise from the rail maintenance facility will impact only one location where a negligible 1 dB over the Project Specific Noise Level is predicted for the less sensitive daytime period only. Further, the likelihood of sleep disturbance from the project is predicted to be minimal and consistent with current rail operations.

In relation to dust, and as reported in Chapter 15, the air quality impact assessment of the Berrima Rail Project (Ramboll Environ 2017b) found predicted concentrations from existing Berrima Branch Line users are well within the acceptable range of air quality criteria at all surrounding receptors. The introduction of additional Hume Coal train movements and associated increase in annual air pollutant emissions will increase ground level concentrations slightly; however, the increase in emissions will not result in exceedance of any applicable air quality criteria at any receptor location.

Further, reports reviewed as part of the NSW Chief Scientist's 2016 report *Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain* identified that the loaded and unloaded surface of rail wagons accounts for approximately 80% of fugitive emissions from coal trains. Hume Coal is committed to covering their coal wagons, which will mitigate the primary source of fugitive rail dust emissions.

Regarding the issue of curfews, the scheduling of train paths on the broader rail network is determined by the track owner, the Australian Rail Track Corporation (ARTC), and not Hume Coal. Hence, a curfew at Berrima and Moss Vale is not an option that is available to Hume Coal. Notwithstanding, a curfew is not considered practical or necessary to minimise noise and vibration due to the reasons outlined above, nor light emissions. The additional source of light from the Berrima Rail Project will be at the rail maintenance facility, where lighting will be installed and operated in accordance with *Australian Standard (AS) 4282:1997 - Control of obtrusive effects of outdoor lighting*.

The issue of delays at level crossings as a result of the additional local trains is discussed in detail in Chapter 17 of this RTS. As discussed, one of the 17 identified level crossings (the crossing on Berrima Road near the Berrima Cement Works) will be replaced by a new road detour including an overbridge, which is being constructed by WSC. The majority of the other 16 identified level crossings are located on minor local roads or private roads, where the traffic volumes are very low and the actual number of vehicles affected by each level crossing closure would be a maximum of either one or two vehicles, or in some cases no vehicles at all.

There are five level crossings located on major roads or important local roads in the Robertson and Moss Vale areas and the rural area between these two townships. However, as most of the potential additional coal train operating times for the Hume Coal trains at Robertson and Moss Vale will be occurring either after 7 pm in the evening or before 6 am in the morning, the number of vehicles using the roads at these times is likely to be low.

There will generally only be two additional daytime coal train operating paths on a typical weekday through the area; one which travels eastbound from Moss Vale Junction to Robertson between 8.30 am to 9.00 am in the morning and one which travels westbound from Robertson to Moss Vale Junction between 2.30 pm and 3.00 pm in the afternoon. These additional train movements are well within the capacity of all sections of the network.

Hume Coal acknowledges the existing concern of some community members relating to rail crossings. However, the additional delays at level crossings resulting from the extra Hume Coal trains will not be a significant increase to the total length of time each day when the affected level crossings will be closed to road traffic. The management of rail level crossings is the responsibility of the respective rail line operators; that is the ARTC for the line between Moss Vale and Robertson, and Boral for the Berrima Branch Line and therefore any future decisions to upgrade railway level crossings is the responsibility of these rail line operators.

21.6 Charitable foundation

The Coal-Free Southern Highlands Group contends that Hume Coal has attempted to win 'hearts and minds' of the local community through donations totalling \$1.44 million to local sporting associations, charities, schools and business groups, submitting that this program has divided the community.

The Hume Coal Charitable Foundation was launched in May 2015. As part of the foundation, Hume Coal provided two rounds of funding per year to local organisations. The foundation invested approximately \$400,000 per annum in the local community with a focus on educational, indigenous and not-for-profit childcare organisations within Wingecarribee LGA. The launch of the foundation is part of Hume Coal's commitment to play an active role in the community in which it operates, which the foundation enables through financial contributions.

Funding applications are submitted across two rounds per annum. The Charitable Foundation has four directors, three of whom represent the local community and are not otherwise associated with the company. This ensures that the decisions made by the Foundation are in the best interests of the community. The directors review the application against the foundations criteria, with the funding focus on education, indigenous programs and not-for-profit pre-school child care. Organisations which have applied for funding have done so willingly.

21.7 Employment

21.7.1 Characterisation of employment in the Southern Highlands

WSC submitted that the EIS incorrectly states unemployment in the region is following an increasing trend, when the data presented in the EIS shows it to be decreasing.

Further, a special interest group submission contented that as unemployment in the Southern Highlands is low and diverse, a case for mining employment is difficult to sustain as a reason for approving the project. Further, any employment generated by the mine would not be sustainable in the longer term given that it has a finite life.

The Hume Coal Project SIA (EMM 2017h) presented unemployment statistics from the Commonwealth Department of Employment's⁴⁵ *Small Area Labour Markets* publication, which reports regional estimates of unemployment and the unemployment rate at both the LGA level and the Statistical Area Level 2 (SA2s) on a quarterly basis. The SIA (EMM 2017h) presented data from the December Quarter 2015 report (Department of Employment 2016) for three reporting periods; June Quarter 2015, September Quarter 2015 and the December Quarter 2015. The unemployment rate in the Wingecarribee LGA during these three quarters was reported as 3.9%, 3.5% and 3.3% respectively. It is acknowledged that this snapshot over the short period of three quarters indicates a decreasing trend in unemployment rather than the increasing trend that the text describes.

However, when the long term unemployment rates are considered in the Wingecarribee LGA, unemployment is shown to be increasing, albeit at a low rate. Unemployment data from the latest *Small Area Labour Markets* publication (September Quarter 2017) is presented in Table 21.2, which shows that for the period June 2014 to December 2015 (the timeframe analysed in the SIA report), unemployment generally followed an increasing trend from 2.8% in June 2014, steadily increasing to 3.9% a year later in June 2015. A small drop in unemployment was experienced through to December 2015 to 3.3%, although still higher than the June 2014 rate.

Table 21.2 Unemployment rate in the Wingecarribee LGA (%)

Jun14	Sep14	Dec14	Mar15	Jun15	Sep15	Dec15	Mar16	Jun16	Sep16	Dec16	Mar17	Jun17	Sep17
2.8	3.1	3.4	3.6	3.9	3.5	3.3	3.2	2.9	3.1	3.2	3.1	3.1	3.1

Notes: the percentages presented are the 'smoothed' official estimates of unemployment by the Department of Employment, which take into account seasonal or other variations.

Therefore, the text in the SIA describing an increasing trend in unemployment in the Wingecarribee LGA was correctly referring to an increasing trend across the timeframe analysed (mid-2014 to December 2015). It is acknowledged unemployment continued to show a small decreasing trend into 2016; although has now remained relatively stable at 3.1% since September 2016.

Further, a recent report by the Brotherhood of St Laurence; *An unfair Australia? Mapping youth unemployment hotspots* (March 2018) found that the Southern Highlands and Shoalhaven have the highest youth unemployment rate in all of NSW. Some regional hotspots have youth unemployment rates well above 20 per cent. The Southern Highlands and Shoalhaven (NSW), Wide Bay (Qld), Tasmania South East and Murray (NSW) experienced rates between 20 and 30 per cent. The report shows a 10.1% increase in young unemployment between 2016 and 2018 (18.8% unemployment in 2016 compared to 28.7% unemployment in 2018).

The SIA presented unemployment statistics as part of characterising the existing social character of the project area and surrounds. Unemployment was just one of numerous factors considered, including population size and composition, education, social infrastructure, health infrastructure and transport infrastructure. In assessing the impacts of the operational phase of the project, the SIA noted a moderate number of jobs will be created. The findings of the SIA therefore do not rely on the unemployment of the region to show a positive benefit of the project, and therefore does not directly link the positive benefit with unemployment data.

21.7.2 Number and source of workers to be employed by the project

Many of the submissions in support of the project raised the aspect of employment, and the jobs the Hume Coal mine will provide, if approved, as one of the reasons for their support of the project. Supportive submissions also noted that increased employment opportunities would encourage younger people to stay in the area, as well as describing the flow on benefits this increased, long term employment would provide through the use of suppliers and contractors and increased economic activity in the region.

⁴⁵ As of December 2017, this department is now called the Department of Jobs and Small Business.

Employment related matters that were raised in submissions objecting to the project are described below.

Questions were raised regarding the number of workers to be employed by the Hume Coal Project, and where these workers would come from.

1. Number of employees and timeframe of employment

WSC contend that it is unclear how long or often the peak production employee contingent would be employed for.

It was argued in some submissions from community members that the number of jobs proposed to be created is an exaggeration, as only experienced and skilled workers from outside the region would be employed. Others state that there would be limited employment of Australian workers.

Some community and special interest groups submitted that the trend in mining is heading towards automation of jobs, with driverless vehicles and other robotic machinery, inferring the number of employees at the mine will therefore not be as much as reported in the Hume Coal Project EIS.

The finding in the EIS that 1,200 direct or indirect jobs will be created was disputed by one special interest group submission, contending that the 1,200 job estimate is based on a multiplier that has been dismissed by the Productivity Commission. Further it was claimed employment in the coal industry had minimal effect on employment in the wider economy.

2. Source of employees

It was claimed that:

- Locals will not be employed, but rather skilled miners from outside the region, and therefore no or limited new jobs will be created.
- jobs generated by the mine will end with the mine's closure and there is no guarantee a single job will be filled by a local resident
- The high median age of the working population in the Southern Highlands means that Hume Coal will have difficulty recruiting employees locally. Further, the median age in the Southern Highlands is increasing, from 42 in 2006 to 47 in 2016, which is much higher than the Australian median age of 38. It was contended that the Southern Highlands has a large retiree population and therefore do not need additional jobs.
- The EIS states that "the project workforce will display a similar age structure to that of the mining industry across Australia" (Appendix R – A.3.1) which it states is 25 to 44. Therefore Hume will have to rely on more workers from surrounding areas within the 45 minute driving limitation, or bring in more workers from further afield, given the aging population.
- Hume coal will not enforce employees living within a 45 minute radius of the mine, and therefore will not employ locals as claimed. Whether fly-in fly-out employees would be used was also raised.
- DPI – Agriculture questioned what percentage of local operational recruitment would be drawn from agricultural-related businesses, and submitted that insufficient information is provided to verify the direct and flow-on impacts on employment.

i Number of employees

As reported in Chapter 2 of the Hume Coal Project EIS, a workforce of around 100 full time equivalent (FTE) employees will be required during the first year of operations, rapidly building up to around 300 FTE at peak production, which is anticipated to be from around Year 5 in the operations phase. This 'peak production' refers to when the mine is producing the maximum 3.5 Mtpa for which approval is sought. It is anticipated the mine will operate at this peak production rate throughout the majority of the mine's 19 year operational life, with the exception of year one as previously stated, and in the final years of operation as the mine progresses towards closure. Across the project life, an average of 275 operational jobs will be generated from 2020 (assumed to be year 1 of the project) to 2041. Figure 2.3 in the EIA (BAEconomics 2017) presents the projected employment for the project over time, from the beginning of construction activities until the mine closes. This figure is replicated as Figure 21.1 below.

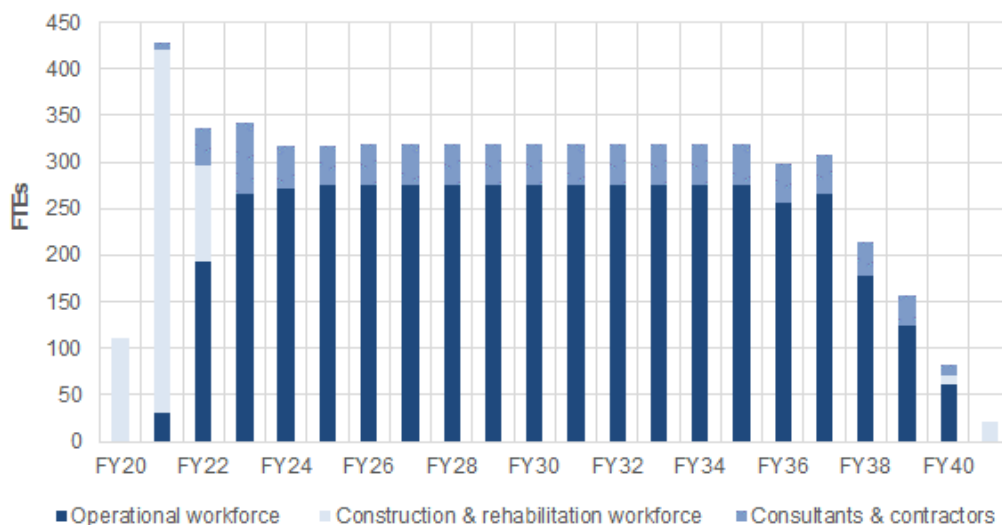


Figure 21.1 Hume Coal Project projected employment schedule

The required workforce, as reported and assessed in the EIS, was carefully calculated based on the proposed mine plan, extraction rate, the number of operators required to run the mining fleet and associated equipment, and the number of support staff that will be needed throughout the mine life such maintenance workers and technical staff.

As stated in Section 2.13.2 of the EIS, Hume Coal's training and recruitment programs will aim to maximise local employment. During the peak of operations it is anticipated that up to 70% of the workforce will be sourced from the Wingecarribee LGA and immediately adjacent areas, with the balance relocating to the area for employment. A sensitivity analysis was also presented in the SIA to account for the scenario where less than 70% of workers can be sourced locally. In this instance only 50% of works were assumed to be sourced from the local LGA. On the basis of the assumptions in the EIS, at least 150 workers and up to 210 will come from the local area, representing the creation of jobs for the local economy. Further discussion on the source of employees is provided in Section 21.7.2ii below, including the extensive work undertaken as part of preparation of the SIA and EIA in predicting the origin of the workforce.

The increasing use of automation in the mining sector is noted in the submissions, with some then drawing the conclusion that employment would be less than stated in the EIS as a result. The Hume Coal Project has incorporated automation in its design, in line with the approach of adopting leading practice wherever possible in all aspects of the project. Accordingly, the number of workers reported in the EIS was calculated with the use of automated machines taken into account. Specifically, the mine plan and associated workforce was derived based on the use of automated continuous miners and haulage systems.

The final point raised is in relation to the flow-on effects of the project on employment, and the additional jobs that will be created. Contrary to the point raised in the submissions, the (EIA) (BAEconomics 2017) does not claim that 1,200 indirect jobs will be created. The EIA reported that the incremental annual average employment flow-on benefits of the project will be 62 FTE jobs. The additional jobs will be a result of additional demand for goods and services which sets the economy in motion as businesses buy and sell goods and services from one another, and households earn and spend additional income. These linkages between businesses and households cause the total effects on the economy to exceed the initial change in demand as a result of the project. In calculating the flow-on employment benefits of the project BAEconomics used accepted multipliers as per the NSW Government (2015) *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* published in 2015.

ii Source of employees and flow-on benefits of employment

As stated in Section 3.4.1 of the SIA, the operations workforce will consist of both semi-skilled and skilled mine operators and maintenance staff, engineers, and managers, requiring varying levels of experience. In the early commissioning and build-up phases a core of experienced workers will be needed. However, as capacity for training increases over time there will be a greater opportunity to recruit less experienced workers. When recruiting, Hume Coal will apply the following criteria:

- completion of Year 12 schooling;
- a responsible character;
- be fit and medically suited to working in an underground mine;
- have a stable employment record; and
- ideally have a trade qualification or working towards one.

Hume Coal will give priority to local recruits who meet the above criteria. It is noted that this criteria does not include being a skilled mine worker. It is acknowledged that some skilled workers will be required and this has been accounted for in the anticipated 30%, and up to 50%, of workers that will be sourced from outside the region, based on an analysis of the ratio and mix of experienced/inexperienced recruits required under industry guidelines and industry practice, and the staged nature of recruitment.

The estimates of the share of workers that will come from outside the local region is considered to be conservative, given that:

- there is an existing skills base in heavy manufacturing that would be directly transferrable in the Southern Highlands SA3 Region (roughly equivalent to the Wingecarribee LGA), and may be attracted to the project workforce; and
- training programs provided by Hume Coal are expected to increase the potential to recruit local workers.

Hume Coal is committed to a residential workforce, with a requirement that employees live within a 45-minute commute of the mine during the operational phase of the project. This will be enforced through the documentation, communication and implementation of the Fatigue Management Policy as part of the project's Safety Management System, in which this will be a key mitigation measure in managing the risk of fatigue during employee's commute to and from the mine. It will also be documented and implemented in the relevant Human Resource policies relating to recruitment, so as to avoid a 'drive-in-drive-out' or 'fly-in-fly-out' workforce to ensure that the benefits of employment from the mine flow to the local region in which it will operate.

Hume Coal has also contributed to 'upskilling' local workers through its apprentice programs which are currently underway. Hume Coal is aware of the need to improve the skills base within Wingecarribee LGA and has established its apprenticeship program to provide training, support and development to enable local people to gain valuable skills and set them on the path to success. Annual funding of \$250,000 supports the placement of apprentices and trainees in local businesses to support economic growth.

Submissions also raised the issue of the Wingecarribee LGA's ageing population, claiming that Hume will have difficulty sourcing the required workforce locally. The SIA presented detailed socio-economic profile of the community, acknowledging that Wingecarribee's population is older than the NSW average. The LGA's median age increased from 38 to 44 between 2001 and 2011, compared with 35 to 38 across NSW. Wingecarribee also has fewer people of a young working age (25–34 years) compared with NSW (7.6% and 13.7% respectively) (ABS 2011a). The largest age cohort in the LGA in 2013 was 0–14 year olds, representing 18.8% of the population, followed by 55–64 year olds (13.9%) and 45–54 year olds (13.7%).

This population structure, including the ageing trend in the region, was taken into account when predicting the amount of employees that will be sourced locally; that is 50-70%, with 30-50% coming from outside the region. As noted, it is considered there is an existing transferrable skill base in heavy industry which accounts for some of the anticipated local positions, as well as training programs to be implemented to up-skill locals so that they can fill some positions.

In relation to DPI-Agriculture's questions regarding impacts on agricultural jobs, it is noted that the agriculture sector is a relatively small employer in the region. The agricultural industry directly employs 3.3% of total employed people within the Wingecarribee LGA (ABS 2011). Further, the existing skills base in heavy manufacturing, rather than agriculture, is expected to fill many of the jobs created by the project. Therefore it is unlikely that a large percentage of the workforce will be drawn from the agricultural sector.

Further, the EIA considered the potential impact on agricultural related employment as a result of the small reduction in agricultural land use through the construction of the mine's surface infrastructure area. The EIA concluded that just 0.2 FTE positions would be lost in the sector.

Questioning from DPI-Agriculture regarding the flow on benefits of employment, these are clearly documented in the EIA for the project (BAEconomics 2017), and in Chapter 19 of the EIS.

The direct net economic benefit of the project for NSW is estimated at \$295 million in net present value (NPV) terms. A key component of this includes net employment benefits in terms of the additional disposable income that will accrue to NSW residents and the NSW share of personal and company income taxes, corresponding to:

- \$134 million (NPV) in terms of net disposable income benefits;
- \$21 million (NPV) in terms of the NSW share of personal income taxes; and
- \$27 million (NPV) in terms of the NSW share of company income taxes.

In addition to the direct impacts described above, the project is will generate flow-on benefits for NSW. Flow-on effects reflect the projected additional expenditures that arise as a result of the project. The additional demand for goods and services sets the economy in motion as businesses buy and sell goods and services from one another, and households earn and spend additional income. These linkages between businesses and households cause the total effects on the economy to exceed the initial change in demand as a result of the project.

The project would give rise to:

- incremental disposable income flow-on benefits of at least \$73 million in NPV terms (\$6 million per annum); and
- incremental annual average employment flow-on benefits of 62 FTE jobs.

The 2015 Guidelines specify that a Local Effects Analysis (LEA) is also conducted that translates the effects estimated at the State level to the local level. The direct benefits of the project for the local economy predominantly consist of the additional disposable income that accrues to the project workforce. The project would give rise to:

- incremental disposable income benefits of \$85 million in NPV terms accruing to the project workforce in the Southern Highlands SA3 Region; and
- incremental payments in shire rates accruing to local government of \$1 million in NPV terms.

Further, the following flow-on impacts are predicted in the Southern Highlands SA3 Region:

- incremental disposable income flow-on benefits of \$44 million in NPV terms or \$4 million per annum; and
- incremental employment flow-on benefits, accounting for agricultural impacts, of 34 FTE jobs.

21.7.3 Impact of the mine on employment in other sectors

Concerns were raised in some business and special interest group submissions over the loss of jobs in other industries that the mine may cause, in particular in tourism and agriculture. It was submitted that unemployment will rise and young families will leave the area as businesses become adversely affected and /or close due to the reduced economic activity caused by the mine.

It was contended that the jobs created by the Hume Coal Project will not offset the decreased employment opportunities in the tourism, agricultural, and healthcare sectors that will occur as a result of the mine. Particular concerns were raised above tourism and agri-tourism; industries that are seen as the largest employer in the Southern Highlands.

Claims that the local economy will be adversely affected by the mine is contradictory to the findings of the peer reviewed EIA prepared by BAEconomics (2017) for the project.

A project is economically beneficial if its benefits exceed its costs measured in today's values (known as NPV). The cost benefit analysis undertaken by BAEconomics (2017) determined that the project's total net direct economic benefit to NSW will be \$316 million in NPV terms. In contrast, the costs associated with the project, which relate to greenhouse gas emissions and a small reduction in agricultural activity as a result of land (117 ha) being removed from agricultural production, were collectively estimated at \$21 million. When deducted from the project's economic benefits, the net benefit of the project is \$295 million. This significant positive economic benefit indicates that the project will benefit the NSW economy. Importantly, locally at the Wingecarribee LGA level, the project will also generate a net positive economic benefit, with a significant total direct and indirect benefit of \$128 million for the local area.

The potential for impacts from the mine specifically on the tourism industry was investigated by Judith Stubbs and Associates (JSA 2017a), as discussed in detail in Chapter 23.

JSA first analysed the extent of tourism employment in the region. The major industries in the Wingecarribee LGA were investigated by looking at the ABS employment data in the Southern Highlands Statistical Area 3 (SA3), which roughly equates to the LGA boundary. The ABS data shows that the significant employers in the Southern Highlands are in the areas of health care and social assistance, manufacturing, and education and training, with each of these industries equivalent in size or somewhat larger than tourism. The data suggests a mixed economy, rather than an economy dominated by tourism, although noting that tourism is an important employer in the Southern Highlands. The JSA analysis found there are a total of 1,510 direct tourism jobs in the Wingecarribee LGA and 196 at a more local level (ie closer to the Hume Coal Project and Berrima Rail Project) in the Moss Vale-Berrima ABS Statistical Area Level 2 (SA2).

By comparison, the Hume Coal Project is expected to provide 300 FTE jobs during the operation phase. These mining jobs are likely to be of higher value, with median individual weekly income in coal mining more than \$2,000 per week compared to \$400-\$599 in tourism industries (JSA 2017a). The assertion therefore that the value of tourism jobs would be greater than the jobs to be created by the Hume Coal Project is not consistent with the data available on employment, and the value of this employment, in the region.

Another important point is that the job types in the tourism industry generally differ markedly from the mining industry. ABS data on employment shows there are much higher proportions of professionals, technicians and trades workers, and machinery operators and drivers in the coal industry, with higher proportions of managers, community and personal service workers, sales workers, and labourers in the tourism industry (JSA 2017a). The different skill sets targeted by the two industries means that they would not be expected to compete with each other for labour.

JSA also note that the increase in income related to an increase in mining jobs is expected to support both the food and accommodation service industries in the Moss Vale-Berrima SA2, with relatively high disposable income enabling increased consumption of dining out and take away meals, and the need for causal accommodation during the operational phase of the project for short visits by specialist mining contractors such as technical consultants, equipment vendor representatives, field engineers or service technicians who are not resident in the Southern Highlands. The net effect would again be expected to be positive for local accommodation and food services, including in localities closest to the mine. Again, this indicates that concerns raised in submissions relating to the potential for negative impacts on local businesses in the region are unfounded.

The above analysis also does not support the assertion that unemployment will rise in the region as a result of the Hume Coal mine.

21.8 Mitigation measures

DPI-Agriculture submitted that insufficient details are provided in the EIS regarding social impact management and/or stakeholder engagement plans, requesting further details on management and mitigation measures. More details on the ongoing functions of the two advisory groups, namely the social reference group and the water advisory group were also requested.

Chapter 8 of the SIA presents the proposed management and mitigation measures to mitigate or reduce potential impacts across the six aspects of population and demographics, labour market, economic change, community services and facilities, housing and accommodation, and community liveability.

Importantly, key management and mitigation measures have already been incorporated into the project design, such as the use of a construction accommodation village. A summary of the mitigation measures is provided below:

- Population and demographics
 - establishment of a construction accommodation village; and
 - commitment to employ as many local people as possible.
- Labour market
 - implementing the employment policy requiring that all operational employees of Hume Coal live within the 45-minute workforce catchment area;
 - giving preference to employing locals wherever possible;
 - encouraging local contractors to tender for work during the construction, operations and closure phases;

- providing training and professional development opportunities for employees beyond those available in other local industries and with a particular focus on safety in the workplace; and
- working with recruitment, education and training providers within the workforce catchment area to encourage them to provide future employment and training opportunities for skills that the project would directly and indirectly generate.
- economic change
 - maximising local business opportunities by giving preference to local suppliers where reliability, quality and financial competitiveness criteria can be satisfied.
- community services and facilities
 - Hume Coal will enter into a VPA or similar mechanism. Notwithstanding, it is noted that the potential increased demand for community services will be low because the project will only add marginally to the LGA's total population.
- housing and accommodation
 - As noted above, Hume Coal will provide accommodation during the construction phase to its workers and contractors.
 - Based on the current availability and forecast future supply of new housing in the region, the operations and closure workforce will not significantly impact the local housing market. It is probable that there will be adequate capacity to cater for the relocated workers and their families meaning mitigation measures will almost certainly not be needed.
- community liveability
 - Up to \$450,000 a year has been spent during the planning and approvals phase on the Hume Coal apprenticeship program and the Hume Coal charitable foundation, which has supported more than 40 local organisations since its inception, including KU Donkin Pre-school, Wingecarribee Family Support Service, Youth Radio MVH-FM, Kollege of Knowledge Kommittee for Kids, BDCU Children's Foundation, Challenge Southern Highlands, Moss Vale Dragons Junior Rugby League Club, Moss Vale Cricket Club, Bundanoon Highlanders Rugby League Football Club and Bowral Rugby Club.
 - It is expected that during construction and operations these programs will be replaced with a VPA and normal workplace training.

These mitigation measures will be documented in a social impact management plan (SIMP). As is the case with all management plans to be prepared and complied with, the SIMP will be prepared following project approval and in consultation with relevant government agencies and the local community, using the multi-stakeholder approach. It will be periodically reviewed and updated as the project progresses through different phases.

A multi-stakeholder approach is used successfully to manage social impacts from mining operations in a number of other mining areas around the world. The approach includes forming multi-stakeholder groups for ongoing monitoring and management of social impacts associated with a project. The groups typically include diverse representatives from the community, such as youth and aged organisations, local businesses, tourism representatives, welfare agencies, emergency and community services, government agencies and environment and community groups. This ensures a broad range of social issues is considered and helps to align the activities of multiple groups. It also provides an effective way of managing and monitoring social impacts, thus fostering the project's integration into the local economy and community.

This approach has been adopted throughout the planning and approvals phase with the establishment of the social reference group and the water advisory group. These groups provided valuable input and feedback throughout the environmental assessment phase. This opportunity will continue during operations of the mine with the establishment of a community consultative community or similar. Further information on these groups is provided below.

Water Advisory Group

This group was established in 2011 to recognise the importance of ground and surface water to our external local stakeholders and interest in potential impacts from both exploration and potential future mining activities. The WAG initially comprised of nine committee members including an independent chairperson (The Hon. Gary Nairn), who possess a high level of skill and experience in community relations, planning and stakeholder management; and technical advisors, observers, staff and support.

Observers included representatives from Office of the Hon. Pru Goward, Member for Goulburn, and the NSW Office of Water. Numerous meetings were held as follows:

- December 2011
- December 2012
- March 2013
- June 2013
- March 2014
- June 2014
- July 2015
- August 2016
- April 2017

Social Reference group

In 2014 Hume Coal established a Social Reference Group includes membership across the region, including residents from Sutton Forest, Berrima, Robertson, East Bowral and Bowral. This group aims to better understand potential social issues (employment, housing etc.) by consulting on issues of interest with community members and incorporating community feedback into the future development proposal. Meetings were held as follows:

- April 2014
- July 2014
- October 2014
- July 2015
- October 2015
- March 2016
- November 2016

22 Health

This chapter responds to matters raised relating to health. The majority of submissions related to the Hume Coal Project EIS, including the health impact assessment (HIA), with the minority relating to the Berrima Rail Project EIS.

NSW Health reviewed the HIA, stating that the methods used to estimate health effects in the HIA report are standard and appropriate. Comments were provided on the areas of air quality, noise and water quality. The issues raised on these aspects by NSW Health are responded to in Section 22.4, 22.5, and 22.7, respectively.

22.1 Methodology and assessment approach of the Health Impact Assessment

In regards to the HIA prepared as part of Hume Coal Project EIS, the EPA in its submission stated that:

- the scope should be expanded beyond impacts associated with air quality and noise to other matters covered in the relevant technical studies, such as chemical contamination of water, safety hazards and other stressors such as social and community cohesion;
- a more formal, structured and comprehensive HIA is required and that this should be generally in accordance with the national guidelines for health impact assessment, to clearly demonstrate all key issues that related to impacts on community health have been identified and assessed;
- the HIA includes only a limited quantitative health risk assessment for long term exposure to particulate matter and does not include reference or provide information to support the findings relating to NO₂ or VOCs;
- the HIA be revised to contain a more robust and comprehensive health risk assessment for exposure to air pollutants and clarify an exceptional event rule is in place for the 24-hour PM₁₀ standard;
- the HIA has only limited information regarding hazard assessment, exposure assessment and risk characterisation, and diesel engine exhaust impacts are not considered; and
- any changes made to supporting assessments will require the HIA to be reviewed and potentially amended to ensure it remains accurate and consistent.
- Matters raised in community submissions relating to the HIA methodology and assessment approach, were inadequate or lack of consideration of mental health and well being issues, such as anxiety and depression.

22.1.1 EPA submission

The Hume Coal EIS was prepared to be in accordance with the SEARs. It is important to note that neither the SEARs, nor the government agency assessment requirements, which were taken into account by the Secretary for DPE when preparing the SEARs, required any preparation of a HIA.

Notwithstanding, so as to provide a comprehensive assessment of the potential impacts, a HIA was developed as part of the EIS. The HIA was developed by a suitably qualified health practitioner, Associate Professor David McKenzie; a respiratory physician with over 30 years of experience and head of the Department of Respiratory and Sleep Medicine at the Prince of Wales Hospital. Dr McKenzie has provided expert evidence on numerous projects relating to health effects from quarrying, mining and air pollution.

The scope and methodology of the HIA is based on the latest version of the guideline document, *Standard Secretary's Environmental Assessment Requirements (SEARs) for State Significant Mining Developments* (2015). While these guidelines do not specifically require a health impact assessment for coal mines, on page 16 it states "*The Air Quality Impact Assessment must assess the risk associated with potential discharges of fugitive and point source emissions for all stages of the proposal. Assessment of risk relates to environmental harm, human health, and amenity*".

Further, Appendix 1 of the SEARs references 'a list of some of the environmental planning instruments, guidelines, policies, and plans that may be relevant to the environmental assessment of this development'. This list included the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (the Approved Methods) (EPA 2016). The AQIA (EIS Appendix K) was prepared in accordance with the Approved Methods (and other relevant guidelines) and the HIA was prepared in this context.

In accordance with the *Standard Secretary's Environmental Assessment Requirements (SEARs) for State Significant Mining Developments* (2015), the AQIA assessed the risk of potential discharges of fugitive and point source emissions for all stages of the project, providing a quantitative assessment of potential air emissions and related impacts for both the construction and operational phases.

Notably, the scope of the HIA was extended beyond air emissions to consider noise emissions predicted from the project, based on feedback received during stakeholder engagement. Other matters referenced by the EPA; namely, chemical contamination of water, safety hazards and other stressors such as social and community cohesion, were considered in other parts of the Hume Coal Project EIS. The relevant conclusion for each is provided below.

1. The water assessment (EIS Appendix E) concluded that activities with potential to impact water quality and associated treatment methods will have a neutral or beneficial effect (NorBE) (refer also to Chapter 8).
3. The HRA (EIS Appendix P), which considered safety hazards, found that the project will not be a hazardous or offensive industry and that it will not pose a significant risk to people, property or the environment (refer to Section 22.3).
4. Other stressors such as social and community cohesion were considered in the SIA. The SIA concluded that, overall, the project will be socially beneficial (refer to Section 22.3).
5. Emissions from diesel engines were included in the predictions of particulate matter in the AQIA (EIS Appendix K) which provided data for the HIA. The AQIA concluded that the project will not have a significant impact on air quality.

Given the above, it is considered that the scope of the HIA is appropriate for the project. Therefore, any changes made to supporting assessments will not require the revision of the HIA.

22.1.2 Community submissions

The consideration of mental health and well-being issues is discussed in the response in Section 22.6.

22.2 Community consultation and input

A number of community submissions referenced the nature and lack of communication with regard to the projects impacting on their health.

Another community member noted distress from their property being listed for acquisition due to noise from the Berrima Rail Project.

The EPA noted that it is uncertain how potential health related issues of concern from the community were identified, including whether or not consultation provided an opportunity to raise health concerns.

Since October 2011, Hume Coal has had a dedicated community liaison team to brief stakeholders and respond to requests for information and meetings. This has provided for extensive stakeholder engagement and consultation during the project planning phase and will be continued throughout all stages of the project.

As discussed in detail in Chapter 7, consultation has included a wide range of mediums designed to provide information and to allow both questions and input. These have included project website, community shop fronts, information sessions and open days, media communications and focus and advisory groups. Hume Coal has endeavoured to provide an avenue for all community concerns and support to be raised.

An independent research consultant, on behalf of Hume Coal, researched community perceptions using quantitative surveys and qualitative focus groups in November and December 2013, October and November 2014, and June and September 2015.

The quantitative surveys each had a sample size of at least 400 people drawn from across the Wingecarribee LGA. In each case a random stratified sample was used to obtain representative samples of the population. Interviews were structured and all stakeholders were asked pre-determined questions so that consistent data were collected.

The focus groups were generally held in the evening and lasted for two hours. Participants were recruited to obtain a representative sample of the population. Health was not identified as an issue of concern by the focus groups (see Figure 7.1 of this RTS).

It is also noted that the community information sessions and open days, which were held throughout 2014, 2015 and 2016, were attended by Hume Coal staff, as well as some of the technical specialists involved in the preparation of the EISs. This included noise and air quality specialists, who were available to answer questions on any relevant matters, including matters related to health.

It is considered that consultation undertaken provided an extensive opportunity for health concerns to be raised.

With regard to property acquisition, Hume Coal recognises that this must be thoughtfully managed and appreciates that any discussions around property purchases may cause distress. It has actively sought to engage with property owners potentially affected noise. Engagement has included information to support the understanding of noise emissions and on mitigation applied during the mine design process, predictions made under the various project stages and weather scenarios, mitigation proposed to manage potential impacts, and relevant government guidelines and policies regarding voluntary acquisition and mitigation.

22.3 General health impacts

A number of submissions from community, business and interest groups raised concerns regarding potential general health impacts of the Hume Coal Project and the Berrima Rail Project, including:

- i. adverse effects on health and well being of local communities, including schools and local residents from dust, noise and light spill. This included general references to physical, emotional and psychological health; and
- ii. lack of consideration from accidents, mine accidents, car accidents and rail accidents. One submission stated that impacts on human health from mining, transport and the handling of coal should be featured in the Cost-Benefit Analysis (CBA) (EIS Appendix Q).

22.3.1 General health and wellbeing

The SIA (EIS Appendix R) scope and content was designed to meet the specific requirements provided in the SEARs and followed both leading practice international and national guidelines in its assessment of the social changes that are likely to occur as a result of the project.

The SIA identified and assessed both positive and negative impacts. This includes consideration of the health and well being of local communities, across the whole community, capturing schools and local residents. In doing so, the SIA considered both measures to enhance social opportunities from the project as well as measures to mitigate negative impacts during all phases of the project. This approach goes beyond regulatory compliance and is consistent with Hume Coal's commitment to adopting leading practices.

The SIA concluded that, overall, the project will be socially beneficial to the whole community. This will be the case for three of the four phases of the project's lifecycle; that is from planning through to the end of operations. Negative effects will outweigh positive effects only during the final closure phase, due to the loss of jobs at the time as the mine closes. This phase will have a short duration compared to the other phases of planning, construction and operation. The greatest benefit will occur during the operations phase and most of these benefits are of long duration and will benefit the whole region. Importantly, there will be an ongoing legacy from the project's contribution to the community during the life of the project through a Voluntary Planning Agreement.

Impacts relating to potential impacts from dust and noise are addressed in Sections 22.4 and 22.5, respectively. Emotional and physiological health is addressed in Section 22.6. In relation to light spill, this will be carefully considered and lighting designed accordingly during the detailed assessment of the surface infrastructure area for the Hume Coal Project. Lighting will be incorporated into the design in accordance with the requirements of Australian Standards 4282 *Control of Obtrusive Effects of Outdoor Lighting*. Further discussion on light spill is provided in Section 18.4.

22.3.2 Accidents

With regard to lack of consideration from accidents, mine accidents, car accidents and rail accidents, the HRA considered hazard scenarios for possible events, such as accidents, which could occur during normal operation of the project to people, property and the environment in accordance with the risk assessment method outlined in *Australian/New Zealand Standard International Organisation for Standardisation 31000:2009 – Risk Management – Principles and Guidelines* (AS/NZS ISO 31000:2009). Overall risks from the project were assessed as low. The identified risks from the project will be further examined as part of detailed project design and reassessed in the ongoing hazard assessment process to ensure risks are kept as low as reasonably practical.

To minimise the risk of fatigue related accidents involving employees travelling to and from the mine, Hume Coal will require all operations employees to live within 45 minutes travel time from the project area. This policy will reduce the risk of fatigue related travel accidents, given that some production employees will be working afternoon and night shifts. Given the utmost importance placed on safety, no other options were considered in this regard.

The CBA was prepared in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW Government 2015b). It compared all costs and benefits attributable to the development, discounted to a common point in time, to arrive at an overall assessment of whether the development is a 'net beneficial' scenario; that is, whether society will benefit from its implementation. A project is net beneficial if its benefits exceed its costs measured in today's values (known as net present value or NPV). The CBA concluded that the project will have a direct net economic benefit to NSW of \$316 million; comprising royalty payments of approximately \$114 million in NPV terms, net employment benefits of \$134 million in net disposable income benefits, \$48 million of the NSW share of personal and company income taxes, and around \$20 million in incremental payroll taxes, council rates and various levies.

22.4 Health impacts relating to air quality

NSW Health (South Western Sydney Local Health District) commented that whilst health effects relating to air quality as a result of the Hume Coal Project are likely to be low, it is important that all reasonable and feasible measures are taken to minimise exposure to air pollutants for local residents.

Health impacts related to air quality were raised in submissions from the community and specialist interest groups, with concerns often raised in general terms with submissions referencing coal dust (forming a component of particulate matter) and diesel emissions. Submissions often stated that this was a particular concern for people at higher risk, being the elderly and children.

Health risks most commonly identified were asthma and other respiratory conditions and cardiovascular disease. Coal dust being carcinogenic was also referenced on occasion. Several submissions stated there would be associated expenses that will be incurred by hospitals and health system.

Other health impacts relating to air quality raised were:

- i. coal dust entering streams and water tanks;
- ii. dust from the temporary reject stockpile;
- iii. impacts on livestock and from dust impacted farming products;
- iv. safe distances from ventilation shafts not given in EIS; and
- v. predominant westerly wind direction towards townships and that locations most at risk from air emissions were Sutton Forest, Berrima, Burradoo, Moss Vale, Bowral, Robertson, and Bowral.

Special interest group, Macquarie University, also provided a number of recommended actions as follows:

- i. monitoring of very fine dust particles <2.5 microns at multiple locations around Berrima, Moss Vale and Burradoo;
- ii. independent monitoring with data accessible to the public;
- iii. assessment of air quality pre-mining and during mining;
- iv. very fine dust particle reading should be random and given for 24-hours real time data to the public, rather than as a weekly or monthly or annual average; pollution will be absent on average data, but daily data would show days of significant pollution; and
- v. high levels of small particles should lead to closure of the mine until pollution levels are at normal range.

Matters raised relating specifically to the Berrima Rail Project with regard to general health impacts included exhaust fumes and coal dust from trains, and PM exposure at Robertson Public school and New Berrima and Berrima.

22.4.1 NSW Health submission

Preparation of the air quality impact assessment for the project involved identifying the best practice measures to reduce particulate matter emissions. As explained in Section 7.3.3 of the assessment (Ramboll Environ 2017a), in 2011 the NSW OEH published the guideline *Coal Mine Particulate Matter Control Best Practice Site-Specific Determination* (OEH 2011). This document describes the process to follow when conducting a project-specific determination of best practice measures. This process was undertaken by Ramboll Environ and the results are presented in Section 7.3.3 air quality impact assessment report.

In accordance with the OEH guidelines, the top four emission sources were identified, with the proposed control measures compared with best practice dust management techniques as identified within *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone, 2011).

The outcome of the analysis for the Hume Coal Project was that the highest ranking sources of TSP, PM₁₀ and PM_{2.5} emissions from the project are:

- wind erosion from coal stockpiles;
- ventilation shaft emissions from underground operations, incorporating both fugitive emissions from coal extraction and transportation and diesel fuel combustion;
- conveyor belt and transfer stations, from both wind erosion and coal transfer emissions; and
- stacking and reclaiming of coal.

A comparison of the controls proposed for the project against best practice control measures (Katestone 2011) found that the control measures proposed for the top-ranked sources of particulate matter emissions are all comparable to current best practice control measures, with the exception of one measure relating to the stacking and reclaiming of coal, which is to avoid stockpiling altogether. This measure is not practicable for the project as stockpiling of ROM and product coal is an essential element. In addition, ventilation shaft emissions are not considered in Katestone (2011). Notwithstanding, emissions from underground ventilation discharge will be managed through a combination of underground operation dust mitigation practices (water sprays at coal extraction and handling points and dust suppression along underground roads) and maintenance of underground mining fleet to maintain manufacturer's engine emissions specifications.

Therefore, the best practice review found that all reasonable and feasible dust control measures will be implemented for the project.

22.4.2 Community submissions

As noted in Section 15.1.1 of this RTS, the scope and methodology of the air quality impact assessment was in accordance with the SEARs and the *Approved Methods for Modelling and Assessment of Air Pollutants* (EPA 2016). This included quantitatively modelling and assessing the project's predicted particulate matter and combustion emissions from a range of scenarios (construction and operations). Conservative assumptions were used to provide upper bound estimates of the project's impacts. Further, the region's air quality is well characterised from a network of monitoring stations operated by Hume Coal and independent bodies (such as NSW OEH).

The AQIA completed for the Hume Coal Project (Ramboll Environ 2017a) predicted concentrations of particulate matter (TSP, PM₁₀ and PM_{2.5}) and gaseous pollutants (NO₂ and individual VOCs) from diesel combustion emissions from across the local region surrounding the project area, with specific predictions made at the closest individual representative residential receptors and key town centres. Model predictions of pollutant concentrations for relevant averaging periods were compared with applicable NSW EPA impact assessment criteria (Section 9 of the air quality impact assessment report). The adopted assessment criteria, listed within the NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, are designed to maintain an ambient air quality that allows for adequate protection of health and amenity.

As reported in Section 15.5.8 of the RTS, predicted particulate matter and gaseous pollutant concentrations, taking the existing ambient air quality into consideration for cumulative effects, are below applicable air quality assessment criteria at all surrounding receptors for both the construction and operational scenarios assessed. On the basis of the modelling conducted and predicted compliance with applicable assessment criteria, the Hume Coal Project will not adversely impact upon the surrounding air quality environment with respect to emissions of fugitive particulate matter or from diesel combustion.

The HIA, which was utilised data from AQIA, was prepared by a leading independent expert, Dr David McKenzie. It considered the epidemiological literature regarding associations between exposure to airborne pollution and ambient noise and various health outcomes, including specifically, health effects of coal mining. It provides a health risk assessment for the project.

Overall, the HIA concluded:

The predictions from the modelling for the highest levels of PM_{2.5}, PM₁₀ and gaseous pollutants from the project, both during peak construction and peak operation, show the project's emissions will be small compared with background levels and that the cumulative levels will be well below the applicable regulatory criteria. The National Environmental Protection (Ambient Air Quality) Measure (NEPM) standards are unlikely to be exceeded other than when they are due to external events such as dust storms and bush fires. The health impact is predicted to be so small as to be immeasurable and well below the regulatory criteria.

The NEPM standards for air quality reflect the medical literature and are set in response to health, social, environmental and economic impacts and other factors.

Notably, the NEPM standards are conservative compared with other developed nations. As an example, the NEPM standards for PM_{2.5} are a 24-hour average of 25 µg/m³ and an annual average of 8 µg/m³. The US EPA standard is a 24-hour average of 35 µg/m³. There are two annual average standards: the secondary standard is 15 µg/m³ and the primary standard is 12 µg/m³, recently introduced to protect sensitive individuals such as asthmatics, children and the elderly. The EU standard is even higher, with an annual mean of 25 µg/m³. The WHO aspirational goal, or guideline, is an annual standard of 10 µg/m³, which is recommended for nations to work towards. The WHO has set three interim targets for annual mean PM_{2.5} levels decreasing from 35 to 15 µg/m³. Thus, the Australian advisory standard of 8 µg/m³ is lower than even the WHO aspirational guideline.

The claim that coal dust is a known carcinogen is not accepted. According to the World Health Organisation International Agency for Research on Cancer (WHO IARC), coal dust cannot be classified as to its carcinogenicity to humans (IARC 1997, IARC 2017) and is currently listed as a Group 3 substance, being "*Not classifiable as to its carcinogenicity to humans*". The recent National Institute for Occupational Safety and Health (NIOSH) meta study, which reviewed health studies for coal dust exposures published post 1995, supports IARC's findings (NIOSH, 2011).

With regard to hospital admissions and associated expenses, in 2010, the NSW Department of Health studied respiratory and cardiovascular diseases and cancers among residents in the Hunter and New England health service areas and compared these with the rest of NSW (NSW Health 2010). Areas with and without coal mines within the Hunter region were also compared.

Overall the rates of respiratory admissions were lower than the rest of NSW. Respiratory presentations to hospitals in Muswellbrook and Singleton (major mining areas with coal-fired power stations) ranked below those of Tamworth and Gunnedah in all age groups. The rate for Muswellbrook was higher than the state average but that for Singleton was lower, indicating no consistent trend with mining activity.

For asthma presentations Singleton ranked 11th in New South Wales in 0 to 14-year-olds, 6th in 15 to 34-year-olds, 3rd in 35 to 64-year-olds and 25th in those aged over 65 (that is, no consistent trend). Overall the rate of hospital admissions for respiratory disease in the Hunter area is lower than that for the rest of NSW. The rate of hospital admissions for asthma was also lower than that for the rest of NSW for both adults and children. There was variation between areas with higher rates in rural areas thought to reflect higher allergen exposure. Overall, there were more emergency department presentations for all conditions in Hunter area compared with the rest of NSW, a finding thought to reflect social factors.

There was no consistent association between presentations to emergency and mining activity with some coal mining areas higher than average and some lower.

Notwithstanding all of the above, Hume Coal will develop and implement a comprehensive Air Quality Management Plan (AQMP), which will be prepared in consultation with the EPA and to the satisfaction of the NSW DPE, in accordance with the recommendations of the AQIA. This AQMP will document management practices and mitigation measures to minimise air emissions from all stages of the project. Hume Coal will continue to undertake a comprehensive air quality monitoring program throughout the life of the project, as per the commitments in the EIS. The results of this air quality monitoring program will be reported in the Annual Environmental Management Report (or Annual Review as it is now referred to), which will be required as a condition of the development consent. This Annual Review will be submitted to relevant government agencies each year, including the NSW DPE and EPA, for review, and will be made publicly available on the Hume Coal website.

Specific matters raised in community submissions are listed below with a response provided beneath each.

i Coal dust entering streams and water tanks

Studies in coal mining areas in Queensland and NSW have investigated the health risks of coal dust deposited on rooftops entering rainwater systems used for potable water supply. The results of the studies have shown that health risks of coal dust entering rainwater systems are low.

Results from leaching tests on numerous coal types in Queensland showed that negligible amounts of trace elements in coal dust were released in the rainwater. All trace elements were below the Australian Drinking Water Guidelines (ADWG) which provide the threshold levels considered safe for human consumption (Lucas et. al, 2009).

Further, studies in NSW near Stratford and villages remote from mining areas failed to indicate any significant difference in laboratory tested results between the two. The majority of the results were within the ADWG, with isolated results that exceeded aesthetic values for zinc, aluminium and iron. Two results exceeded ADWG for lead; however these were believed to be due to poor conditions at the dwelling and tanks (Parkinson and Stimson, 2010).

Notwithstanding, it is noted that all rainwater tanks should be maintained in accordance with the advice outlined in NSW Health's Rainwater Tanks brochure to ensure water is safe for drinking (NSW Health 2007). It is good practice for all rain water systems in any location to install a simple first flush system to prevent particulate matter (or any other undesirable materials) that have collected on the roof being washed into the rain water tank.

ii Dust from the reject stockpile.

Dust from aboveground coal and temporary reject stockpiles is considered in Section 15.5.7 of this RTS. Stockpiles were included as emission sources in the air quality modelling which demonstrated compliance with all applicable air quality impact assessment criteria at all sensitive receptors and town centres.

As detailed in Section 7.3.3 of the air quality impact assessment report, the proposed mitigation and management measures for the Hume Coal Project are in accordance with or above accepted industry best practice dust control measures.

This includes control of emissions on the temporary rejects storage area through the application of water sprays to maintain elevated surface moisture content and mitigate potential wind erosion emissions.

As concluded in the HIA, the health impact is predicted to be so small as to be immeasurable and well below the regulatory criteria.

iii Impacts on livestock and from dust impacted farming products were also referenced.

Potential impacts of dust deposition on agriculture are considered in Section 15.5.6 of this RTS. It was concluded that that emissions from the project are unlikely to have any impact on surrounding vegetation and not adversely affect the health of horses or other livestock in the surrounding region.

iv Safe distances from ventilation shafts not given in EIS.

Location of ventilation shafts is addressed in Section 15.5.9 of this RTS. As described, emissions from underground mining operations were quantified through the conservative use of maximum recorded ventilation shaft monitoring data from similar underground coal mining operations in NSW. Predicted concentrations are well below applicable impact assessment criteria and that the ventilation shaft emissions would not adversely impact on the surrounding environment. There are no emissions from the downcast shafts or the drifts during mine operations due to the fact these locations will be used for drawing air into the underground mine.

As concluded in the HIA, the health impact is predicted to be so small as to be immeasurable and well below the regulatory criteria.

v Predominant westerly wind direction towards townships and that townships most at risk from air emissions were Sutton Forest, Berrima, Burradoo, Moss Vale, Bowral, Robertson, and Bowral.

Significant meteorological data analysis was completed as part of the Hume Coal Project air quality impact assessment. Multiple years of real-time monitoring data from multiple local area stations was collated in order to obtain a comprehensive understanding of local meteorological conditions. The closest receivers in all directions were modelled. As described in Section 15.5.7 of this RTS, modelling included periods of sustained high winds (gusts up to 95km/hr) blowing for continuous hours from the west.

Air quality modelling demonstrated compliance with all applicable air quality impact assessment criteria at all sensitive receptors and town centres. As concluded in the HIA, the health impact is predicted to be so small as to be immeasurable and well below the regulatory criteria.

22.4.3 Special interest group submission

A number of recommendations were made by the Macquarie University in its submission. These are listed below with a response beneath each recommendation.

i Monitoring of very fine dust particles <2.5 microns at multiple locations around Berrima, Moss Vale and Burradoo.

Section 10.4 of the air quality impact assessment documents anticipated future air quality monitoring for the Hume Coal Project. Existing PM₁₀, PM_{2.5}, dust deposition and meteorological monitoring equipment will form the basis of the monitoring network.

As described in Section 15.6.4 of this RTS, if the project is approved, the final air quality monitoring network would be selected in accordance with the requirements of the NSW EPA, with regards to the number of stations, pollutants to be recorded and duration of air quality monitoring. In the event that existing equipment requires relocation, the results of the dispersion modelling, location of neighbouring receptors and layout of surface operations will be used to identify appropriate alternative monitoring locations. Final site selection will be made in accordance with applicable Australian Standards and NSW EPA requirements. Air quality monitoring requirements will be documented in the Environment Protection Licence for the project issued by the NSW EPA.

ii Independent monitoring with data accessible to the public.

Monitoring data will be accessible to the public. The results of this air quality monitoring program will be made available on the Hume Coal website and in the Annual Environmental Management Report (or Annual Review as it is now referred to), which will be required as a condition of the development consent. This Annual Review will be submitted to relevant government agencies each year, including the NSW DPE and EPA, for review, and will be made publicly available on the Hume Coal website.

iii Assessment of air quality pre-mining and during mining.

Monitoring results will be assessed against relevant air quality impact assessment criteria. Hume Coal will continue to undertake a comprehensive air quality monitoring program throughout the life of the project, as per the commitments in the EIS.

iv Very fine dust particle reading should be random and given for 24-hours real time data to the public, rather than as a weekly or monthly or annual average; pollution will be absent on average data, but daily data would show days of significant pollution.

As described above, if the project is approved, the final air quality monitoring network would be selected in accordance with the requirements of the NSW EPA, with regards to the number of stations, pollutants to be recorded and duration of air quality monitoring. Monitoring results will be accessible to the public.

v High levels of small particles should lead to closure of the mine until pollution levels are at normal range.

An analysis of proposed emission mitigation measures is documented in Section 7.3.3 of the air quality impact assessment report. This analysis, conducted in accordance with guidance from the NSW EPA, compares proposed measures against accepted coal industry best practice dust control measures for each significant emissions source at the Project, including stockpiles, conveyors and transfer points. The review identified that proposed mitigation and management measures for the Hume Coal Project are in accordance with or above accepted industry best practice dust control measures.

The AQIA prepared for the project predicted that concentrations for all pollutants will be well below all applicable air quality impact assessment criteria at all sensitive receptor locations.

As noted above, an extensive network of air quality and meteorological monitoring equipment is already in place at the project area, and includes real-time measurements of meteorological conditions and particulate matter concentrations (PM₁₀ and PM_{2.5}). Operations will be managed to achieve compliance.

Further, if approved, the Hume Coal Project will be required to operate in accordance with the requirements of the EPL, which will include air quality limits. In the unlikely event that dust levels regularly exceed criteria operations may be suspended while mitigation measures are implemented. This will be outlined in the air quality management plan, and carried out as part of the management of air quality onsite. If regular non-compliances with the EPL occur, the EPA, as the regulatory authority with the required mandate to enforce compliance with the EPL, can issue notices or require other appropriate action so that compliance with the relevant air quality criteria is achieved.

22.4.4 Berrima Rail Project

With regard to coal dust associated with the Berrima Rail Project, the HIA references a number of relevant studies in its assessment of impact of fugitive emissions from coal trains along the rail corridor. The Australian Rail Track Corporation (ARTC) quantified fine particulates generated from rail transport including coal trains in the Newcastle area rail corridor (September 2012). Monitors were set up 3 m from the tracks in Metford and Mayfield. While there were some differences between the two sites, passenger trains produced the highest peak levels of total suspended particles (TSP), PM₁₀ and PM_{2.5} while the mean levels for PM₁₀ and PM_{2.5} were higher for coal and freight trains, with no significant difference between loaded and unloaded coal trains or between coal trains and other freight trains.

The differences between the types of train were small and thought to be due to speed (higher for passenger trains) and duration of passing (longer with coal and freight trains). The transient increases in airborne particles with trains ranged from 2.2–4.8 µg/m³ for PM₁₀ and 0.5–1.2 µg/m³ for PM_{2.5} respectively for Mayfield and Metford. Most of the dust was entrained from the ground rather than fugitive from the trains, and only a small percentage was coal dust even when the dust appeared black. The Queensland Department of Science, Information Technology, Innovation and the Arts (Neale D et al. 2013) monitored dust levels at six locations along the rail corridors of coal trains from the west to the Port of Brisbane in 2013 and produced similar results to the NSW study.

The 24-hour mean levels of PM₁₀ and PM_{2.5} did not exceed the Queensland EP(A)P criteria on any day with the highest PM_{2.5} value less than the annual objective of 8 µg/m³. The levels were similar to those elsewhere in the region and related to regional emissions rather than the trains. The levels did not seem to be influenced by the number of trains each day, which varied considerably.

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The Queensland Department of Health concluded there were unlikely to be any additional adverse health effects from dust particles for people living along the rail corridor. A similar conclusion was reached in the NSW report.

As referenced in the Section 12.3.1, the findings of the NSW Chief Scientist in the 2016 report *Independent Review of Rail Coal Dust Emissions Management Practices in the NSW Coal Chain* are also acknowledged regarding existing uncertainty and data gaps relating to potential fugitive emissions from rail wagons. However, as per the NSW Chief Scientist report, reviewed reports identify that the loaded and unloaded surface of rail wagons accounts for approximately 80% of fugitive emissions. Therefore, the covering of rail wagons will mitigate the primary source of fugitive rail dust emissions.

Modern “bat wing” design coal wagons have long hopper openings and minimal surfaces on which parasitic coal can accumulate, and their use will minimise the occurrence of wagon loading overspill and subsequent parasitic coal loading on wagons leaving the site, as will the use of a modern, automated train loading facility.

The NSW Chief Scientist report recommends that control measures currently implemented by the coal industry are continued and encourages the implementation of new mitigation strategies. It is considered that through the implementation of covered rail wagons, a measure never before implemented in the Australian coal mining industry, the Hume Coal Project is indeed adopting the recommendations of the NSW Chief Scientist.

As the Hume Coal rail wagons will be covered, there will be minimal fugitive coal dust emissions released as trains move from the mine site to port, including at the Robertson Primary School.

The AQIA prepared for project predicted that concentrations for all pollutants will be well below all applicable air quality impact assessment criteria at all sensitive receptor locations, including Robertson Public school and the nearest townships of New Berrima and Berrima. Therefore, there are unlikely to be any health effects from dust particles associated with the rail movements from the project.

22.5 Health impacts relating to noise

NSW Health acknowledged that the Hume Coal Project EIS states that sleep disturbance and health impacts are not expected to occur. However, it is claimed that assessment methods for sleep disturbance in the Industrial Noise Policy are limited and some references to older policy documents are not appropriate. NSW Health therefore recommended that a comprehensive noise monitoring and mitigation program is put in place to reduce noise exposure and to promptly respond to noise complaints.

Community and special interest group submissions also raised concerns relating to noise, particularly from coal trains (Berrima Rail Project) at Robertson Public school and New Berrima and Berrima, and more broadly from the mine, with some raising concerns regarding acquisition.

22.5.1 Sleep disturbance

The recommendation by NSW Health for noise monitoring and mitigation will be adopted, which will be required by the conditions of the development consent and the EPL, and will be developed through the site's operational environmental management plan. Therefore, near neighbours to project related infrastructure can be assured that appropriate sleep disturbance targets will be satisfied as required by current government policy. To that end, since the noise impact assessment was completed for the Hume Coal Project EIS and Berrima Rail Project EIS, the EPA's INP has been superseded by the *Noise Policy for Industry* (NPfI) (EPA 2017), which includes for the first time noise targets for sleep disturbance which will likely drive noise limits in the development consent, if granted. These newer targets are not dissimilar to former government positions on sleep disturbance, and align with World Health Organisation (WHO) recommendations.

22.5.2 General noise impacts

Concerns were raised more broadly about noise impacts from the mine and associated train movements.

In relation to noise from the Hume Coal Project, and as discussed in Chapter 14, the results of the noise modelling showed that with mitigation measures in place, the general amenity of the area will remain the same or otherwise satisfy EPA recommended amenity criteria, with only a few properties to the north of the project boundary predicted to be impacted to a level where they will be entitled to voluntary mitigation (nine properties) or acquisition (two properties).

The NSW government's *Voluntary Land Acquisition and Management Policy* (VLAMP) (NSW Government 2014) was developed with the aim of protecting health, preserving amenity and controlling intrusive noise. If exceedances of relevant criteria occur and this results in unacceptable impacts, the VLAMP provides a clear and transparent process so that an appropriate outcome is achieved to the satisfaction of all parties, and importantly, that the aims of the policy are achieved.

Noise impacts relating to train movements and potential impacts on health are discussed below.

22.5.3 Noise from coal trains

The potential for noise impacts on the township of Berrima from both the Hume Coal Project and the Berrima Rail Project were assessed.

As described in Section 14.1.2 of this RTS, assessment locations 19, 20, 21, 23, 24, 69, 70, 71, 72 and 73, were included within Berrima to represent that group of residences. The predicted noise levels at these locations (eg 19 and 21) show predicted noise levels below (ie satisfy) criteria for industrial operations (refer to Table 5.1 of NVA for the Hume Coal Project and Tables 5.1 and 5.2 of the Berrima Rail Project). Furthermore as these locations are found to the south of Berrima and closest to the Hume Coal Project and Berrima Rail Project, noise impacts to any other residences further north would be expected to be less. Additionally, rail operational noise Table 5.3 confirms noise levels are predicted to be well below (ie satisfy) criteria at assessment locations that are much closer to the proposed rail spur than the Berrima residences.

As described in Section 14.3 of this RTS, the noise assessment from proposed rail operations has been completed in accordance with state government policy. This includes an assessment of sleep disturbance, and hence has relevance to health. The assessment included network rail operations in the area of Robertson, where noise criteria are predicted to be satisfied.

The Robertson Primary School is approximately 100 m from the nearest rail track. The addition of Hume Coal trains on these sections of track is predicted to lead to a negligible (<0.5dB) increase in total rail noise.

The nearest residences are approximately 20 m from the track. The addition of Hume Coal trains on these sections of track is predicted to lead to a negligible (<0.5dB) increase in total average rail noise to all locations potentially affected and therefore be unlikely to increase the incidence of disturbed sleep patterns.

The HIA considered potential impacts from operational noise, construction noise, traffic noise, low-frequency noise and potential sleep disturbance for nearby residents.

The HIA concluded that the predicted worst case noise levels are not enough to cause measurable health impacts or sleep disturbance.

22.6 Community concern and stress over the potential mine impacting health

Submissions referencing community concern over the mine's impact on health predominately raised stress and mental health issues, such as depression and anxiety. This was in the context of during mining operations and during the extended baseline information collection and assessment process which has occurred. Several submissions specifically referenced stress associated with land access, survey and assessment preparatory work.

Stress from uncertainty over the mine's approval and land values and property prices decreasing was also contended as leading to sleeping disorders and substance abuse in addition to the mental health issues noted above.

Hume Coal acknowledges the extended baseline monitoring and environmental assessment and approval process that has been, and continues to be undertaken in seeking development consent for the Hume Coal Project. Hume Coal are seeking approval through the required legal process pursuant to the provisions of the NSW EP&A Act and associated regulations and supporting guidelines. This process involves a number of statutory timeframes which must be followed, and requires extensive baseline monitoring which Hume Coal have undertaken. Considerable time has subsequently been spent analysing the results and preparing detailed technical studies so as to present a robust and comprehensive EIS for consideration by relevant stakeholders and government agencies. It is noted comments regarding land access for exploration purposes are outside of the scope of this RTS.

As described in Section 21.3, the SIA identifies and assesses both positive and negative impacts of the project. This included consideration of the health and well being of local communities. As noted in Chapter 24 of the Hume Coal Project EIS, Hume Coal is sensitive to some sections of the community experiencing stress and anxiety about the project's potential impacts on the local area.

Studies have been undertaken in other jurisdictions relating to the stress and anxiety and coal mining, which recognise that health and well-being impacts need to be considered at a community level. In a study of the health of Hunter Valley communities in proximity to coal mining and power generation, where this is a significant concentration of such activities, Merritt et al. (2013) found that:

There were no significant differences in management rates of mental health conditions in the Hunter Valley region compared with the rest of rural NSW. Management rates of depression and anxiety were not higher, nor were prescription rates of antidepressants.

This indicates similar levels of anxiety are experienced in the Hunter Valley region compared to rural NSW as a whole, although the causes of anxiety may vary between regions.

The extensive engagement completed for the project to date has aimed to provide the timely provision of factual and relevant information and to create a process that provides opportunities for stakeholders to express their views and enable timely feedback on matters raised. This engagement will continue as reflected by the continued operation of the Berrima community office, and the dedicated community liaison team that will continue to function during the next phases of the project, should it be approved.

As described in Section 21.8 of the EIS, a set of mitigation and management measures will be put in place that have been designed to address specific impacts associated with each phase of the project. All of the measures will be developed and detailed in a Social Impact Management Plan (SIMP). The SIMP will include periodic monitoring of the effectiveness of measures and will be revised as necessary throughout the life of the project. Social impacts will be managed using a multi-stakeholder approach that has proven to be effective in other resource development jurisdictions. An outcome of effective engagement is anticipated to be a minimisation of stress and potential health impacts associated with the mine.

In response to concerns raised relating to land values and property prices in submissions, Judith Stubbs and Associates (JSA 2017b) were commissioned to prepare a report on the potential impact of the Hume Coal Project in this regard. The report is attached in Appendix 6, and considered whether there has been an impact of the Hume Coal Project to date on property values, and more generally whether an increase in coal mining in an area is associated with a decline in property values. The results of the analysis do not support the claim of an adverse impact on property values, and are discussed in detail in Section 20.4.

22.7 Health impacts relating to water quality and contamination

NSW Health raised a couple of matters relating to groundwater and bore water:

- i. **Privately owned bores and water quality** - In the area surrounding the project there is likely to be a number of unregistered bores which can be used for a variety of purposes, including stock and domestic, such as drinking water. It is recommended that an assessment of the impact on groundwater quality accessed by bores is undertaken to assess suitability for drinking water purposes. The private bores surrounding the site should be monitored during the mine operation phase to ensure no deterioration in water quality. A bore water quality monitoring plan should be established in consultation with DPI Water and the EPA.
- ii. **Effluent management** – The EIS outlines grey water being managed by primary treatment and drip irrigation on landscape areas, and black water being tertiary treated for reuse in the coal preparation plant. The potential risk of exposure of workers to black water effluent is not covered. There is also no discussion on the quality of effluent. It is recommended that effluent quality is monitored and the quality should dictate its end use.
- iii. **Sediment dams** - Runoff collected in sediment dams during the construction phase and in the stormwater basins, mine water dams and the primary water dam during the operation phase should be constructed, maintained and monitored so as not to become a mosquito breeding hazard.

A number of community submissions also raised health impacts relating to water contamination. Points made were:

- i. contamination of water tanks, dams, reservoirs and Sydney drinking water; and
- ii. coal fines and mine rejects being a potential sources of heavy metal and carcinogenic compounds and being placed in direct contact with the groundwater resource.

22.7.1 Privately owned bores and water quality

Landholder bores will not experience change in groundwater quality as a result of the project. As described in Chapters 9 and 10 of this RTS report, the groundwater quality assessment in both the Hume Coal Project EIS and subsequent work undertaken as part of the revised water assessment concludes that there will be negligible impacts to groundwater quality. The risk of any potential impact to groundwater from the quality of collected water (for example in the primary water dam) or coal reject slurry transferred into underground workings has been assessed as part of the RGS hydrogeochemical modelling program and has been demonstrated to be negligible (RGS 2018). Further detailed discussion on water quality is provided in Chapter 10.

22.7.2 Effluent management

Treated wastewater will be reused via spray irrigation systems in areas with restricted access. Monitoring of wastewater quality, soils and groundwater within the vicinity of the wastewater infrastructure will also occur. As described in Section 8.3.6, a conceptual effluent reuse plan for the Hume Coal Project and the Berrima Rail Project has been prepared as part of the revised water assessment (Harris Environmental 2018). This will form part of the Water Management Plan for the Hume Coal Project. Details of this additional work are included in Section 2.3.3 of the Revised Water Assessment (refer to Appendix 2).

The effluent treatment facility will be installed and maintained in accordance with the required approvals from Wingecarribee Shire Council in accordance with the Section 68 of the *NSW Local Government Act 1993*, and with Section 5 of the *Use of Effluent by Irrigation Guidelines* (DEC 2004).

22.7.3 Sediment dams

As described in Section 8.5, two main water management plans (WMPs) will be developed for the project, one for the construction phase (CWMP) and one for the operational phase (OWMP). These plans will be sub-plans of the environmental management system. The WMPs will document the proposed mitigation and management measures for the approved project, and will include the surface and groundwater monitoring program, reporting requirements, spill management and response, water quality trigger levels, corrective actions, contingencies, make good measures, and responsibilities for all management measures. Implementation of these management plans will ensure that the water dams on site are managed and maintained effectively so as to not pose a health hazard.

22.7.4 Contamination of water tanks, dams, reservoirs and Sydney drinking water

Section 8.4.10 of this report in Chapter 8 (surface water) discusses in detail the potential for impacts on water quality as a result of the project.

An additional analysis was undertaken as part of the Hume Coal Project Revised Surface Water Assessment (WSP 2018, Section 5.6, refer Appendix 2) to assess potential water quality impacts associated with coal dust deposition in the Oldbury Creek and Wells Creek catchments. The analysis found that the estimated surface water runoff contaminant concentrations resulting from dust deposition are significantly lower than the mean baseline concentrations and the guideline values. The surface water quality impact associated with dust deposition in the Oldbury Creek and Wells Creek catchments is therefore considered to be insignificant and will have a neutral effect on the beneficial use of surface water in the project area.

Further, as described in Section 8.4.2, the project poses no threat in the short or long-term to the water quality of regional water supplies, including Warragamba Dam or the Sydney drinking water supply. Any releases that will occur by stormwater basins on site are predicted to be compliant with NorBE criteria. With provision of vegetated swales and constructed wetlands, runoff from access roads outside of the water management system is also predicted to be compliant with NorBE criteria. Although the overall annual loads are predicted to be reduced, potential increases in concentrations of certain components in surface water flow as a result of reduction in baseflow are not predicted to alter the beneficial use of the resource. The effects of baseflow reduction and, separately, coal dust deposition on streamflow water quality are predicted to have a neutral effect with respect to the existing beneficial use category.

22.7.5 Rejects and water contamination

As described in Chapter 10 (Section 10.2.1), the hydrogeochemical modelling undertaken for the Hume Coal Project has demonstrated that the quality of leachate from limestone-amended reject slurry (reject material mixed with water from the primary water dam) stored underground is similar to existing groundwater quality at the site (RGS 2018). Therefore, the potential for coal rejects to cause any contamination issues and potentially impact on users accessing groundwater down gradient of the proposed mine is negligible.

23 Tourism

This chapter responds to matters raised in the submissions regarding the tourism industry in the Southern Highlands, and the potential impact of the Hume Coal Project and Berrima Rail Project on this industry. The potential for co-existence of the two industries is also explored in this chapter in response to submissions on this aspect.

Judith Stubbs and Associates were commissioned to prepare a report on the potential impacts of the Hume Coal Project and Berrima Rail Project on tourism. The full technical report is included in Appendix 5, and the responses to key issues summarised in this chapter.

23.1 Value of the tourism industry to the region

A number of community submissions raised matters relating to tourism, stating that tourism is an important industry for the Southern Highlands region. Many submissions made claims about the extent of the tourism industry in the area, with some going so far as to say the region is reliant on this industry. Specific issues raised include the following:

1. Tourism employment - It was submitted by some, including WSC, that the EIS misrepresents the importance of the tourism industry to the region, and that the income from tourism would be more valuable than the mine. It was submitted that tourism is a major employer in the region, with some submissions claiming employment of 2,500 people in the region, in a variety of occupations including restaurants and cafes, accommodation, heritage and unique places of interest, shops and rural agri-tourism, such as vineyards and berry farms. Some stated that this employment is more valuable than the jobs that will be created by the Hume Coal Project. Whilst tourism is not tracked separately in the Australian Bureau of Statistics (ABS) data, it was also submitted that accommodation, food services and retailing accounts for 21% of employment in the Moss Vale – Berrima Statistical Division (2011), SA2, compared to 0.8% for mining. The conclusion is then drawn in many submissions that impacts on tourism as a result of the mine will be detrimental to the area.
2. Importance of the industry to the region – It was submitted that the EIS underestimates the extent of the tourism industry and in particular the number of accommodation facilities available. It was stated that the Southern Highlands has one of the highest levels of tourist expenditure of any non-coastal local government area in NSW. WSC also claimed that tourism is all but dismissed in the Economic Impact Assessment.

23.1.1 Tourism employment in the region

The number of tourism related jobs in the Wingecarribee LGA, as well as at the more local level of the Moss Vale – Berrima area, was investigated by Judith Stubbs and Associates to examine the value of tourism in the region.

Employment data relating to industry of employment by place of work was obtained from the latest available ABS data (the 2011 census), and places of work that are associated with tourism were identified to determine direct employment in the tourism industry. While some industries are clearly associated with tourism, such as accommodation and restaurants, there is underlying demand for these industries from the resident population and from tourists who are visiting friends and relatives for personal reasons rather than visiting an area due to tourist attractions. JSA accounted for this underlying demand in estimating the direct employment from tourism in the Wingecarribee LGA and Moss Vale-Berrima area.

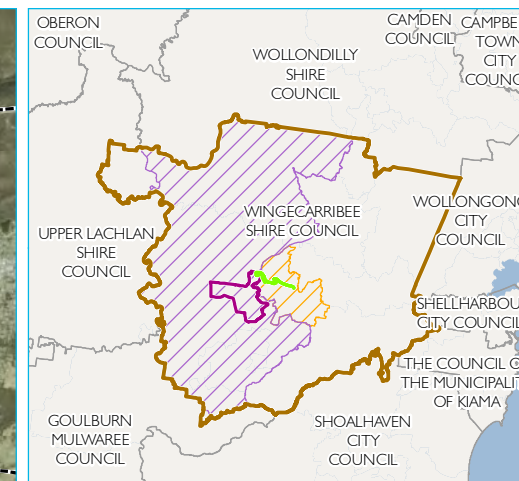
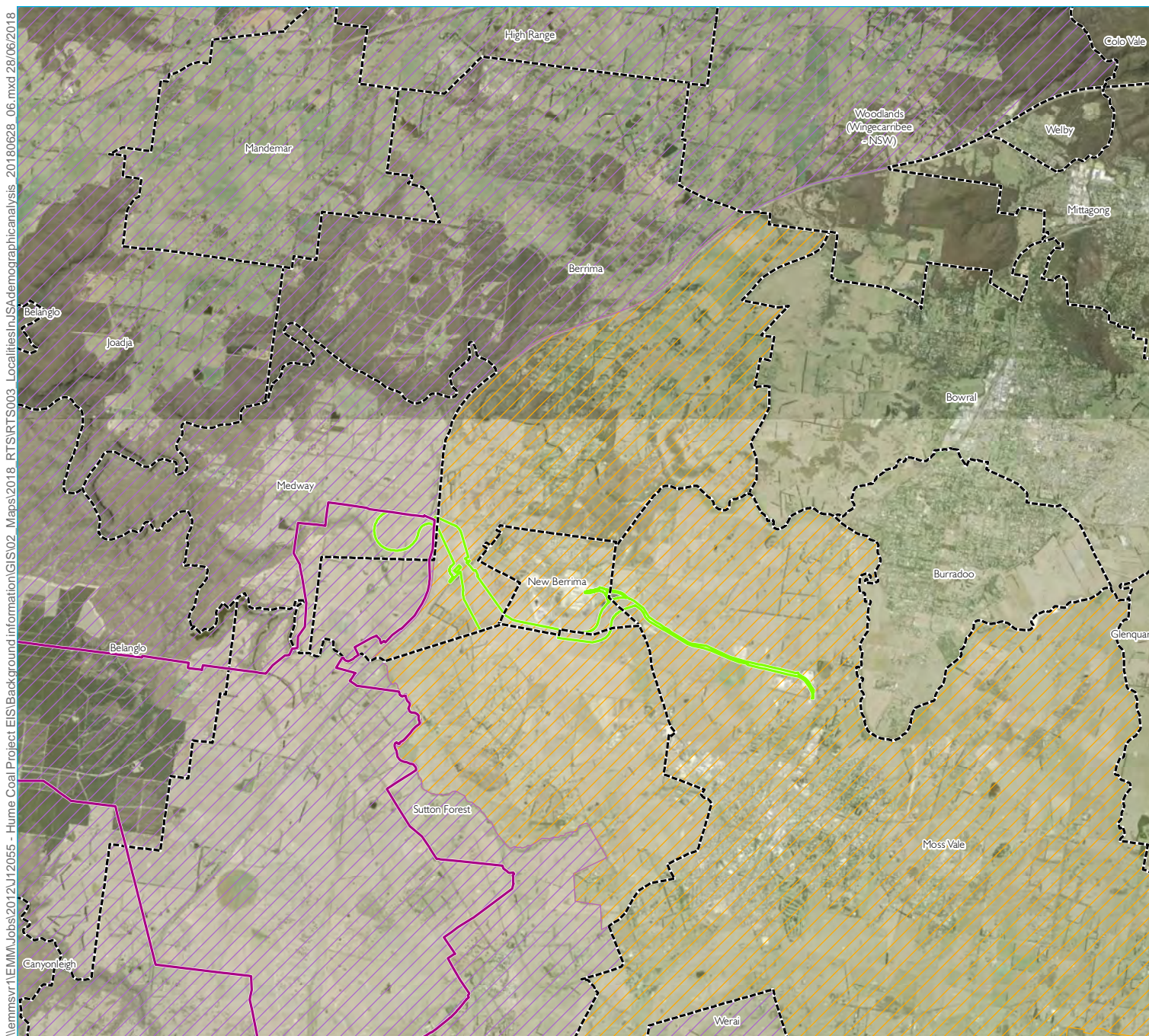
The results of the JSA analysis estimated a total of 1,510 direct tourism jobs in the Wingecarribee LGA, and 196 at a more local level (ie closer to the Hume Coal Project and Berrima Rail Project) in the Moss Vale-Berrima ABS Statistical Area Level 2 (SA2). The area covered by the Wingecarribee LGA and the Moss Vale-Berrima SA2 level is shown in Figure 23.1.

By comparison, the Hume Coal Project is expected to provide 300 full time equivalent jobs. These mining jobs are likely to be of higher value, with median individual weekly income in coal mining more than \$2,000 per week compared to \$400-\$599 in tourism industries (JSA 2017a). While the mining jobs are of shorter duration than tourism jobs with an expected life of 19 years, this is offset by the greater value of these jobs. The net present value of a mining job over 19 years is \$1.1 million compared to a net present value of a tourism job over 60 years of \$0.4 million, noting that the 60 years for tourism jobs recognises that these jobs are likely to continue well into the future. The assertion therefore that the value of tourism jobs would be greater than the jobs to be created by the Hume Coal Project is not consistent with the data available on employment, and the value of this employment, in the region.

Another important point is that the job types in the tourism industry generally differ markedly from the mining industry. ABS data on employment shows there are much higher proportions of professionals, technicians and trades workers, and machinery operators and drivers in the coal industry, with higher proportions of managers, community and personal service workers, sales workers, and labourers in the tourism industry (JSA 2017a). The different skill sets targeted by the two industries means that they would not be expected to compete with each other for labour.

JSA also note that the increase in income related to an increase in mining jobs is expected to support both the food and accommodation service industries in the Moss Vale-Berrima SA2, with relatively high disposable income enabling increased consumption of dining out and take away meals, and the need for casual accommodation during the week for mining contractors and workers not resident in the Southern Highlands. The net effect would again be expected to be positive for local accommodation and food services, including in localities closest to the mine.

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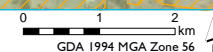
- KEY**
- Berrima Rail Project area
 - Hume Coal Project area
 - Wingecarribee Shire Council local government area
 - Local Government Area (in inset)
 - State suburb (SSC 2016) boundary
 - Statistical area 2 (SA2) boundary (2016)
 - Moss Vale - Berrima
 - Southern Highlands

Localities used in the JSA
demographic analysis, including
Moss Vale - Berrima SA2

Hume Coal Project and Berrima Rail Project
Response to submissions
Figure 23.1



Source: EMM (2018); DFSI (2017); Hume Coal (2017); ABS (2016)



23.1.2 Predominant industries in the Wingecarribee LGA

The major industries in the Wingecarribee LGA were also investigated by JSA by looking at the ABS employment data in the Southern Highlands Statistical Area 3 (SA3), which roughly equates to the LGA boundary. The ABS data shows that, in addition to tourism, the significant employers in the Southern Highlands are in the areas of retail, health care and social assistance, manufacturing, accommodation and food services, and education and training, with each of these industries equivalent in size or somewhat larger than tourism. The data suggests a mixed economy, rather than an economy dominated by tourism, although noting that tourism is an important employer in the Southern Highlands. The ten industries with the highest employment in the Southern Highlands (based on one digit ABS data)⁴⁶ are listed below, with the number of people employed in brackets.

- Retail Trade (2,216)
- Health Care and Social Assistance (2,082)
- Manufacturing (1,805)
- Accommodation and Food Services (1,591)
- Tourism (1,510)
- Education and Training (1,417)
- Construction (983)
- Professional, Scientific and Technical Services (971)
- Other Services (636)
- Agriculture, Forestry and Fishing (626)
- Public Administration and Safety (534)

Figure 23.2 shows the proportion of employment at the one digit employment data level in the Wingecarribee LGA compared to NSW. As shown, Wingecarribee has much higher levels of employment compared to NSW in agriculture, forestry and fishing (76% higher); accommodation and food services (49% higher); manufacturing (36% higher); retail trade (34% higher); rental, hiring and real estate services (31% higher); health care and social assistance (11% higher); education and training (11% higher); and other services (7% higher).

⁴⁶ The ABS uses the *Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006* to classify industries. As the number of digits increases, the fineness of detail also increases. The one digit classification represents the overarching, broad categories industries are divided into (of which there are 19). These 19 categories are then further subdivided into more specific categories at the 2, 3 and 4 digit level. For example at the one digit level there are 19 classifications, whereas at the four digit level these are further subdivided into 715 categories.

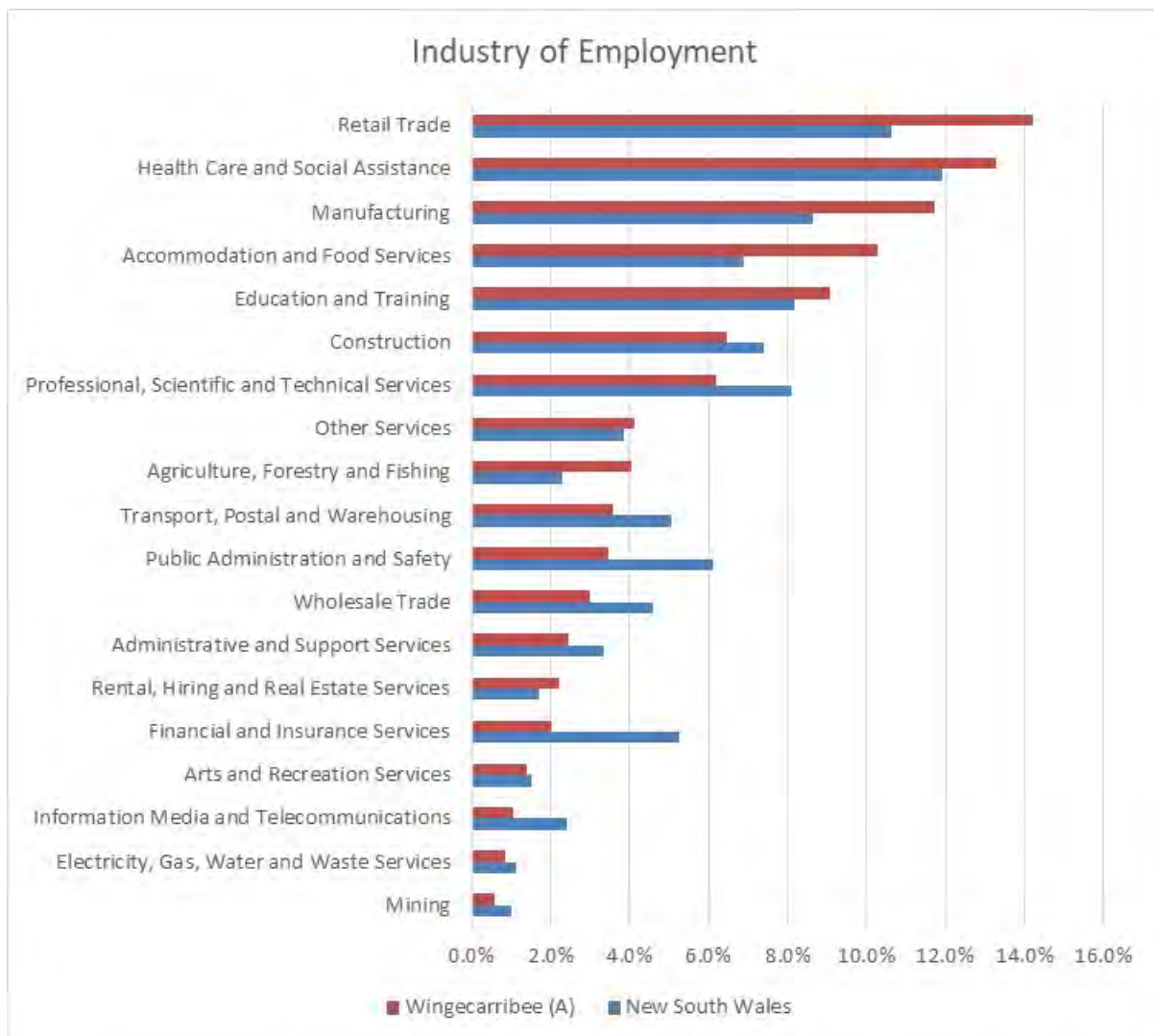


Figure 23.2 Industry of employment by proportion of workforce, Wingecarribee LGA and NSW

The evidence of a diverse economy in the Wingecarribee LGA therefore does not support the assertion raised in the submissions that the region is reliant on tourism.

An associated issue is whether significant impacts are anticipated to occur in relation to existing tourism uses and employment in the locality from the Hume Coal Project and Berrima Rail Project. This is discussed in the response in Section 23.2.3.

The claim by WSC that the EIS dismisses the tourism industry from the economic assessment is responded to in the economics chapter of this RTS report (refer to Chapter 20). In summary, the characterisation of the local economy and the estimate of flow-on benefits were undertaken in the economic assessment in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW Government 2015b). The social impact assessment prepared for the EIS also characterised and considered the local economy of the Southern Highlands (as detailed in Chapter 4 of the SIA (EMM 2017h)).

With regards to the disagreement over the number of tourist facilities quoted in the EIS and in the submissions, it is acknowledged that the number of tourist facilities in a particular region varies depending on the source used. As pointed out in the JSA (2017a) report, the number of tourist facilities listed on Destination NSW is different to that on Trip Advisor or in the Yellow Pages. The Hume Coal Project EIS and accompanying Social Impact Assessment report (EMM 2017h) used the data published by Destination NSW, which is the lead government agency for the NSW tourism and major events sector, established under the *Destination NSW Act 2011*. The references for the data sourced from Destination NSW are provided below (as listed in the reference list of the Hume Coal Project Social Impact Assessment):

- Destination NSW 2015a, LGA Accommodation Profiles, viewed 4 April 2016, www.destinationnsw.com.au/tourism/facts-and-figures/local-area-profiles.
- 2015b, Regional Tourism Statistics, viewed 18/04/2016, www.destinationnsw.com.au/tourism/facts-and-figures/regional-tourism-statistics.

Notwithstanding, the JSA (2017a) investigation into the current status and value of tourism in the Southern Highlands region used employment data rather than the number of accommodation facilities to provide a robust and objective assessment of the tourism industry.

23.2 Co-existence of the coal industry and tourism

Concerns were raised in community and special interest group submissions that the development and operation of the Hume Coal mine will have a negative impact on tourism. Many submissions from the community, special interest groups and businesses claim that the presence of the mine would lead to a reduction in tourists visiting the region, and that this in-turn would significantly impact on the industry and many local businesses. It is therefore claimed that the two industries; mining and tourism, cannot co-exist.

Potential dust and noise impacts are two of the main reasons for concern about the impact on tourism. Visual amenity, and in particular the potential view of the mine from Hume Highway, was also raised as a possible detractor to tourists visiting the region. Others submit that an increased demand on housing will also affect the tourism industry.

The potential negative impact on tourism in Berrima as a result of the Hume Coal Project and the Berrima Rail Project was specifically raised in numerous community and special interest group submissions. Many of the respondents are concerned that the tourism industry will suffer in Berrima particularly as a result of air quality, as well as noise and visual impacts. It was also submitted that the proposed mine is not compatible with the 'cultural heritage' tourism in Berrima. WSC raised the concern that the importance of Berrima to the tourism industry has been largely overlooked in the EIS.

To answer the questions and concerns raised about a coal mine and tourism co-existing in the region, JSA looked at a number of aspects; the existence of industrial land uses in the region, the proximity of tourism related businesses in the locality to these existing industrial land uses and the Hume Coal Project, the statistical relationship of coal mining with tourism across NSW, and the predicted impacts of the Hume Coal Project on aspects relevant to tourism such as air quality, noise and vibration, visual amenity and the heritage. The findings of each of these are summarised below.

23.2.1 Existing industrial land uses in the region

The Wingecarribee LGA has a relatively diverse economy, as explored in the response above in Section 23.1.2. It has above average employment in accommodation and food services that are strongly associated with tourism. The region has long been associated with tourism-related activities such as accommodation, restaurants, specialty retail, sightseeing and outdoor recreational activities. The region also has higher than average employment in manufacturing and related industries, associated with the locality's existing density of, and long association with, industrial uses, and the historical identification of this part of the Southern Highlands with heavier industrial uses including the Berrima Cement Works, Berrima Colliery (which ceased operation in 2013) and major transport infrastructure such as the Hume Motorway and the Main Southern Rail Line.

Although the higher than average employment in accommodation, food services and retail may be expected from an attractive area on the 'Sydney drive route', the above average performance in manufacturing, which is a larger employer than the hospitality sector in the Wingecarribee LGA, is not generally characteristic of regional economies.

The Wingecarribee LGA's strong ability to attract manufacturing-related industries, and the subsequent concentration of employment in manufacturing in the LGA, is likely due to a range of factors including the strategic location of the Wingecarribee LGA within the Sydney-Canberra-Melbourne transport corridor, the relatively low cost of industrial land compared with Sydney, and the proactive policies of WSC; both historically and as expressed in its *Economic Development Strategic Plan 2008-2016*.

However, land zoned for industrial land uses is not evenly distributed across the LGA, but rather disproportionately clustered in the Moss Vale-Berrima locality, as shown on Figure 23.3. This is largely due to the establishment of the Moss Vale Enterprise Zone by the council, and the strategic decisions of relevant industries. Excellent access to the Hume Motorway and the Main Southern Rail Line from Sydney to Melbourne, including freight and passenger services, is also a likely reason for the concentration of industrial uses. This is likely to expand in the future, including on vacant industrial zoned land in the immediate locality of New Berrima and Berrima as part of the Moss Vale Enterprise Zone.

WSC's report *Economic Development Strategic Plan 2008-2016* describes the Enterprise Zone as the major location for future industrial development in the Shire. Future related opportunities include the establishment of an intermodal and logistics hub akin to an 'inland port', and major expansion of related industrial uses including manufacturing, transport and warehousing on undeveloped areas of the Enterprise Zone. As shown on Figure 23.3, the Moss Vale Enterprise Zone is in close proximity to the Hume Coal Project Area, whilst a large portion of the Berrima Rail Project area crosses the zone.

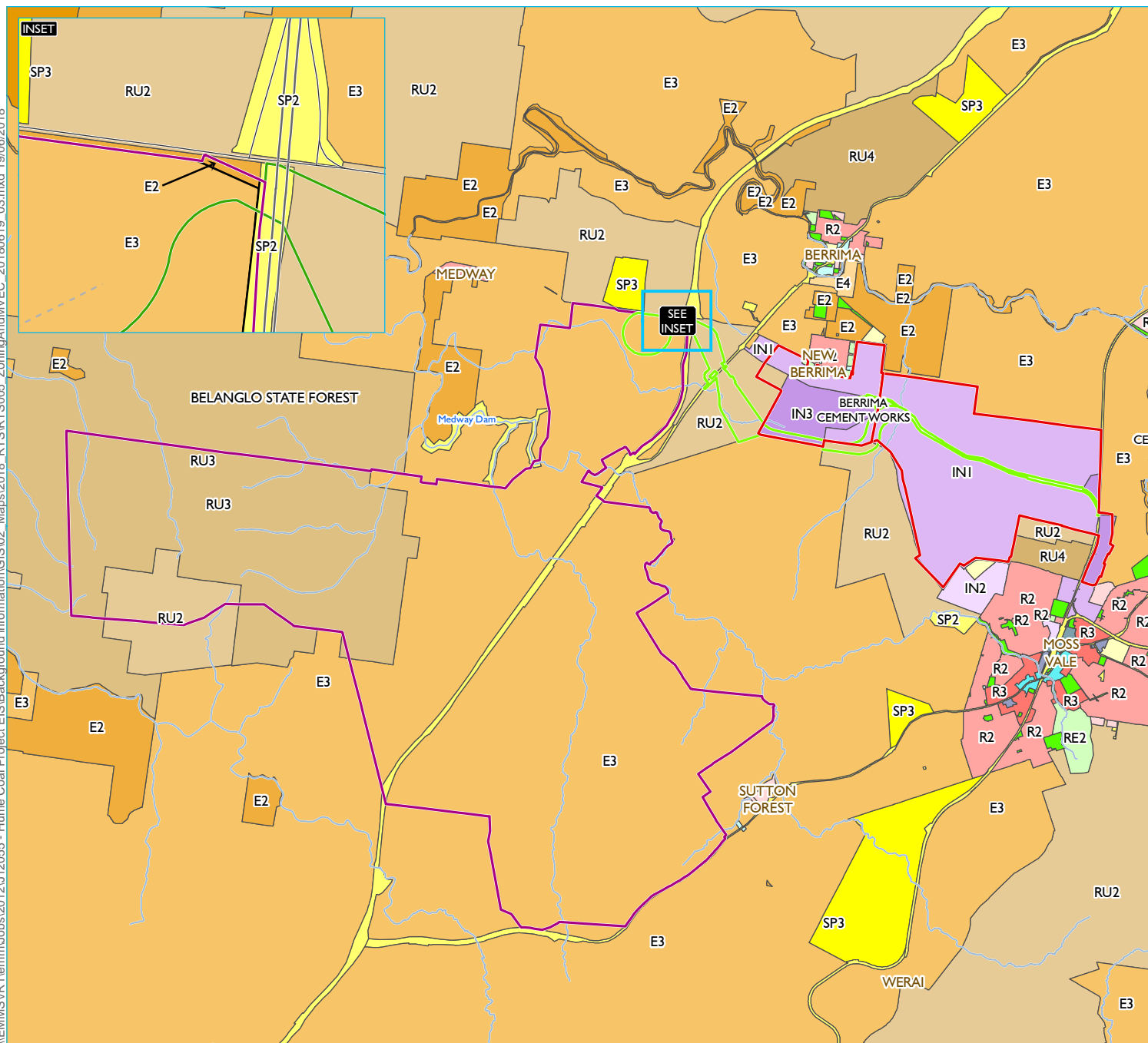
Notably, whilst the Moss Vale-Berrima area contains around 20% of the Wingecarribee LGA's population, it has around 52% of the LGA's manufacturing jobs and 15% of its accommodation and food service jobs.

As expected with the high rate of manufacturing employment in the Moss Vale-Berrima area, a wide range of industrial facilities currently operate in the region. Within industrial zoned land proximate to Moss Vale town centre, industrial facilities include Joy Mining, Dunsteel, Omya and the Moss Vale Recycled Building Centre. Other industrial uses are located along Douglas Avenue and Berrima Road moving west from Moss Vale toward Berrima, and include Dux Hot Water, Cromford pipe manufacturers, the Resource Recovery Centre, the Southern Rural Livestock Saleyards and Ingham's Feed Mill. These are generally quite visually prominent from Berrima Road and/or Douglas Avenue. Immediately to the south of New Berrima on Taylor Avenue is Boral's Berrima Cement Works, which is located on land zoned IN3 Heavy Industrial. JSA (2017a) notes that the cement works are a prominent feature visible within the Berrima locality, including from Berrima Road and a range of surrounding rural properties, as is also explained in the Hume Coal Project EIS (EMM 2017a). For example, the No. 6 Kiln Stack and Cooler are 85 m and 37 m high, respectively (Air Quality Professionals 2015). Notably, Boral's Berrima Cement Works are around 140 ha in size, which is around 20% larger than the surface area of the proposed Hume Coal surface infrastructure area.

In addition, a development application has recently been lodged with Wingecarribee Shire Council by Austral Masonry (NSW) Pty Ltd for a proposed masonry plant at 416 Berrima Road, Moss Vale, directly east of the Berrima Cement Works. If approved, the plant will have a 220,000 tpa capacity and will operate 24 hours a day, seven days per week, with up to 115 trucks accessing the site per day.

Up until October 2013, the Berrima Cement Works was supplied coal for the manufacturing of cement from its own Colliery, the Berrima (Medway) Coal Mine. The coal mine had been in operation for more than 90 years and provided up to 220,000 tonnes of coal a year to satisfy production needs. Coal is now purchased and transported in from other producers.

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KEY

- Hume Coal Project area
- Berrima Rail Project area
- Moss Vale Enterprise Corridor
- Drainage line

Land use zone

- B1 Neighbourhood Centre
- B2 Local Centre
- B4 Mixed Use
- B5 Business Development
- E1 National Parks and Nature Reserves
- E2 Environmental Conservation
- E3 Environmental Management
- E4 Environmental Living
- IN1 General Industrial
- IN2 Light Industrial
- IN3 Heavy Industrial
- R2 Low Density Residential
- R3 Medium Density Residential
- R5 Large Lot Residential
- RE1 Public Recreation
- RE2 Private Recreation
- RU2 Rural Landscape
- RU3 Forestry
- RU4 Rural Small Holdings
- SP1 Special Activities
- SP2 Infrastructure
- SP3 Tourist

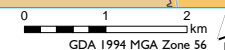
Zoning and industrial land in the Wingecarribee LGA

Hume Coal Project and Berrima Rail Project
Response to submissions

Figure 23.3



Source: EMM (2018); DFSI (2017); DPE (2017); Hume Coal (2017);



23.2.2 Tourism businesses in the region

There are a wide range of tourism-related businesses in the Moss Vale-Berrima locality and more broadly in the Wingecarribee LGA. These are of varying physical relationship and proximity to existing industrial uses and industrial zoned land. A review of employment data in sectors related to tourism indicates that there are four main urban centres where tourist activity is more prominent; Berrima, Sutton Forest, Moss Vale and Bowral, with Bowral containing by far the highest density of tourism related jobs.

Of the localities most associated with tourism, Berrima is the most proximate to the Hume Coal Project (at around 4 km from the edge of B1 zoned land in Berrima and around 5 kms from the town centre), and the centre most likely to experience negative impacts on tourist uses and tourist-related employment. Berrima is recognised as one of the best preserved examples of a Georgian village in Australia.

Registered accommodation services tend to be clustered within or close to the towns of Berrima, Moss Vale and Sutton Forrest, and along the Old Hume Highway, the Illawarra Highway and Argyle/Moss Vale Road. There are no accommodation businesses proximate to or visible from the proposed Hume Coal Project surface infrastructure area, with the closest publicised accommodation service around 5 km away within the cluster of accommodation in Berrima, and Highfield Cottage in Sutton Forest around 7 km away. There is no relationship between these closest services and the proposed Hume Coal mine, being separated from the mine by distance, favourable topography, and the Hume Motorway.

Notably, existing accommodation services tend to be more proximate to and/or have a greater physical relationship to industrial uses elsewhere in the locality.

There is also generally no physical relationship between the Hume Coal Project surface infrastructure area and food services, with a tendency for them to be more proximate to existing industrial uses and zoned areas. There are two notable exceptions to this; the Zen Oasis Vegetarian Restaurant, which is around 1 km from the proposed surface infrastructure area, and the Briars Historic Inn, which is around 1.5 km from larger industrial uses such as Dux Hot Water to the North of Moss Vale.

As such, it is likely that the Zen Oasis Restaurant would be one tourism related land use that may be affected due to proximity and topography; a point noted in the EIS and discussed further below in Section 23.2.3. Accordingly, a number of mitigation measures are proposed to mitigate the predicted residual impacts. Tree screens have already been planted along the project area boundary parallel to Medway Road, which will provide partial screening of project related infrastructure. In relation to noise, consistent with the VLAMP (NSW Government 2014), mitigation measures may include mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal amenity, upgraded facade elements like windows, doors, roof insulation etc. to further increase the ability of the building to reduce noise levels.

It is also noted in the JSA (2017a) report that car travel routes to many of the tourist facilities in the Moss Vale-Berrima area already take the resident and visitor past a range of industrial uses, as well as Industrial zoned land which will be subject to future development, depending on which route is taken, and the order of visiting different tourist uses and attractors. Past impacts, including significantly greater general and heavy vehicle movement prior to the bypassing of Berrima, and the more recent closure of Berrima Colliery, have been significant compared with the use of trains to freight coal under the current Hume Coal Project proposal. Perceptual associations with a coal mine have also been a feature of the immediate locality until Berrima Colliery's closure in 2013.

Moreover, industrial uses and activities have co-existed with tourism uses and activities historically, and are not incompatible now from the employment data and research undertaken in the preparation of the JSA report. This raises a further question as to whether there will be significantly greater and unique amenity impacts from the mine that have not been experienced in relation to current and past industrial uses, or to those that would be expected from future industrial expansion in the immediate locality of New Berrima-Berrima. This is addressed in the JSA report and summarised below.

23.2.3 Predicted impacts of the mine that may affect tourism

As noted above, the mine is less proximate to a number of sensitive receivers, including residential properties and roads, than existing industrial land uses, some of which are more visible, more concentrated and arguably more prominent as land uses than the proposed Hume Coal Project. Notably, the large area proximate to New Berrima and Berrima is zoned for General Industrial use and prioritised for future industrial expansion as part of the Moss Vale Enterprise Zone.

For the Hume Coal Project and Berrima Rail Project to have a significant impact on tourism, the impacts of these projects, and specifically visual and other amenity impacts, would need to be significantly greater than existing industrial uses.

i Visual amenity

In relation to visual amenity, some changes in view will be experienced by cars travelling along Medway Road west of the Hume Motorway towards Medway Village, and by residents living along Medway Road, also west of the Hume Motorway. The visual impact assessment found that with the planting of trees along Medway Road as a visual barrier, the impact to these receivers will be moderate to low. Intermittent views to the surface infrastructure will be possible by cars travelling along the Hume Motorway in the region of the Medway Road overbridge; in particular of the stockpiles, overland conveyor system and coal loading facility. These views will be experienced in the context of the Hume Motorway and the associated Medway Road interchange, itself a significant man made visual impact on the landscape. Importantly, visual impacts associated with the mine will not be experienced by southbound traffic (coming from Sydney) exiting the Hume Motorway for Berrima. Some views of the rail line will be experienced at the intersection with Medway Road and the Hume Motorway south bound off ramp; however this was assessed by the visual assessment (EMM 2017g) as a moderate to low impact views, with this impact reducing to low as trees already planted continue to grow and become more effective at screening.

JSA (2017a) concludes that it seems unlikely these visual impacts will adversely affect tourism industries given the spatial separation from tourist uses in the locality (with the exception of the Zen Oasis Vegetarian Restaurant); the generally transient experience of visual impacts by visitors to the locality; the context of the visual impacts in an area with significant man made industrial elements including the Hume Motorway and cement works; and the continued existence of tourism uses in the locality despite the existing visual impacts associated with industrial uses such as the Berrima Cement Works, the Hume Motorway and the Main Southern Railway.

In relation to the township of Berrima, none of the proposed works will be visible from the town due to intervening topography. With regards to lighting, it is noted that there is existing light pollution from the Boral Cement Works, about 2 km from Berrima. By comparison, the mine works are about 4 km from Berrima, and so could be expected to have a lesser impact than that of the cement works, which operates 24 hours per day, seven days per week. In addition, measures will be implemented at the Hume Coal mine to limit offsite impacts related to lighting. Lighting will be designed and operated with consideration of the principles in Australia Standard 4282 (AS4282) *Control of Obtrusive Effects of Outdoor Lighting*. Lighting protocols to be adopted will include setting up of mobile lighting plant so that lighting is directed away from external private receptors, lighting sources will be directed below the horizontal to minimise potential light spill, and screening of lighting will occur where possible for viewers internal and external to the project.

ii Air quality

As described in the EIS and in Chapter 15 of this RTS report, the construction and operation of the mine will result in emissions well below applicable impact assessment criteria at neighbouring sensitive receptors. The predicted incremental air quality emissions from the Berrima Rail Project are all predicted to be well below the applicable air quality criteria at all receptors.

A range of best practice mitigations are proposed at the mine operations, including the transport of coal in covered wagons. As such, amenity and tourism related impacts as a result of emissions to air arising are likely to be negligible.

iii Noise

In relation to noise, 12 identified sensitive receivers are predicted to experience noise above the relevant criteria; 11 as a result of the Hume Coal Project and one as a result of the Berrima Rail Project. Three properties are also predicted to experience exceedances of the sleep disturbance criterion, with this impact arising from train movements on the rail loop at night.

All of these receivers except one, the Zen Oasis Restaurant, are residential properties and not related to the tourism industry. As discussed above, tourism related properties and facilities are generally remote from the mine site. Under the worst case adverse weather conditions, Zen Oasis is predicted to experience a moderate noise impact of 3 to 5 dB above the relevant noise criteria, and will therefore be entitled to mitigation measures so that that this impact is mitigated to an acceptable level. The potential impacts to patrons of Zen Oasis, understood to largely be during the daytime, will be somewhat masked by the relatively higher ambient noise levels during the day from existing sources such as the Hume Highway traffic noise. For example, predicted project site related noise for this location (15) is up to 40 dB $L_{Aeq,15min}$ during adverse weather, whilst existing L_{Aeq} noise levels are reported to be in excess of 46 dB (as described Table 2.1 of the Hume Coal Project Noise Impact Assessment (EMM 2017I)).

Importantly, it is noted that the Zen Oasis is a commercial premises. However, as a conservative approach the noise assessment results described above are with reference to the EPA noise criteria that apply to *residential* properties.

iv Heritage

With respect to European heritage, 17 heritage items have been identified within the Hume Coal Project area and nine are listed within the Berrima Rail Project area. Of these items, the mine is expected to have a moderate impact on Mereworth House and Garden due to its location adjacent to the surface infrastructure area, and a low to moderate visual impact on the Exeter Sutton Forest Landscape. Importantly, Mereworth House and Garden is owned by Hume Coal, and so this potential impact will not have any influence on tourism in the area. The rail works are expected to impact on views and vistas from Mereworth House and Garden and the Sorensen garden at the cement works depending on the route option, and on the former Berrima rail corridor. The remaining heritage items will not be affected, primarily due to the lack of subsidence associated with the mine.

Importantly, no physical impacts are predicted on heritage items associated with key tourism areas such as the towns of Berrima, Sutton Forest and Burradoo, which are the main tourism destination centres in the locality. Visual impacts on tourism are discussed above.

23.2.4 The relationship of coal mining and tourism across NSW

To answer the question as to whether coal mining and tourism can co-exist, JSA (2017a) investigated the statistical relationship between mining and tourism employment across NSW and Australia. This enabled an objective and statistically robust assessment to be made.

JSA reported that at a national scale, there is little evidence that the presence of coal mining is related to either increases or decreases in employment in tourism industries. Using a cross-sectional data set for all LGAs in Australia, the analysis conducted by JSA predicts that each three coal mining jobs result in one additional tourism job per 100,000 population. However, this result is not statistically significant at the 95% confidence level, and therefore JSA conclude that at the LGA scale, there is no discernible relationship between coal mining and employment in tourism, either positive or negative.

To investigate this further, JSA compiled a data set for all LGAs in Australia in 2011 comparing coal mining employment (as a proxy for the intensity of coal mining within an LGA) with tourism industries per 100,000 of usual resident population. The results of the analysis by JSA show an increase in tourist employment with an increase in coal mining employment. This increase likely reflects the higher wages in coal mining leading to increased purchasing power in the region. However, the result is not statistically significant and the best conclusion is again, at the LGA scale, that there is no discernible relationship between coal mining and employment in tourism, either positive or negative.

Notwithstanding, a number of NSW LGAs with active coal mining (open cuts and underground) have significant employment in tourism industries, suggesting that the two uses are not incompatible. This includes the Hunter Valley region, Lake Macquarie, Wollongong and Lithgow.

Table 23.1 shows NSW LGAs with active coal mining, along with JSA's estimated tourism employment. The data does not support the hypothesis that tourism and coal mining are incompatible, when assessed at the LGA scale.

Table 23.1 LGAs with active coal mining and estimated tourism employment

LGA	Coal mining employment	Tourism employment
Singleton	4773	209
Muswellbrook	2408	291
Wollongong	1480	2178
Lake Macquarie	1284	589
Wollondilly	1219	-1671 ¹
Mid-Western Regional	1186	431
Lithgow	1048	97
Cessnock	518	886
Narrabri	261	52
Gunnedah	169	112
Liverpool Plains	96	-156
Gloucester	85	42
Great Lakes	32	827

Source: ABS Census 2011, MinView (NSW Planning and Environment) and JSA analysis.

Note: 1. Negative number means that fewer people are employed in the LGA than would be expected based on NSW averages.

JSA compiled a data set for employment in the active coal mining LGAs listed in Table 23.1 in the categories of retail trade, accommodation and food services (being industries linked to tourism), and coal mining for the years 2001, 2006 and 2011. The data was analysed to determine the change in coal employment and the percentage change in employment in retail trade and accommodation and food services for the periods 2001-2006 and 2006-2011.

The analysis showed a 0.7% reduction in employment in retail trade and a 0.3% increase in employment in accommodation and food services for each additional 100 people employed in coal mining at the LGA level. It is noted that once again, there is considerable variation in the data, and neither coefficient is statistically significant as different to zero at the 95% level of confidence.

Looking at the region relevant to the Hume Coal Project, according to 2011 ABS data in 2011 there were 2,240 jobs in retail trade and 1,616 jobs in accommodation and food services in the Wingecarribee LGA (ABS Census 2011). Based on the expected 300 coal mining jobs from the Hume Coal Project and the results of the analysis above across active coal mining LGAs in NSW, a loss of 50 jobs in retail trade is predicted, with a gain of 16 jobs in accommodation and food services. The net gain in full time equivalent jobs is calculated at 277, noting that the jobs lost will be of lower value than the coal mining jobs gained.

In addition to the above analysis, JSA used a case study approach to investigate an area where coal mining and tourism currently co-exists. To identify a suitable case study location, all operational mines in the Hunter Valley and the Lithgow/Mudgee area were mapped, along with mapping of accommodation and restaurants using data from Trip Advisor. Tourist facilities were taken from Destination NSW, noting that other sources, such as the Yellow Pages and Trip Advisor show different numbers of tourist facilities.

Two locations were identified where an area with a cluster of tourism facilities was in close proximity to active coal mining; Muswellbrook and Broke. The table below shows comparative data for the three locations for selected indicators.

Table 23.2 Tourism case study areas – Comparison of selected variables

Indicator	Berrima	Broke	Muswellbrook
Population	600	579	12,075
Distance to Sydney	125 km (1 hour 38 minutes)	168 km (2 hours 23 minutes)	253 km (3 hours 1 minute)
Distance to nearest coal mine above ground workings	4.2 km	6.3 km	5.0 km
Accommodation facilities	7	26	5
Restaurants	7	3	1
Food and Drink	3	6	0
Tours	0	1	0
Attractions	6	0	7
Nearest Mine	Hume Coal (underground)	Glencore Bulga Underground and Bulga Open Cut	Muswellbrook Coal (There are two other mines within 8 km of Muswellbrook)
Production	3.5 Mtpa ROM	16 Mtpa ROM	2 Mtpa

Of the two locations, Broke is most similar to Berrima in that it is a small town with a destination tourism sector. By contrast, Muswellbrook is much larger and the tourism industry there appears to be as a result of its location on the New England Highway with accommodation catering to passing traffic. Accommodation in Broke and surrounds comprises farm stays, holiday houses and the like. Broke provides destination tourism based on the rural landscape and proximity to wineries. It is a rural area with an active tourism industry located within around 6 km of large scale underground and open cut coal mining. However, it is somewhat further from Sydney and so perhaps less attractive to day visitors. In August 2017, Broke had 26 accommodation facilities, three restaurants and six facilities offering food and drink, providing further evidence that tourism and coal mining are compatible.

JSA's review of Broke does not support the view that coal mining and tourism are incompatible. Coal mining does not appear to have had an adverse impact on tourism in Broke. Based on a search on Trip Advisor on 16 August 2017, around half of the accommodation was booked for the upcoming weekend, and the median number of days booked between 17 August and 30 September (a period of 44 days), was 11 days. Accommodation was generally expensive with a median daily rental of \$449 compared to motel accommodation in nearby areas such as Cessnock (\$105-\$140 per night).

23.3 Agricultural tourism

DPI-Agriculture submitted that the EIS does not sufficiently address the potential impacts on agricultural-related tourism infrastructure, including visual amenity related impacts. Some community submissions also raised concerns over the potential impact on agriculture related tourism in the region.

The review of employment data in sectors related to tourism by JSA (2017a) indicates that there are four main urban centres where tourist activity is more prominent in the Southern Highlands; Berrima, Sutton Forest, Moss Vale and Bowral. Of these, Bowral has by far the greatest density of tourism related jobs. Notably Bowral is remote from the Hume Coal Project, over 10 km from the surface infrastructure area.

Notwithstanding, there are a number of agricultural related tourism business in the area, and in particular wineries. As described in the Agricultural Impact Statement (EMM 2017k) prepared for Hume Coal Project, cultivation for grapes is the most common cropping enterprise in the Wingecarribee LGA, accounting for 214 ha or 35% of the area under cultivation. The Southern Highlands was declared an official wine region in 1999 and viticulture enterprises produce a range of cool climate wines. The nearest wineries to the Hume Coal surface infrastructure area are Cherry Tree Hill Wines (approximately 5 km from the surface infrastructure area), Eling Forest (approximately 7 km away), Sutton Forest Estate Wines (approximately 12 km away) and Southern Highlands Winery (also approximately 7 km away).

Horticulture has also seen specialist crops such as berries, mushrooms, fruits, truffles, lavender and olives planted catering for boutique food markets. Fruit and berry orchards occur on 111 ha of land, on 27 different farms, accounting for 18% of land under cultivation. A new market is opening for the production of cider, preserves and other foodstuffs. Whilst these horticultural businesses are not necessarily related to tourism, some may have a shop front open to the public.

As already shown in this chapter, significant impacts on tourism are not predicted as a result of the Hume Coal Project and Berrima Rail Project, and this conclusion extends to these agricultural related tourism businesses. These businesses are remote from the surface infrastructure area and visual or other amenity impacts are not predicted. Any potentially impacted privately-owned bores relied upon by these business will have appropriate make good measures applied to ensure there is no impact to water supply. JSA (2017a) concludes that there is no evidence the presence of a coal mine is related to increases or decreases in tourism industries.

