UNITED WAMBO OPEN CUT COAL MINE PROJECT

March 2017

RESPONSE TO SUBMISSIONS
PART A

GLENCORE

Peabody ENERGY

umwelt

UNITED WAMBO OPEN CUT COAL MINE PROJECT

Response to Submissions - Part A

FINAL

Prepared by
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on behalf of
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Executive Summary

The Environmental Impact Statement (EIS) for United Wambo Open Cut Coal Mine Project (the Project) was placed on public exhibition from 11 August 2016 to 22 September 2016. This report provides a response to the submissions made on the Project.

Under a Joint Venture arrangement, United Collieries Pty Limited (United) and Wambo Coal Pty Limited (Wambo) propose to develop the Project which will involve combining the existing open cut operations at Wambo with a proposed new open cut coal mine at United. The Project has been designed to optimise future open cut coal mining operations across these two adjoining mining areas, maximising coal recovery and the efficient use of Wambo's existing mining infrastructure, while providing the operational flexibility required to actively manage the mine to minimise environmental impacts.

During the public exhibition period 101 submissions were made on the Project. This included 13 government agency submissions and 88 community and interest group submissions. The 88 submissions received from the community and interest groups included 3 submissions in support of the Project.

The EIS also assessed two associated applications to modify Wambo's existing development consents to harmonise them with the Project and of the 101 submissions, 13 submissions related to these modification applications (11 community and two from the Environment Protection Authority).

A total of 76 submissions were received from community members. Of these, 71 (93 per cent) were objections, three (4 per cent) were in support and two (3 per cent) provided comments. In addition, 11 of these submissions related to the harmonisation modifications.

Analysis of the 71 objecting community submissions was undertaken and the top five concerns were the ecological impacts of the Project (54 per cent), noise impacts (49 per cent), validity of economic benefits and assessment (34 per cent), air quality concerns (33 per cent) and final voids (33 per cent).

With regard to those submissions that were supportive of the Project, these centred on the economic benefits of the Project, particularly with regard to job security and positive economic impacts at a local, State and national level.

Part A of the Response to Submissions (this report) provides clarification and additional information in relation to the key issues raised in the submissions from the community, community groups and NSW Government agencies and Singleton Council excluding matters relating to biodiversity. Part B will respond to specific issues raised by the Commonwealth's Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) and matters relating to biodiversity. These issues were subject to ongoing consultation at the time of preparation of Report A.

In response to the submissions on the Project and the outcomes of ongoing stakeholder consultation, the Joint Venture has refined aspects of the Project and made additional mitigation and management commitments. The key updates include:

- changes to the design of the proposed final voids to reduce potential for impacts from the voids into the future and to improve the appearance of the voids
- additional battering of the upper benches of the United Open Cut will also be implemented as part of the closure process to improve the visual amenity of the void and reduce highwall height
- a reduction in the proposed additional disturbance area for the Project by approximately 37 hectares (including avoiding approximately 19.2 hectares of Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered Ecological Community)
- additional mitigation and management commitments including measures related to air quality, final voids, rehabilitation and measures to manage interactions with the Hunter Valley Gliding Club. There have also been refinements made to groundwater and heritage commitments.

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1.0 Introduction

The Environmental Impact Statement (EIS) for the United Wambo Open Cut Coal Mine Project (the Project) was placed on public exhibition from 11 August 2016 to 22 September 2016. This Response to Submissions (RTS) has been prepared to address the key issues raised in the submissions received during the public exhibition period.

Under a Joint Venture arrangement, United Collieries Pty Limited (United) and Wambo Coal Pty Limited (Wambo) propose to develop the Project which will involve combining the existing open cut operations at Wambo with a proposed new open cut coal mine at United. The Project has been designed to optimise future open cut coal mining operations across these two adjoining mining areas, maximising coal recovery and the efficient use of Wambo's existing mining infrastructure, while providing the operational flexibility required to actively manage the mine to minimise environmental impacts.

During the public exhibition period 101 submissions were made on the Project. This included 13 government agency submissions and 88 community and interest group submissions. The 88 submissions received from the community and interest groups included 3 submissions in support of the Project.

The EIS also assessed two associated applications to modify Wambo's existing development consents to harmonise them with the Project (refer to Section 1.1.1) and of the 101 submissions, 13 submissions related to these modification applications (11 community and two from the EPA).

This RTS has been prepared by Umwelt (Australia) Pty Limited (Umwelt) on behalf of United and Wambo to address the key issues raised in the submissions. The RTS is divided into two separate reports. This Report (Part A) responds to the issues raised in the submissions of the Project made by the New South Wales (NSW) Government Agencies and the community (including Interest Groups) excluding matters relating to biodiversity. Part B will respond to specific issues raised by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) and matters relating to biodiversity. At the time of preparation of Part A, these matters were subject to ongoing consultation and assessment work.

This Report (Part A) includes:

1. a brief summary of the Project to provide context for the submissions made by the Government Agencies the community and interest groups (**Section 1.1**)

2. an analysis of the issues and themes raised in the community submissions (**Section 2.0**)

3. a detailed response to Government agency submissions (**Section 3.0**)

4. a detailed response to community and interest group submissions (**Section 4.0**).

1.1 United Wambo Open Cut Coal Mine Project

United Collieries Pty Limited (United) and Wambo Coal Pty Limited (Wambo) operate neighbouring mining operations located approximately 16 kilometres west of Singleton in the Hunter Valley region of NSW (refer to **Figures 1.1** and **1.2**). Under a Joint Venture arrangement, United and Wambo propose to develop the Project which will involve combining the existing open cut operations at Wambo with a proposed new open cut coal mine at United.

The existing Wambo underground mine is not part of the Project and will continue to be operated separately by Wambo.

The Project

The Project includes open cut mining operations in two areas (refer to **Figure 1.3**):

- the proposed United Open Cut
- ongoing mining of the approved Wambo Open Cut with a proposed minor surface boundary extension in addition to a depth increase to maximise coal recovery.

The Project will maximise resource recovery by integrating the management of these two mining operations and removing operational constraints, enabling extraction of an additional approximately 150 million tonnes (Mt) of run-of-mine (ROM) coal over 23 years. The Project will provide continued employment for the existing Wambo open cut workforce (approximately 250 positions) and create additional employment from the development of the Project (up to approximately 250 additional positions at peak production).

The Project is anticipated to deliver up to 10 million tonnes per annum (Mtpa) of ROM coal from the combined operations of the United and Wambo Open Cuts. The Project will deliver ROM coal to the Wambo coal handling and preparation plant (CHPP) along with coal deliveries from the Wambo underground. Total deliveries of ROM coal to the Wambo CHPP will be limited to the currently approved production rate of 14.7 Mtpa ROM coal.

In addition to seeking approval for integrated open cut mining at United and Wambo, the Project will require changes to existing mining and public infrastructure within the Project Area including:

- ongoing use of the Wambo CHPP, mine infrastructure area and related facilities for the life of the Project (approval sought via a modification to the existing Wambo mine development consent, refer to **Section 1.1.1**)
- ongoing use of the Wambo train loading facility for the life of the Project (approval sought via a modification to the existing Wambo train loading facility development consent, refer to **Section 1.1.1**)
- ongoing use of, upgrades to and expansion of the existing Wambo and United mining infrastructure
- realignment of a 2 kilometre section of the Golden Highway and the relocation of sections of 330 kV and 66 kV transmission lines to maximise coal recovery from the United Open Cut.

The design of the Project was developed having regard to the potential environmental and social impacts associated with mining operations, with the aim of minimising potential impacts. A comprehensive stakeholder engagement strategy was implemented as part of the Project design and environmental assessment process which included consultation with approximately 665 stakeholders, with Project newsletters also being distributed to approximately 700 stakeholders. Since the exhibition of the EIS, United has continued to engage with government agencies and the community (refer to **Section 1.3**).

FIGURE 1.1

Locality Plan

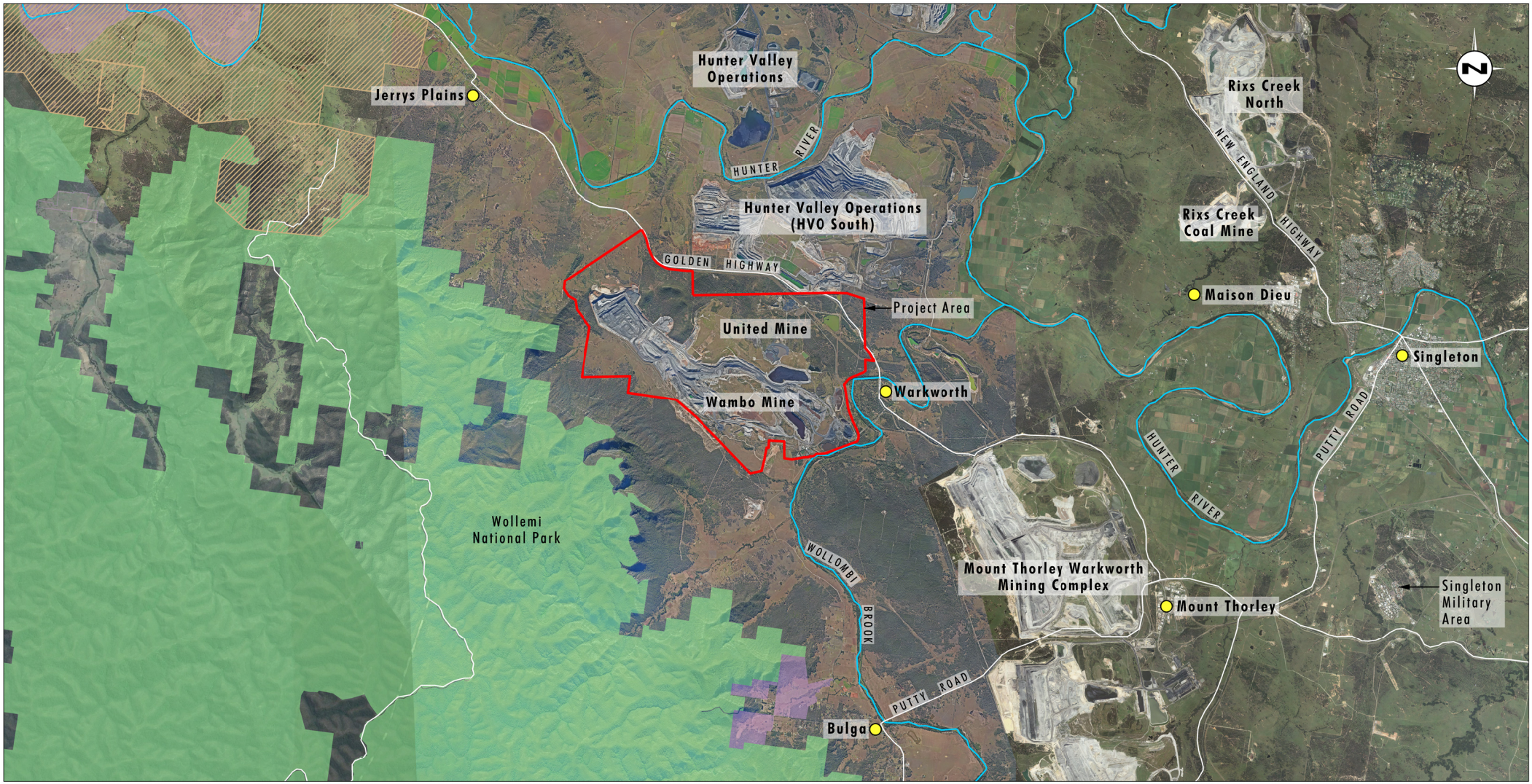

Image Source: AAM (2012), United (2015), Google Earth - CNES/Astrium 2016, Sinclair Knight Merz 2016, (2008)
Data Source: Glencore (2015), Minview (2015)

0 2.5 5.0 7.5km
1:150 000

Legend

- Project Area
- National Park
- SRLUP Viticulture CIC
- SRLUP Equine CIC
- Road
- River

FIGURE 1.2

Regional Context

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20170201 9.55

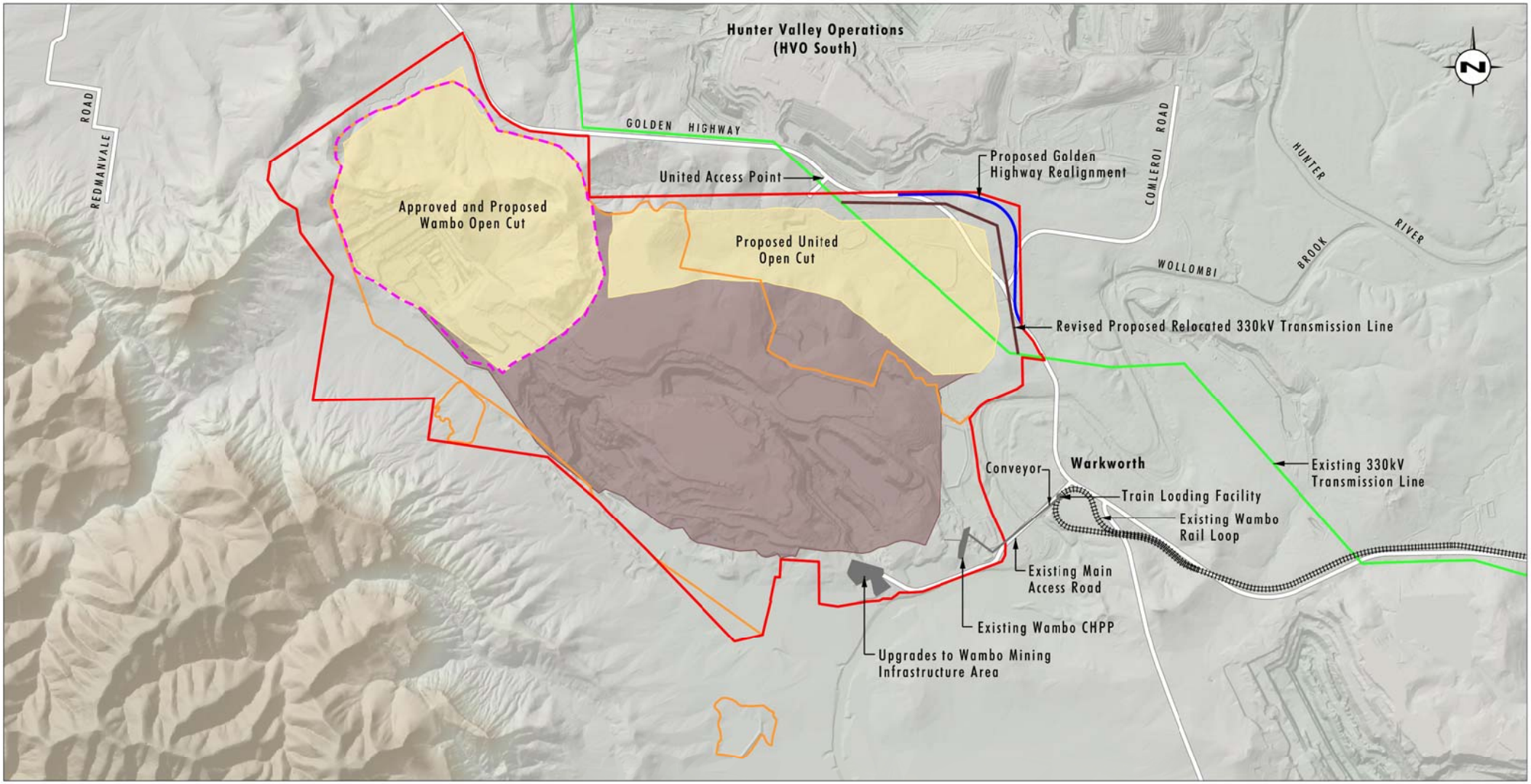

Image Source: United LiDAR (2015)
Data Source: Glencore (2015)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Proposed Conceptual Extraction Area
- Active Mining Area
- Approved Wambo Surface Development Area
- Approved Wambo Open Cut
- Proposed Golden Highway Realignment
- Existing 330kV Transmission Line
- Revised Proposed Relocated 330kV Transmission Line

FIGURE 1.3

Overview of the Project

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20170130 16.59

The engagement strategy outcomes assisted in refining the Project design and identifying appropriate management and mitigation measures.

Benefits of the Project

As discussed in the EIS, the Project will result in significant benefits at a local, regional and State level. These benefits include:

- an improved final landform across the Wambo and United mining areas, with the proposed mining operation placing overburden extracted as part of the mining process to achieve a more natural final landform. The final landform achieved for the Project will be a substantial improvement on the final landform that would have resulted from two adjoining and separate mines. The approach to developing the final landform included in the EIS incorporated community feedback to achieve an improved design and in response to some of the submissions received on the Project, further work has been undertaken and revisions made to the conceptual final landform as discussed in **Section 1.2**
- maximising coal resource recovery from the existing disturbed mining footprint and adjoining areas, utilising the existing disturbed landscape, whilst minimising environmental and social impacts
- optimising use of the existing Wambo mining infrastructure, maximising the use of existing capacity and removing the need for duplicating infrastructure to meet production demands
- ongoing employment for the Wambo Open Cut workforce whilst adding up to approximately 250 operational positions at peak production (up to approximately 500 total operational positions), with resultant flow on effects to the local and regional economy
- Wambo currently has approval to produce up to 14.7 Mtpa ROM coal. The Project combined with the separately managed Wambo underground will remain within this existing limit. That is, no change is proposed to total maximum production that is already approved for the Wambo complex
- peak construction phase employment of approximately 120 employees, combined with the economic benefits flowing from the expenditure of approximately $380 million capital required to implement the Project
- recovery of an additional approximately 150 Mt of ROM coal
- an ongoing contribution to the local, regional and State economies from two long standing and well established mining operations
- increase the gross regional product by a projected approximately $2.1 billion in net present value terms, over the life of the Project
- increase the NSW gross State product (including the Hunter region) by approximately $3.0 billion in net present value terms over the life of the Project
- a net benefit of $414 million to NSW over the life of the Project in present value terms
- royalty revenue stream flowing to the NSW government estimated to be $369 million over the life of the Project
- significant export earnings for Australia.

Through implementation of this Project, the Joint Venture believes it can contribute substantial economic benefits at local, regional and State levels whilst coexisting with the local community.

1.1.1 Harmonisation Modifications

In addition to seeking approval for integrated mining of the United Open Cut and Wambo Open Cut and associated activities, a modification to the current Wambo development consents is also proposed to align these consents with the Project. This will include modifications to both the Wambo mine development consent (DA 305-7-2003 Modification 16) (covering the mine, CHPP and associated activities) and the Wambo train loading facility development consent (DA 177-8-2004 Modification 3).

For the purposes of the EIS, these modifications were collectively referred to as the Harmonisation Modification. In summary, the proposed modifications include extending the life of these consents so that the existing mining infrastructure (including but not limited to the Wambo offices, MIA, CHPP, train loading facility, water management infrastructure, and other ancillary infrastructure) can continue to be operated for the life of the Project at currently approved capacities (where capacity is relevant). The existing Wambo underground mining operations will not be modified as part of this application.

As discussed in the EIS, it is intended that the Wambo Open Cut will continue to operate under the existing conditions of the Wambo mine development consent until such time as mining operations commence under a development consent which is granted for the Project. This will provide for ongoing operation of the Wambo Open Cut under its existing approvals until mining operations comprising the Project have commenced, at which point it is appropriate for these operations to be regulated by a new development consent for the Project. It is noted that some construction activities may be undertaken under the new development consent prior to United commencing mining operations for the Project. United will notify DPE of the date on which mining under the new development consent commences in order to provide clarity as to the date from which operations at the Wambo Open Cut will be regulated by the new development consent for the Project.

The modifications proposed for the Wambo mine development consent include:

- extension of life of the existing and approved Wambo infrastructure for the life of the Project, including
    - the Wambo CHPP
    - the MIA and sites offices
    - explosives magazine and hydrocarbon storage facilities
    - access roads and internal haul roads
    - water management system
    - tailings and reject management facilities
    - other ancillary infrastructure and associated activities
- upgrades to the existing Wambo washbays, workshop capacity, fuel farm and stores areas
- upgrades to the administration, car parking and bathhouse facilities in the existing Wambo MIA
- upgrades or modifications to ancillary infrastructure and services including power and telecommunication infrastructure
- placement of tailings including within the Project's open cut voids and capping with overburden and coarse rejects for the life of the Project

- allowance for the Wambo CHPP to receive coal from the United Open Cut (and modified Wambo Open Cut) for processing and stockpiling prior to being transported from the Wambo train loading facility

- upgrades to increase the capacity of the ROM receival facility for the open cut operations

- ongoing exchange of water between the United and Wambo operations to allow for integration of the water management systems.

The modification proposed for the Wambo train loading facility development consent (DA 177-8-2004) includes:

- extension of life of all of the coal handling and train loading facilities including the rail spur, rail loop, coal reclaim area, product coal conveyor, train load-out bin and refuelling infrastructure for the life of the Project and ongoing receipt of coal from both Wambo and United

- an increase to the number of trains utilising the train loading facility, including the refuelling infrastructure, from a maximum six trains to a maximum of eight trains per day for the life of the Project. No change is proposed to the existing approved total annual movements as no change in maximum capacity is proposed.

1.2 Project Changes Following EIS Exhibition

Three minor changes have been made to the Project since the public exhibition of the EIS. These changes are:

- changes to the design of the final voids in response to submissions on the EIS. Further details about these changes are provided in **Section 3.1**

- a change to the alignment of the 330kV transmission line and 66kV transmission line which results in a slight reduction in the additional disturbance footprint for the Project. The change to the alignment has been determined in consultation with TransGrid. The revised 330 kV transmission line alignment is shown on **Figure 1.4**

- United has also revised the additional disturbance footprint for the Project as part of its ongoing refinement of the Project design. This refinement has resulted in a reduction in the additional disturbance footprint by approximately 36.5 hectares as shown on **Figure 1.5**. This reduction in the additional disturbance footprint has resulted in the following reductions in impacts of the Project:

    - avoidance of impacts on 19 hectares of vegetation conforming to the EPBC Act-listed Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered Ecological Community (CEEC)

    - avoidance of impacts on 26.9 hectares of native woodland vegetation and fauna habitat

    - avoidance of impacts on 8.3 hectares of native grassland or shrubland vegetation.

It is also noted that a private residence, Residence 28, has been purchased since the EIS was exhibited. Residence 28 was predicted in the EIS to be significantly impacted by noise and would likely have been afforded acquisition rights if the Project is approved.

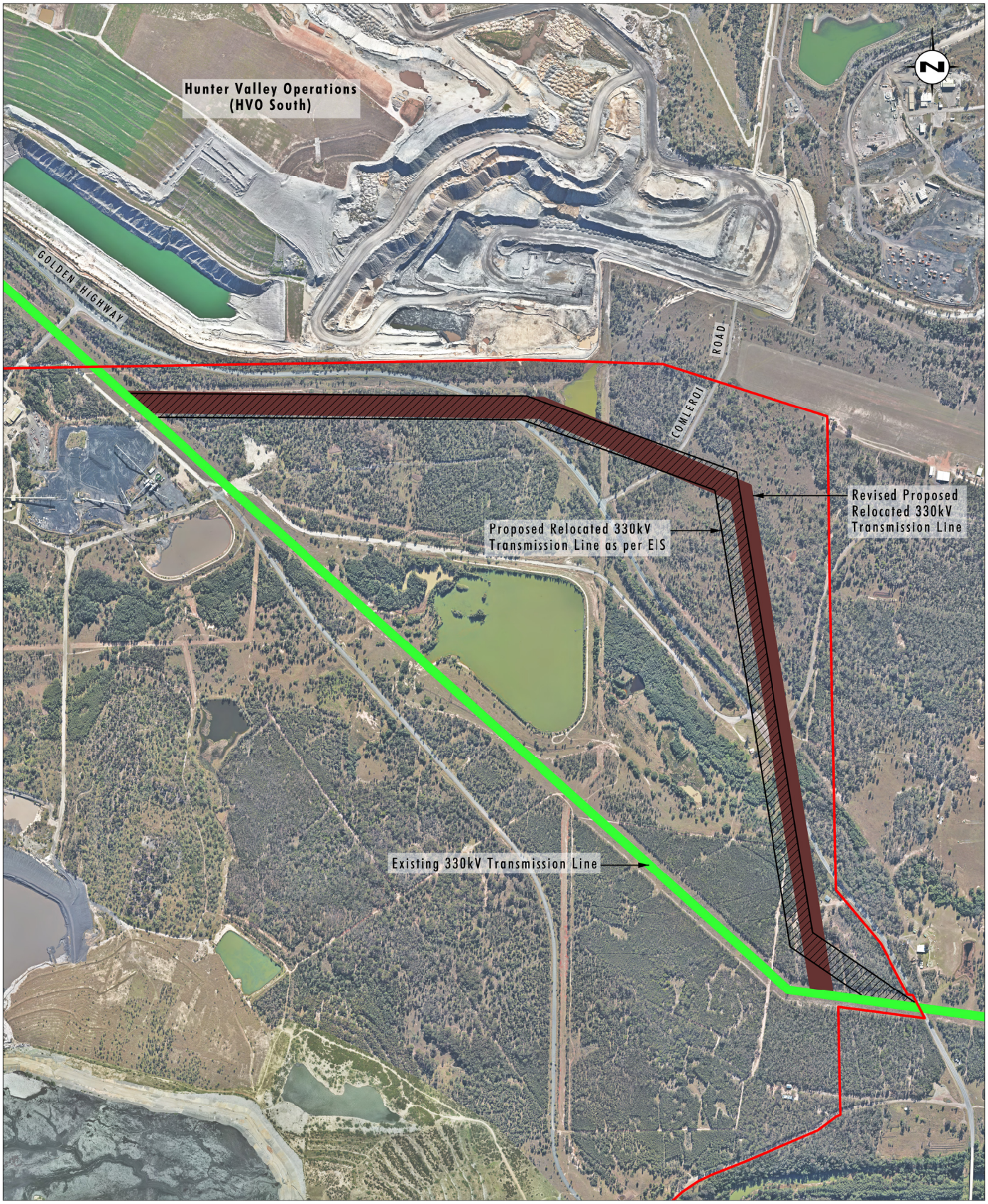

Image Source: AAM (2012), United (2016)
Base Data Source: Glencore (2015)

0 250 500 750m
1:15 000

Legend

- Project Area
- Existing 330kV Transmission line
- Revised Proposed Relocated 330kV Transmission Line
- Proposed Relocated 330kV Transmission Line as per EIS

FIGURE 1.4

Revised Conceptual Alignment of 330kV Transmission Line Relocation

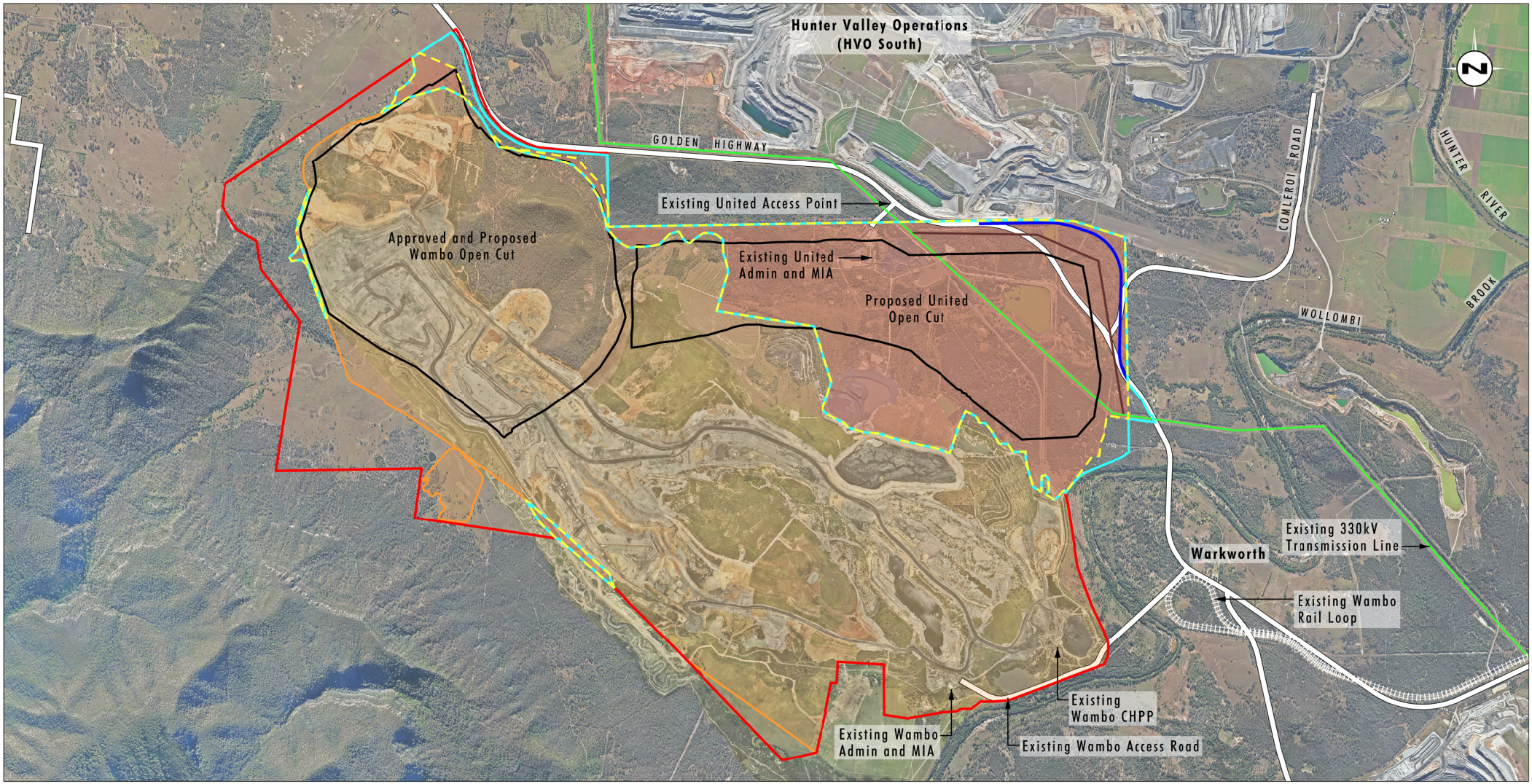

Image Source: United (2016)
Data Source: Glencore (2014)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Revised Conceptual Additional Disturbance Area
- Conceptual Additional Disturbance Area
- Approved Wambo Surface Development Area
- Proposed Conceptual Extraction Area
- Conceptual Golden Highway Realignment
- Existing 330kV Transmission Line
- Revised Conceptual Relocated 330kV Transmission Line

FIGURE 1.5

Revised Conceptual Additional Disturbance Area

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1.3 Ongoing Stakeholder Engagement

During and post the public exhibition period for the EIS, United has undertaken ongoing stakeholder engagement for the Project. This has included meetings with landholders within the affectation zone for the Project (including the noise affectation zone and the noise management zone) as well as a number of other local community members. Where relevant, this has included discussions regarding the issues raised in submissions made on the Project.

United has also undertaken ongoing consultation with government agencies in regard to their submissions to clarify issues and ensure that an appropriate response is provided in this report. A summary of the ongoing consultation undertaken for the Project since the lodgement of the EIS for public exhibition is provided in **Table 1.1**.

Table 1.1 Stakeholder Engagement since EIS Lodgement

Stakeholder Group	Stakeholder	No. of Meeting / Participants	Description
Community	Residents in Affectation Zone	21 meetings	Further discussion of the findings in the EIS as they relate to the individual property. Provision of property specific impact information. Discussion of proposed management and mitigation measures and seeking of feedback. Discussion of options related to voluntary acquisition as relevant. It is noted that one of these properties has been purchased by the Joint Venture since exhibition of the EIS (R28).
	Residents in Noise Management Zone	8 meetings	Further discussion of the findings in the EIS as they relate to the individual property. Provision of property specific impact information. Discussion of proposed management and mitigation measures and seeking of feedback.
	Other Community Members	3 meetings	Further discussion of the findings in the EIS as they relate to the individual property. Provision of property specific impact information.
Aboriginal Community	Registered Aboriginal parties	83 parties	Notification of EIS exhibition.
Community Groups	HEL/HCN Singleton Clay Target Club	2 meetings	Discussion on the findings of the EIS.
	Hunter Valley Gliding Club	2 meeting	Discussion of the issues raised in the Gliding Club submission.

Stakeholder Group	Stakeholder	No. of Meeting / Participants	Description
Neighbouring Mining Operations	HVO	1 meeting	Meeting to discuss the Project and the HVO South MOD 5
Government Agencies	DPE	6 meetings	Ongoing meetings regarding the submissions on the EIS. Senior Officer's Resource Assessment Committee (SORAC) Meeting, including the Department of the Environment and Energy, DRE, EPA, DPI Water
	Singleton Council	1 meeting	Project Update meeting and ongoing discussions on the Voluntary Planning Agreement.
	NSW Office of Environment and Heritage (OEH)	6 meetings	Meetings regarding the biodiversity assessment and offsetting and OEH submission on the EIS.
	Environment Protection Authority	3 meetings	Ongoing discussions about the required EPL variations that would be required as part of the Project, if approved.
	Heritage Council of NSW	1 meeting	Phone conversation to discuss the Heritage Division's response and request a meeting for the purposes of reviewing the response to agency submission.
	NSW Department of Trade, Investment (Division of Resources and Energy)	1 meeting	Meeting to discuss DRE submission and the response.
	NSW Department of Primary Industries (Water)	1 meeting	Phone conversation to discuss DPI Water's response and request a meeting for the purposes of reviewing the response to agency submission.
	NSW Roads and Maritime Services	1 meeting	Phone conversation to discuss RMS's submission and request a meeting for the purposes of reviewing the response to agency submission.

Stakeholder Group	Stakeholder	No. of Meeting / Participants	Description
	Dams Safety NSW	Correspondence	Correspondence related to the design of the transmission line relocations to confirm no subsidence impacts.
	Department of the Environment and Energy	4 meetings	Meetings to discuss the biodiversity assessment and offsetting.

2.0 Submission Analysis

2.1 Agency Submission Analysis

The 13 government agency submissions addressed in this Response to Submissions report were from:

- Singleton Council
- Division of Resources and Energy (DRE)
- Environment Protection Authority (EPA)
- Department of Primary Industries – Water (DPI Water)
- Office of Environment and Heritage (OEH) – addressed in detail in Part B
- Office of Environment and Heritage - Heritage Division
- Transport for NSW
- Roads and Maritime Services (RMS)
- Department of Finance, Services and Innovation - Mine Subsidence Board (MSB)
- Australian Rail Track Corporation (ARTC)
- Rural Fire Services (RFS)
- Hunter New England Health
- Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) – addressed in detail in Part B.

Some further issues for consideration were also raised by the Department of Planning and Environment (DPE) to be addressed in this report.

None of these agencies identified that they oppose the Project, however, several agencies made submissions seeking further clarification regarding aspects of the assessment of the Project. These submissions are discussed further in **Section 3.0.**

In addition, there were two agency submissions on the harmonisation modifications, both from the EPA, comprising:

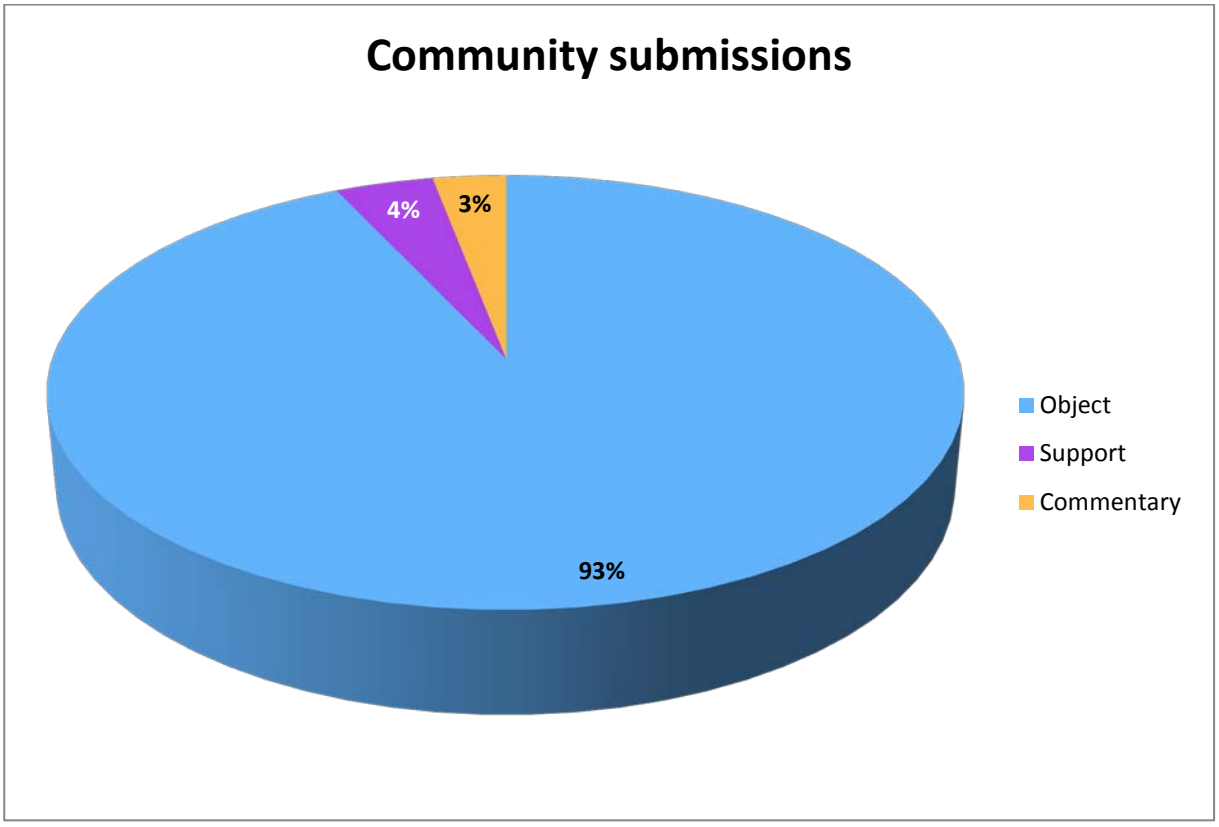
- EPA submission on Wambo Mine Modification DA305-7-2003 Mod 16
- EPA submission on Wambo Mine Modification DA177-8-2004 Mod 3.

It is noted that both of the submissions on the harmonisation modifications refer to the EPA submission on the State Significant Development Application.

2.2 Community Submission Analysis

Of the 88 submissions from community members and interest groups, a total of 76 individual submissions were received from community members (it is noted that one community member submitted a supplementary submission to their original submission, however, as they are from the same individual these have been counted as one submission). Of these, 71 (93 per cent) were objections, three (4 per cent) were in support and two (3 per cent) provided comments (refer to **Graph 2.1**).

Of the 76 individual submissions, 11 related to harmonisation modifications, which are discussed further in **Section 2.4.**



Graph 2.1 Percentage of Supporting and Objecting Community Submissions

Of the 76 community submissions, 25 were from the local area (including Jerrys Plains and Bulga), 31 were from other parts of the Hunter Region and 18 from elsewhere in NSW. Two of the community submissions received were from interstate (Queensland and Victoria).

A content analysis was undertaken on all community submissions to understand the key issues raised by the community in relation to the Project. Objections to and comments and support on the Project were analysed separately, as the themes within the submissions were distinct.

2.2.1 Supporting Submissions

With regard to those submissions that were supportive of the Project, these centred on the economic benefits of the Project, particularly with regard to job security and positive economic impacts at a local, State and national level.

"The export income generated by the project will assist in the state of NSW and the national interest by contributing positively to employment and Australia's balance of trade."

"I fully support this proposal. This will keep job security in our community which will continue to benefit our small businesses around our district, which in turn benefits all locals living in the area."

"I support this proposal and strongly believe that this proposal will create opportunities for local businesses within Singleton and surrounding areas and provide a positive injection to the community and the industry as a whole."

2.2.2 Submissions Providing Comment on the Project

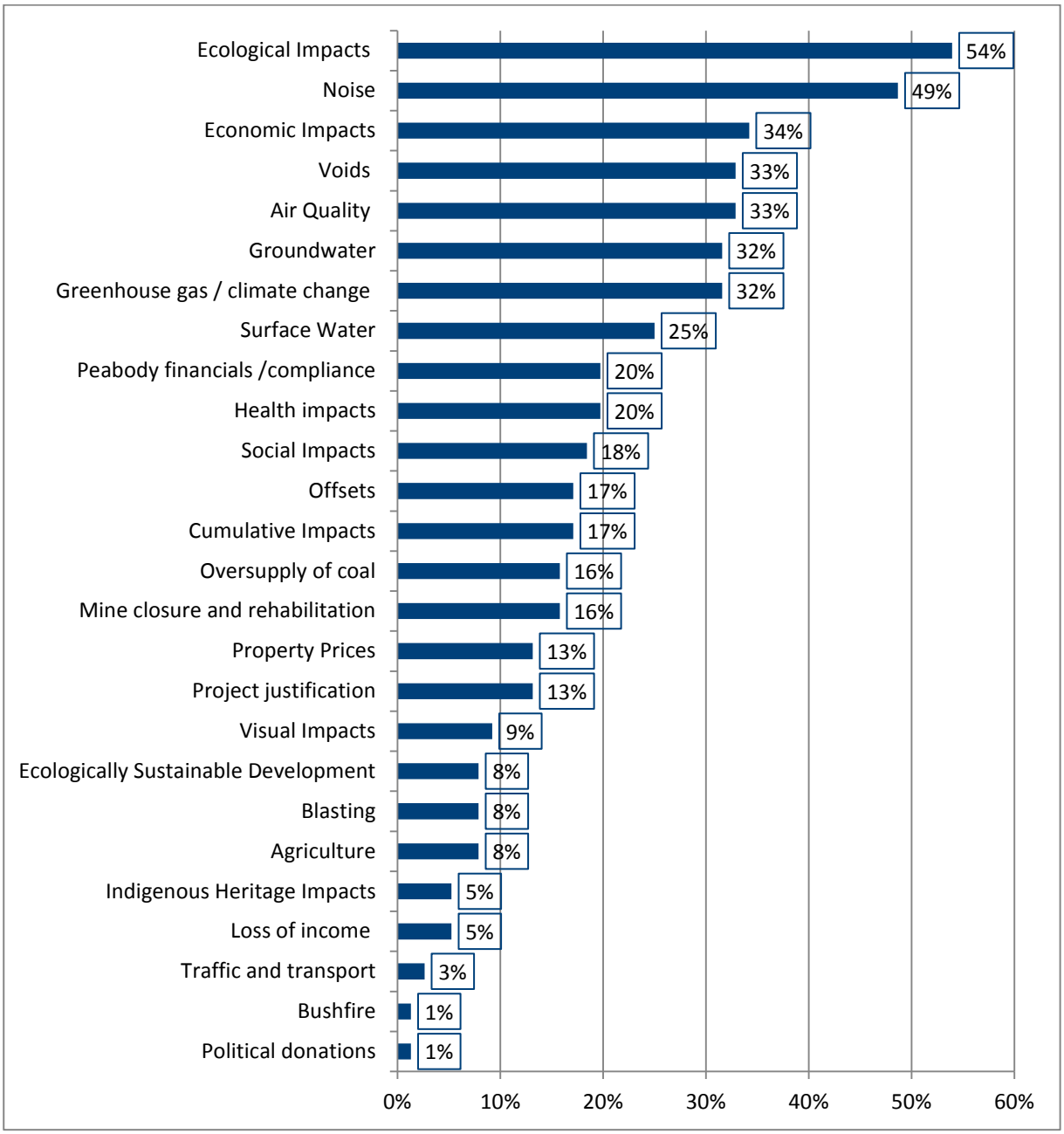
Two submissions were received that provided feedback on the Project, which was not able to classified as either in support or objecting to the Project. Both submissions were made by near neighbours to the Project Area. In one submission the authors expressed that they had a good working relationship with Wambo and United, however, they have concerns about the way in which the NSW Government is regulating mining projects. As a result, the authors have concerns about the transparency and consistency of Government decision making with regard to communities and mining projects.

The other submission commented that due to the impacts in terms of dust, noise and quality of life, the mining companies in operation around Jerrys Plains should provide compensation to land owners, such as assistance with property maintenance.

A response to these submissions is provided in the relevant sections within **Section 4.0** of this report.

2.2.3 Objecting Submissions

Analysis of the 71 objecting submissions was undertaken and the top five concerns were the ecological impacts of the Project (54 per cent), noise impacts (49 per cent), validity of economic benefits and assessment (34 per cent), air quality concerns (33 per cent) and final voids (33 per cent) (refer to **Graph 2.2**).



Graph 2.2 Overarching themes of objection submissions

A response to these submissions is provided in the relevant sections within **Section 4.0** of this report.

2.2.4 Harmonisation Modifications

Eleven submissions from community members were received on the Harmonisation Modifications.

The main issues that were raised with regard to Wambo mine development consent – DA 305-7-2003 Modification 16 were:

- air quality (2)
- negative economic impacts (2)
- property values (2)
- indigenous heritage impacts (2)
- noise (2)
- destruction of farming land (2)
- groundwater
- blasting
- climate change / greenhouse gases
- visual impacts
- ecological impacts.

The main issues that were raised with regard to Wambo train loading infrastructure – DA 177-8-2004 Modification 3 were:

- climate change / greenhouse gases (5)
- negative economic impacts (5)
- ecological impacts (4)
- health impacts (3)
- Indigenous heritage impacts (3)
- air quality
- noise
- visual
- agriculture
- impacts to groundwater.

It is important to note that all of the issues raised above have been collectively responded to in the community submissions section.

2.3 Interest Group Submission Analysis

Submissions were received from 12 interest groups, with 11 providing an objection to the Project and one providing comments.

2.3.1 Objecting Submissions

The 11 interest group submissions that objected to the Project outlined a range of issues, with ecological impacts most frequently cited, followed by impacts to groundwater and air and noise concerns. Concerns were also raised about final voids, Peabody's financial status, perceived overstatement of the economic benefits of the Project and the impact of the Project on climate change.

The issues raised in objections are discussed in detail in **Section 4.0** of this Report.

2.3.2 Submissions Providing Comment

One interest group submission was received that provided feedback about the Project that was neither in support of, or objecting to, the Project. This submission provided comments on the Project and focused on the history of mining in the Hunter region, discussion of the perceived importance of ancestral heritage and concerns with regard to air quality and noise as a result of the Project.

A response to the issues raised in this submission is provided in the relevant sections within **Section 4.0**.

3.0 Agency Submissions

The issues raised in the agency submissions are identified in the following sections in text boxes, with a response provided following each text box.

3.1 Department of Planning and Environment

3.1.1 General

a. Provide a map showing the project area boundaries proposed for the Project (SSD 7142), Wambo mine (DA 305-7-2003) and the Wambo train load out facility (DA 177-8-2004).

The approved Development Application areas for the Wambo mine development consent, the Wambo train loading facility development consent and the Project Area are shown on Figure 1.9 of the EIS. For ease of reference this figure is reproduced as **Figure 3.1** in this report. It is noted that Modification 12 (approved on 12 December 2016) has subsequently resulted in a change to the Wambo mine development consent area. This has been updated on **Figure 3.1**.

There are no changes proposed to the approved Development Application areas for the Wambo mine development consent or the Wambo train loading facility development consent as part of the Project. As requested by DPE, the updated plan also shows the existing approved disturbance area at Wambo, the proposed conceptual additional disturbance area (hereafter additional disturbance area) proposed as part of the Project and the disturbance area for Modification 12 of the Wambo mine development consent which was approved on 12 December 2016. As discussed in the EIS, the Wambo underground mine is not part of the Project and will continue to be operated separately by Wambo.

b. Section 3.2.3 of the Main EIS provides information on the harmonisation modifications. It appears that the EIS proposed a period of time when the Wambo Open Cut will be subject to the existing Wambo Mine development consent as well as the SSD consent. Clarify the timeline for commencement of the SSD consent and for Wambo Open Cut operation to become solely regulated by the SSD consent.

As discussed in Section 3.2.2 of the EIS, Wambo currently operates the Wambo Open Cut and underground operations along with the Wambo CHPP and train loading facility. Under the Joint Venture, United (or another Glencore related company) will operate all future open cut mining in the Project Area following the receipt of the required State and Federal approvals for the Project.

As outlined in the EIS, United has committed to notify DPE of the date on which mining under the new development consent commences in order to provide clarity as to the date from which operations at the Wambo Open Cut will be regulated by any new development consent granted for the Project.

As discussed in Section 3.2.3 of the EIS, it is intended that the Wambo Open Cut will continue to operate under the existing conditions of the Wambo mine development consent until such time as mining operations commence under a development consent which is granted for the Project The exact timing of when mining operations would commence following granting of any development consent is dependent on a range of factors such as the time required to gain the necessary supplementary NSW and Commonwealth

government approvals, time required for approval of any required environmental management plans, time required for construction works and the need to hand operational control over from Wambo to United.

This will provide for ongoing operation of the Wambo Open Cut under its existing approvals until mining operations comprising the Project have commenced, at which point it is appropriate for these operations to be regulated by a new development consent for the Project.

While the Project has been designed to maximise the use of existing infrastructure, some new or relocated infrastructure will be required. As outlined in the EIS, some construction activities may be undertaken under the new development consent prior to United commencing mining operations for the Project. In effect there may be a period of time at which the existing Wambo mine development consent and the State Significant Development (SSD) development consent may run in parallel while construction activities associated with the Project are commenced. Once mining operations commence under the Project, all open cut mining operations are proposed to be solely regulated by the SSD consent, if approved.

c. Section 3.5 of the Mine EIS indicates that mining within the Wambo Open Cut will be undertaken at a reduced rate to integrate with the United Open Cut. A number of public submissions were received raising concerns about impacts to residences north of the project area. Provide information on whether the reduced mining in the Wambo Open Cut prolongs mining in the northern part of the mine and if so, discuss this proposal in terms of impacts to residences to the north of the project area.

Mining in the Wambo Open Cut would be prolonged as a result of the Project.

The 2003 EIS for the Wambo mine indicated that open cut mining would be complete by approximately 2017; however, the progression of mining has been slower than originally planned. As discussed in Section 2.2.3 of the EIS, concurrent with the approval process for this Project, Wambo lodged an environmental assessment for a proposed modification to the approved Wambo mining operations (Modification 12) which was approved on 12 December 2016. The modification includes an extension to the life of the approved open cut mining operations by 3 years (i.e. to nominally 2020) to allow for continued mining in the approved Wambo Open Cut. Rehabilitation works would continue after this time.

Under the Project, the depth of the Wambo Open Cut will be increased resulting in additional coal being extracted and extending the life of this mining area. Mining within the Wambo Open Cut will also be undertaken at a reduced rate than that currently approved with equipment to be shared between the Wambo Open Cut and the United Open Cut resulting in distribution of the noise sources and allowing for integration of the mining operations. Amongst other benefits, this will allow for the development of an improved final landform. It is also noted that the Project will not result in mining any closer to residents to the northwest of the Project Area (i.e. in the Redmanvale Road area); however, there will be a small extension to the north to improve resource recovery. As discussed in the EIS, the integration of the Wambo Open Cut and the proposed United Open Cut provides greater flexibility during mining operations to manage environmental impacts by providing increased opportunities to move equipment in adverse conditions and to plan mining operations to minimise impacts.

The duration of mining in the Wambo Open Cut as part of the Project will depend on a range of factors including market demand and geological conditions. Based on the concept mine plan included in the EIS, mining activity in the Wambo Open Cut will continue to around 2039, however, mining at a reduced rate in the Wambo Open Cut area has been shown to provide improved environmental outcomes.

The EIS has assessed the potential impacts of the Project, including the prolonged life of the Wambo Open Cut. The results on sensitive receptors are discussed in Section 6.0 of the EIS. Consultation has been undertaken with landholders within the predicted affectation areas.

d. Provide a clear indicative life of mine production schedule for each year of operation of the mine and for the life of the project. Details of ROM coal and waste rock tonnage to be extracted and an estimate of the saleable product coal must be included in the schedule.

An indicative life of mine production schedule for each year of the operations of the mine and for the life of the Project is provided in **Appendix 1**. It is noted that this schedule is indicative only and was used for the assessment in the EIS. Mining operations are dynamic and mining schedules change in response to a broad range of factors such as geological conditions, market demand, equipment availability / productivity, environmental conditions (e.g. poor weather) and the impacts of environmental controls (e.g. shutdown of equipment to minimise noise or dust). Due to these factors the schedule is indicative only and will change throughout the life of the mining operation, with production levels assessed to and capped at 10 Mtpa of ROM coal.

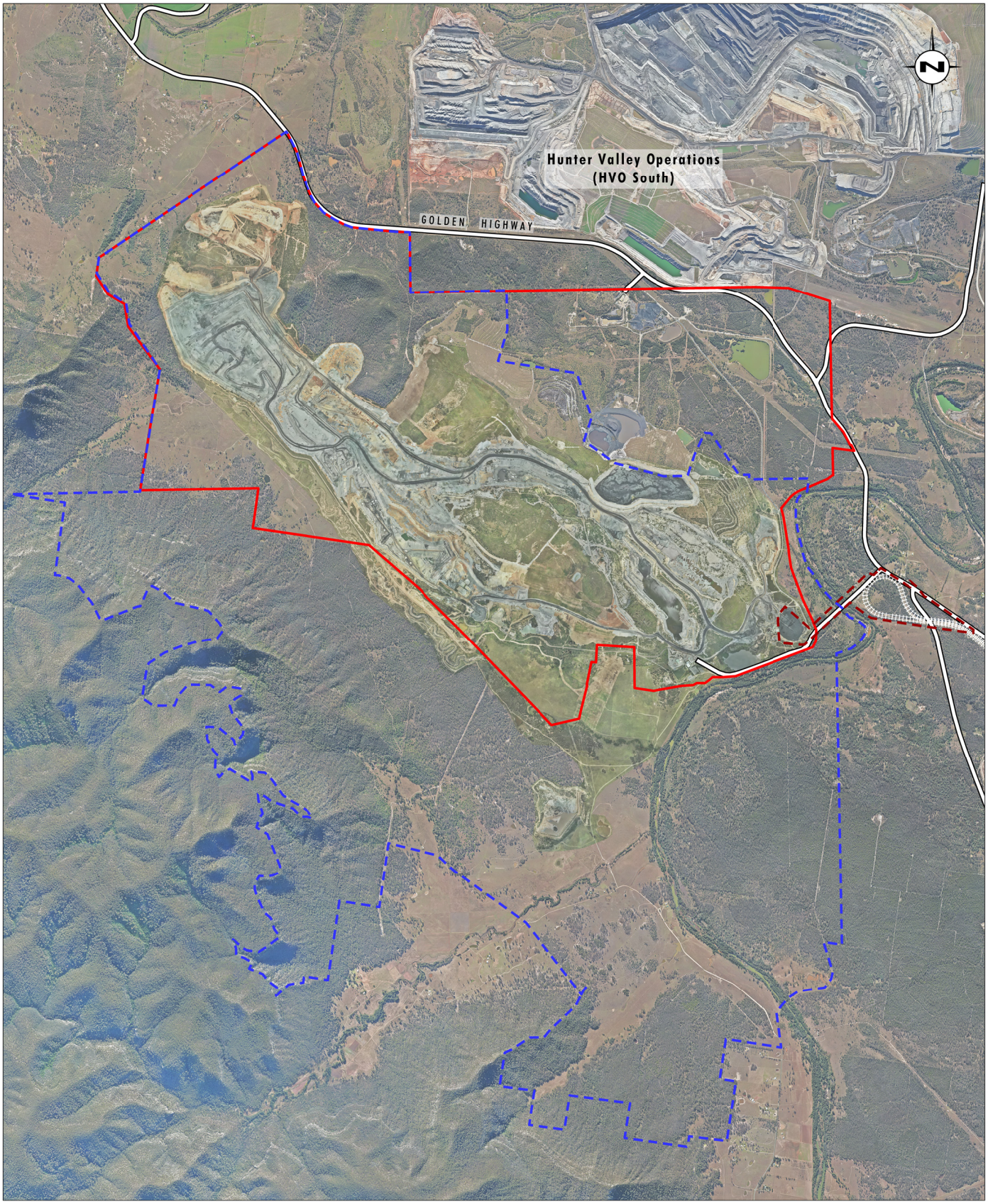


Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area (SSD 7142)
- Wambo Mine Development Consent Development Application Area (DA 305-7-2003)
- Wambo Train Loading Facility Development Application Area (DA 177-8-2004)

FIGURE 3.1

Approved Wambo Development Application Areas

3.1.2 Air Quality

The following responses have been prepared with the assistance of Jacobs Pty Limited (Jacobs) which completed the Air Quality Impact Assessment (AQIA) for the Project.

a. The Department commissioned a peer review of the Air Quality Impact Assessment (Attachment B). This review identified a number of areas that require clarification and/or revision for the AQIA to be considered adequate for the assessment of air quality impacts. DPE requests that the RTS address and respond to each recommendation in the peer review.

The AQIA for the Project was subject to a peer review by Pacific Environment Pty prior to the EIS being finalised and submitted for public exhibition. This peer review was undertaken to ensure that the Air Quality Impact Assessment was of a high quality and met relevant guidelines and industry expectations. The minor improvement recommendations made from this peer review were addressed as part of finalisation of the assessment report.

DPE commissioned a further peer review of the Air Quality Impact Assessment by Ramboll Environ. A response to comments in the peer review is provided in **Appendix 2**. The outcomes of the peer review process and the response provided by Jacobs do not change the key findings of the AQIA as outlined in the EIS.

b. Provide verification of the performance of the meteorological modelling against an actual meteorological monitoring dataset.

As outlined in the AQIA a CALMET model was input with data from four weather stations and used to generate a meteorological data file for use in the air quality model for the Project. This approach is considered industry best practice as it uses data from a number of weather stations (as opposed to a single data source) and considers how the meteorology will respond to terrain. The approach using CALMET has been peer reviewed by two parties (one commissioned by United as part of EIS preparation and one by Ramboll Environ on behalf of DPE) and found to be appropriate. The EPA has also reviewed the AQIA and has not raised any issues regarding the CALMET approach.

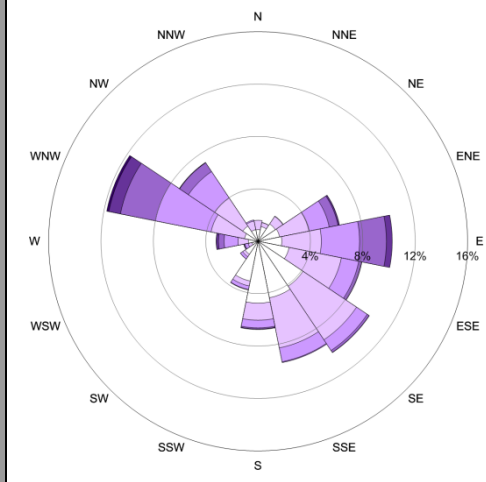
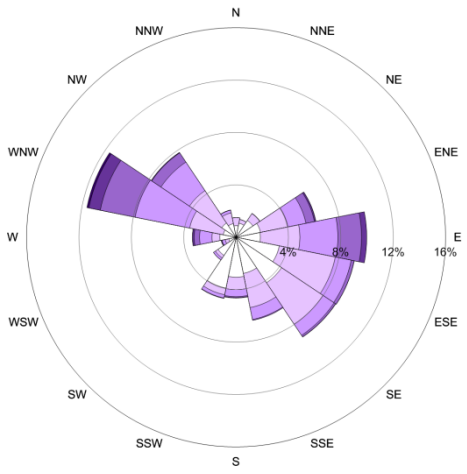
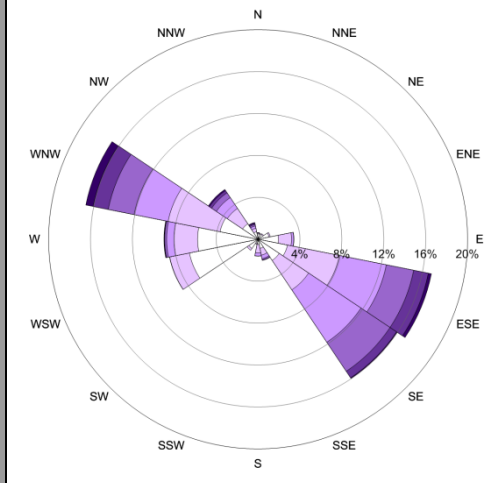
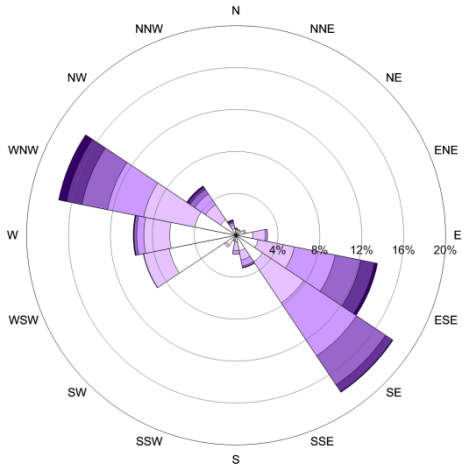
Jacobs undertook verification of the performance of the meteorological modelling by demonstrating that the meteorological data used by the dispersion model are consistent with the measured meteorological data. This verification has been carried out by:

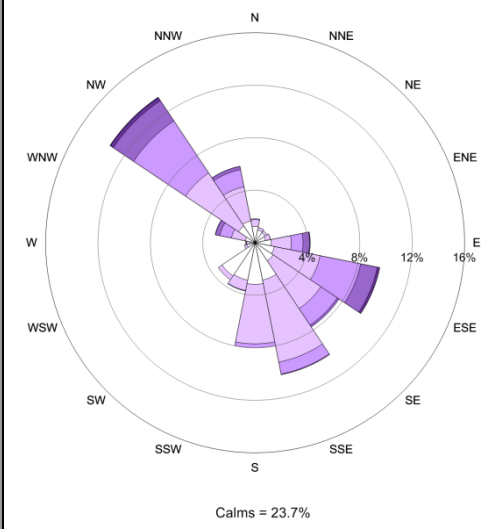
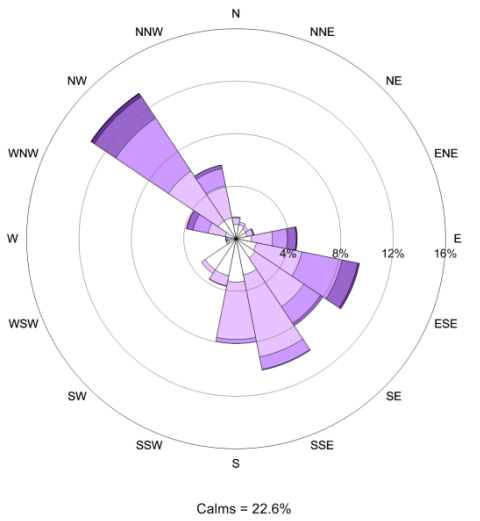
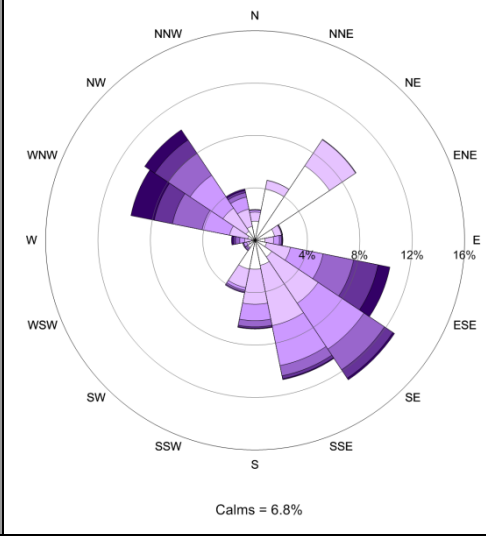
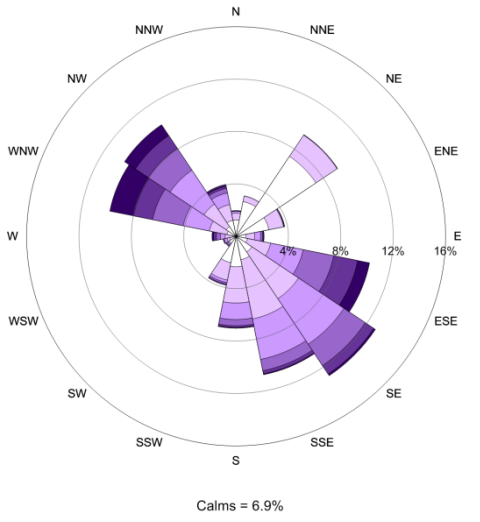
- extracting hourly wind speed and wind direction data from the CALMET output at the locations of the Wambo, Jerrys Plains, Warkworth and Maison Dieu meteorological monitoring stations
- preparing wind-roses from each of the four datasets
- comparing the wind-roses for each dataset to verify that the meteorological data used by the air dispersion model are consistent with the measured meteorological data.

Table 3.1 compares the measured data with the CALMET output (which represents the data used by the air dispersion model). The comparison is also presented as annual wind-roses for the 2014 calendar year. It can be seen from these figures that the simulated patterns at each location are almost identical to the measured patterns. There are some very minor differences, which is because the measured data have missing records and in these instances CALMET was provided with prognostic data in order to develop a complete dataset.

This comparison confirms that the meteorological data used by the dispersion model are consistent with the measurement data.

Table 3.1 Comparison of measured wind data with CALMET simulated data

Location	Measured	From CALMET output
Wambo		
Jerrys Plains		

Location	Measured	From CALMET output
Warkworth		
Maison Dieu		

Source: Jacobs

c. Provide confirmation that emissions from neighbouring mines were estimated using the same emission factors for the project emissions sources.

Emissions from neighbouring mines were estimated using the same emission factors as for the Project emission sources. The approach to estimating emissions from neighbouring mines is described in Section 6.2 of the AQIA.

d. The mitigation measures provided to manage diesel combustion emissions are incomplete. Consideration of the NSW EPA 2014 *NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions* should be made.

The proposed mitigation measures to manage diesel combustion emissions associated with the Project aim to address the equipment maintenance and engine replacement strategies from the *NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions* (EPA 2014). Specifically, the measures proposed by United include:

- servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance
- targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle
- defining failure modes, effects and criticality
- constructing timelines for downtimes.

The *NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions* (EPA 2014) also lists the following in-service non-road diesel engine emission control technologies:

- diesel oxidation catalysts
- partial diesel particulate filters
- diesel particulate filters.

These technologies represent engine exhaust after-treatments. The current deficiency in information from suppliers inhibits Glencore from ascertaining emission level reductions delivered for each engine and therefore Glencore is unable to develop comprehensive and detailed costings for implementation and maintenance of these technologies, hence they have been determined to not be appropriate for the Project at this stage.

Glencore has specified lower emission engines (US Tier 2) for all new mining equipment tenders since 2011, and has purchased these engines where available.

Glencore has advised it considers that the most appropriate approach in the short to medium term is to support the harmonisation of National standards introduced in a practical timeframe and to replace Tier 0 engines with lower emission Tier engines (where fuel efficiency is not materially impacted) as a part of the routine overhaul process. Once Tier 4 equipment becomes available, it should become mandatory in new equipment being purchased.

e. Section 9 of the AQIA states that the proposed dust management measures have been compared to the measures in the *NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions* and found that the majority of proposed measures are consistent with best practice dust mitigation measures. Please provide an assessment that supports this statement.

Statement e. is incorrect. Section 9 of the AQIA states that:

> The proposed dust management measures as outlined have been compared to the measures outlined in the 'NSW Coal Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining' (Donnelly et al 2011)".

Table 3.2 provides information to support the statement in the AQIA, in terms of a comparison between the measures documented by Donnelly et al (2011) and the measures proposed for the Project.

Table 3.2 Comparison of Best Practice Measures to Prevent and/or Minimise Particular Emissions and the Measures Proposed for the Project

Activity	Measures identified from Donnelly et al (2011)	Proposed emission management measures	Consistent?
Stripping topsoil by scraper	Control measures for this activity are not specifically identified but can be inferred from the bulldozers information below.	Watering of haul routes Restricting vehicle speeds	Yes
Drilling overburden	*"Best practice control measures include air extraction to a bag filter. No mines were found to use this practice."*	Water injection and application of water to drill cuttings upon removal Dust curtains Ceasing operations when visible dust is generated	No (bag filters are not considered best practice in NSW as more effective measures adopted)
Blasting overburden	*"Best practice control measures include delaying shot to avoid unfavourable weather conditions and minimising the area blasted"*	Pre-blast checks including review of meteorological conditions	Yes
Hauling overburden and coal on unsealed roads	*"Control measures include watering, grading, well-defined haul routes, speed limits to 40 km/h and/or the use of suppressants."*	Watering of haul routes Gravel compaction and maintenance of haul routes Restricting vehicle speeds if required under adverse conditions Clearly marked haul routes Fleet optimisation to reduce vehicle kilometres travelled Prompt clean-up of any material spillage	Yes

Activity	Measures identified from Donnelly et al (2011)	Proposed emission management measures	Consistent?
Loading and unloading of overburden	*"Current practices adopted to control emissions from loading and dumping overburden were found to be water application, minimisation of drop heights and suspension or modification of activities during adverse weather conditions. Best practice control measures were identified as minimising drop heights and / or the application of water".*	Minimisation of fall distances during unloading and loading Planning of dump locations based on weather conditions Ceasing operations during adverse dust conditions	Yes
Unloading coal to ROM bin	*"Best practice control measures for minimising emissions from the ROM hopper is enclosure with air extraction to a fabric filter or other control device. No mines in the GMR adopt this approach."*	Water sprays and partial enclosure	No (air extraction to fabric filters are not considered best practice in NSW as more effective measures adopted)
Coal processing	Control measures for this process are not specifically identified.	Enclosure *It is noted that coal processing will be undertaken at the existing, approved Wambo CHPP with no changes proposed to this facility as part of the Project.*	N/A
Dozers or loaders on ROM and product coal stockpiles	*"Best practice control measures include minimising the travel speed and distance travelled by bulldozers and the application of water to keep travel routes moist"*	Watering of travel routes Minimisation during dusty conditions Reduced travel speed during dusty conditions *It is noted that product stockpiling activities will be undertaken under the Wambo mine consent.*	Yes

Activity	Measures identified from Donnelly et al (2011)	Proposed emission management measures	Consistent?
Conveyors to stockpiles	*"The use of wind shielding on conveyor sides, water sprays at conveyor transfers, enclosure of transfer points, and, soft-loading chutes."*	Covered / enclosure Belt cleaning *It is noted that coal processing will be undertaken at the existing, approved Wambo CHPP with no changes proposed to this facility as part of the Project.*	Yes (except for water sprays and soft-loading chutes)
Wind erosion from partially rehabilitated dumps, and ROM and product coal stockpiles	*"Control measures include watering exposed areas, minimising areas of disturbance, progressive rehabilitation and use of suppressants"*	Partial rehabilitation / stabilisation Water sprays on ROM bin Minimisation of FEL drop heights when loading *It is noted that product stockpiling activities will be undertaken under the Wambo mine consent.*	Yes
Grading roads	Control measures for this activity are not specifically identified. This activity forms part of the control measures for haul roads.	Watering of haul routes Restricting vehicle speeds if required in adverse conditions Clearly marked routes	N/A
Machinery exhausts and plant and equipment	Control measures for this activity are not specifically identified.	Servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance. Targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle. Defining failure modes, effects and criticality. Constructing timelines for downtimes.	N/A

f. Provide a comparative assessment of the Project compared to the air quality impacts of the approved Wambo mine to sensitive receivers. The Department seeks clarification that the closest receivers to the project would experience similar (or lower) air quality impacts than those previously approved.

The air quality impacts of the approved Wambo mine have been, and continue to be, accurately quantified by air quality monitoring. Section 5.2 of the AQIA provided a detailed discussion of the data, which showed that:

- in terms of PM_{10} concentrations, most monitoring sites in the vicinity of Wambo mine have experienced at least one day above the EPA's 50 µg/m^3 criterion in the past five years, but annual averages have complied with EPA criteria for all locations
- TSP and NO_2 concentrations are below their relevant EPA criteria
- depositional dust levels have exceeded EPA criteria near mining areas (as expected) but are below EPA criteria at sensitive receptor locations.

The measurements for 2014 (where available) were then also compared to future projections for the Project to identify the potential change in air quality. The outcome of this comparison was summarised in the Executive Summary of the AQIA, showing that Warkworth has the potential to experience deterioration in air quality and that all other sensitive areas would not experience deterioration in air quality as a result of the Project.

Model predictions from the Wambo Development Project EIS (Holmes Air Sciences 2003) have also been compiled and compared to those from the Project. It is also noted that in terms of cumulative impacts, there are additional mining operations that have been approved since the 2003 Wambo cumulative model was prepared (e.g. Warkworth Extension) and which were therefore not considered in the cumulative assessment undertaken in the 2003 Wambo EIS. **Table 3.3** shows the results, focusing on the nearest properties to the southeast (Residence 19 in Warkworth) and northwest (Residence 28 at Moses Crossing). Property 320 has also been added to the comparison as Residence 28 has recently been purchased by the Joint Venture and Residence 320 is the next closest private property not subject to acquisition rights north of the Project. There are some differences to be observed when comparing the two sets of the results, specifically:

- the mining years will not match, so the highest model predictions for each particulate matter classification during the mine life would be the more appropriate way to compare the results
- changes have occurred at other mining operations since 2003. These changes will only be reflected in the current modelling (i.e. not included in the Approved Wambo Mine numbers in **Table 3.3**
- changes have occurred to the modelling approach to reflect advances in science (model selection, emission estimation, performance evaluations), and these changes have generally resulted in an improvement to the model performance and more accurate predictions of air quality impacts
- different assessment criteria were used in the Wambo Development Project EIS. For example, 150 µg/m^3 was used as the cumulative criterion for maximum 24-hour average PM_{10} as opposed to 50 µg/m^3.

The most stable (air dispersion) model statistics are annual averages and as discussed in the AQIA these also tend to show much closer agreement with measurement data than other averaging times. In terms of understanding how dust levels from the Project will compare to those from the approved Wambo mine (noting that the open cut operations at Wambo are the primary source of dust from Wambo and the Project incorporates these open cut operations), the key comparison is comparing the Wambo mine (project only) emissions to the Project (project only) emissions. A review of the comparative data in **Table 3.3** indicates the following:

- annual average TSP and PM_{10} levels for the Project are similar to or less than those predicted in the 2003 EIS for Wambo at all three locations. This indicates that average dust levels from the Project should be consistent with those experienced from the Wambo mine

- annual average dust deposition levels are similar, slightly higher in Warkworth for the Project but meet relevant criteria. This difference in predictions for the Project verses Wambo is likely due to changes in modelling approaches, but overall supports the findings that the average dust levels from the Project should be consistent with those experienced from the Wambo mine

- in regard to maximum 24-hour average PM_{10} higher levels are predicted for the Project at Residence 19 in Warkworth Village compared to for the Wambo mine in the 2003 EIS. It noted that this residence has current voluntary acquisition rights for Wambo and is within the affectation zone for the Project. For both other locations, the predictions for the Project are less than those for the approved Wambo mine.

Cumulative annual average PM_{10} concentrations at Residence 19 are up to the same level as model results that were presented for the approved Wambo mine (that is, for both the approved Wambo mine and Project the maximum predicted cumulative annual average PM_{10} dust level is 39 $\mu g/m^3$). Cumulative annual average PM_{10} concentrations at Residence 28 with the Project are below the model results for the cumulative impact with the approved Wambo mine (Project cumulative is 23 $\mu g/m^3$ while approved Wambo is 27 $\mu g/m^3$). Cumulative annual average PM_{10} concentrations at Residence 320 with the Project are below the model results for the cumulative impact with the approved Wambo mine (Project cumulative is 18 $\mu g/m^3$ while approved Wambo cumulative is 20 $\mu g/m^3$).

It is also useful to compare the estimated emissions. The TSP emissions for the approved Wambo operation were estimated to be up to 4,195,167 kg/y (Holmes Air Sciences 2003). This can be compared to the estimated TSP emissions for the Project which are up to 4,081,329 kg/y (Jacobs 2016). The Project emissions are therefore effectively the same, or slightly lower, than for the approved operation. This outcome arises mainly from the passage of time as there have been changes to the recommended emission factors. The emission factors for several key activities such as wind erosion have, in general, reduced when compared to approaches in 2003.

Table 3.3 Dust model predictions for approved Wambo mine compared to the Project

Residence ID	Approved Wambo Mine		Project	
	Project only	Cumulative	Project only	Cumulative
	Highest of Year 2, 7 and 9	Highest of Year 2, 7 and 9	Highest of Year 2, 6, 11 and 16	Highest of Year 2, 6, 11 and 16
Annual average PM_{10} in µg/m^3				
19[1]	14	39	13	39
28[2]	16	27	6	23
320	12	20	3	18
Annual average TSP in µg/m^3				
19[1]	18	47	13	69
28[2]	18	31	6	58
320	14	23	3	53
Annual average dust deposition in µg/m^3				
19[1]	0.8	1.5	1.3	4.0
28[2]	0.5	0.7	0.6	3.1
320	0.3	0.5	0.4	2.6
Maximum 24-hour average PM_{10} in µg/m^3				
19[1]	22	40	87	120
28[2]	27	41	25	63
320	29	42	10	54

Notes:
1. Residence 19 has existing acquisition rights under the Wambo mine development consent
2. Residence 28 has been purchased by the Joint Venture

As noted previously in this response, the impacts of the approved mine have been, and continue to be, quantified by air quality monitoring. The measurements for 2014 (where available) were compared to future projections for the Project to identify the potential change in air quality. The outcome of this comparison was that Warkworth (represented by Residence 19) has the potential to experience a deterioration in air quality and that all other areas would not experience a deterioration in air quality. This outcome is summarised by **Figure 3.2** which shows that Warkworth village may experience a measureable change in the number of days above 50 µg/m^3. No other (monitored) locations are expected to experience an increase in the number of days above 50 µg/m^3.

g. Provide further detail on the proposed air quality monitoring program including monitoring locations, capabilities and frequency.

The full details of the monitoring program are yet to be finalised and would be determined in consultation with relevant government agencies as part of the pre-commencement works for the Project but, at a minimum, is proposed to include:

- four TEOMs which will continuously measure PM_{10} (logging at 10 minute intervals) at the locations shown in Figure 4 of the AQIA

- one meteorological station at the location shown in Figure 4 of the AQIA. Measured parameters will include wind speed, wind direction, sigma theta, temperature at 2 metres and 10 metres above ground, relative humidity, and rainfall

- a network of dust deposition gauges, collected monthly. The number and locations of the separate Wambo and United Collieries gauges will be reviewed and consolidated.

As noted in the AQIA, the air quality monitoring currently operated by Wambo and United will be reviewed and consolidated to meet the needs of the Project. The revised monitoring program will be included in the Air Quality Management Plan that would be required under the development consent.

The potential effect of the Project on $PM_{2.5}$ levels has been predicted in the AQIA. In summary, the assessment indicated that emissions from the Project were unlikely to cause exceedances of the EPA's $PM_{2.5}$ criteria at any private residential property except for Residence 19 (Warkworth Village). It is acknowledged that the prediction of $PM_{2.5}$ has necessarily had to rely on several assumptions which led to a level of increased uncertainty in the $PM_{2.5}$ assessment. These uncertainties have mainly arisen from an absence of relevant monitoring data.

The absence of site specific $PM_{2.5}$ monitoring data meant that background levels that would apply at the nearest sensitive receptors were estimated from PM_{10} monitoring data and using an assumption on the proportion of PM_{10} which is $PM_{2.5}$. It is noted that this is standard practice in the preparation of AQIA in NSW and is accepted by the EPA. The absence of $PM_{2.5}$ monitoring data also meant that it was not possible to validate the performance of the model for predicting $PM_{2.5}$ using local monitoring data as was done for PM_{10}.

Further discussion on the use of alternative assumptions for $PM_{2.5}$ is provided in **Appendix 2** and **Section 3.3**, although it is suggested that these alternative approaches will not resolve potential $PM_{2.5}$ issues with any more certainty than is presented in the AQIA. As part of the implementation of the Project, United is therefore proposing a campaign of $PM_{2.5}$ monitoring to provide local $PM_{2.5}$ monitoring data to confirm that the predictions of $PM_{2.5}$ in the AQIA are accurate. The proposed $PM_{2.5}$ campaign monitoring would be included in the Air Quality Management Plan and will include sites at Warkworth and along Redmanvale Road. The campaign monitoring would include:

- monitoring of $PM_{2.5}$ using a beta attenuation mass (BAM) monitor concurrently and co-located with the PM_{10} TEOM monitor located at AQ01 (refer to Figure 4 of the AQIA). The rationale for this location is that it is downwind of mining operations under the prevailing northwest winds and therefore more likely to measure contributions from activities at the Project Area

- campaign monitoring for a period forecast to be 3 to 6 months pending a review of whether suitable northwest winds have been observed during that time

- comparing the $PM_{2.5}$ concentration estimates to the EPA's 25 µg/m^3 criterion
- identifying whether further $PM_{2.5}$ campaign monitoring would be required.

If further $PM_{2.5}$ monitoring is required as a result of the campaign monitoring above, then United would develop an implementation program at this time in consultation with DPE.

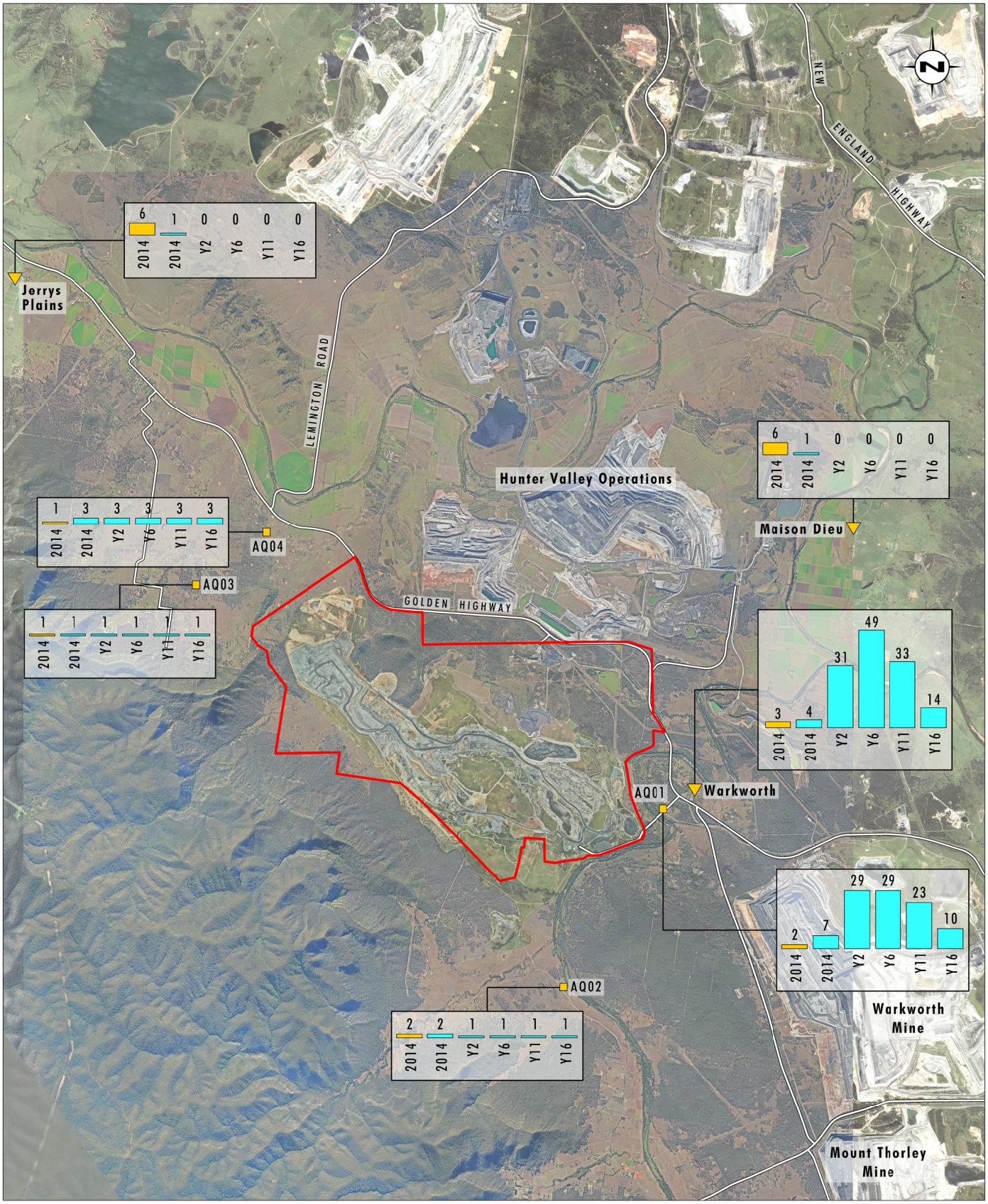


Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

Legend

- Project Area
- Wambo Monitoring Site
- OEH Monitoring Site
- Measured Result
- Model Prediction

FIGURE 3.2

Predicted Number of days above 50$\mu g/m^3$ PM_{10} with the Project and all other mining sources

File Name (A4): R18/3509_558.dgn
20170130 17.18

3.1.3 Noise

a. The Department shares a number of concerns raised by EPA in regards to noise. In particular, the Department expects the RTS to provide sufficient information that enables an assessment and determination of noise criteria and conditions for a potential Project consent and potential amended Wambo Rail and Wambo Mine consents. The EIS and Noise Impact Assessment should be revised based on one of the options proposed by the EPA, or else provide a suitable methodology for the management of noise for the United Wambo Project, and the associated mining infrastructure under Wambo's management, separately.

As further discussed in **Section 3.4**, there was a slight misinterpretation of the Noise Impact Assessment (NIA) in the EPA submission. Consistent with the approach agreed with DPE and EPA prior to the completion of the NIA, the NIA provided separate assessments for the State Significant Development (SSD) Application and that for each of the proposed modifications. Specifically, the results in Table 6.1 and 6.2 and Appendix F Table F.1 of the NIA are for the SSD Project only (i.e. the United Open Cut and the Wambo Open Cut only under United's management). The NIA also provides an assessment of the extension of life of the Wambo CHPP and the Wambo train loading facility. No changes are proposed to either of these facilities and therefore there will be no changes to their noise generation, with the only changes being an increase in the duration of use. The NIA did not present project specific contributions for the Wambo train loading or CHPP infrastructure or for the Wambo underground mine, however, the contribution from these noise sources was included in the cumulative assessment.

As detailed in **Section 1.0**, the Project seeks to combine the existing open cut operations at Wambo with a proposed new open cut coal mine at the United. The continued operation of Wambo's CHPP, train loading facility and underground mines will continue to be owned and operated by Wambo and subject to the existing Wambo development consents and Environment Protection Licence (EPL). It is noted however, that an extension to the life of operation of the CHPP and coal terminal forms part of the Project, as modifications to the existing Wambo approvals, and has been assessed in the EIS and the NIA.

Accordingly, the existing noise criteria for the Wambo mine will continue to apply until such time as mining operations commence under a new development consent which is granted for the Project (i.e. the development consent and EPL should include two sets of noise criteria that apply to Wambo mine being that prior to the commencement of mining operations under a development consent granted for the Project, and noise criteria that apply following the commencement of mining operations under a development consent granted for the Project).

This will provide for ongoing operation of the Wambo Open Cut under its existing approvals until mining operations comprising the Project have commenced (i.e. to allow time for gaining necessary approval of any required environmental management plans, construction works and transfer of operational control from Wambo to United).

As agreed in further discussions with DPE and EPA a compliance noise model has been developed to identify the contribution of the Wambo infrastructure and underground mine on the areas surrounding the Project. This has been completed to inform the process of setting relevant noise criteria under respective EPLs. The findings are presented in **Appendix 3**.

The approach to the compliance model in **Appendix 3**, has been completed in accordance with the processes identified in Section 10 of the INP, and provides for the establishment of achievable noise limits for existing industrial operations on the basis existing approved industrial operations.

On the basis of the compliance model results presented in **Appendix 3**, it is envisaged that criteria for the Wambo operations (less the operation of the Wambo Open Cut) that would apply from commencement of the Project will be developed in consultation with DPE and the EPA.

In regard to the options proposed by the EPA for assigning management responsibility for noise, it is not proposed to revise the EIS or NIA so that a single entity is responsible for the management of noise from all surface activities. The open cut operations will be operated by United on behalf of the Joint Venture and the CHPP/rail loop will continue to be operated under separate consents by Wambo. The Wambo underground mine will continue to be managed by Wambo and is not part of the Project. As there will be two separate mining operations with different ownerships and different managing companies, it is not possible or appropriate for one party to assume responsibility for all noise generation.

The issues raised by the EPA in relation to ongoing management of the operations are in the context of setting appropriate compliance limits for operation of the Project and existing Wambo mine and infrastructure.

It is considered that the EPA's requirements can be met through an appropriately designed management regime and monitoring network, which will be supported by the implementation of proactive noise mitigation and monitoring measures as committed to as part of the EIS.

In relation to the ongoing management of noise impacts, the following process will be implemented across the Project and Wambo operations:

- the Joint Venture will be the initial point of contact for complaints / exceedances for all of the noise receiver areas surrounding the Project (complaints for Wambo or Joint Venture) – via a Complex Hotline (for Wambo and Joint Venture operations), a Joint Venture employee will handle the complaint and direct it to the responsible party to address

- as a first point of allocation, complaints / exceedances in Areas 1, 2 and 3 will be attributed to Wambo, with Areas 4, 5, 6 and 7 attributed to the Joint Venture (refer to Figure 6.8 of the EIS for designation of these areas)

- the Joint Venture would then review the complaint using an agreed Complaints Management Protocol (as outlined in the Noise Management Plan (details below); the Joint Venture, by agreement, could re-assign a complaint based on the review process within agreed timeframes to meet regulatory response times

- the operation responsible (Wambo or Joint Venture) for the noise complaint would then assume accountability, record it for compliance purposes and address it in accordance with regulatory requirements and expectations.

This proposed approach to the ongoing management of noise across the Project and ongoing Wambo operations will be further developed and detailed in the Noise Management Plan for the Project, and supporting management processes (such as a Pollution Incident Response Management Plan (PIRMP) for the operations) which would be prepared in consultation with the EPA and DPE in accordance with any conditions of the development consent.

Notwithstanding the management and response process identified above, the ongoing management of noise compliance will entail the following process:

- the noise monitoring program will establish noise levels in the surrounding receiver areas, this will be in the form of real time noise monitoring network established for the Project

- for Areas 1, 2 and 3 the noise contribution from the Wambo surface facilities and CHPP would be determined using a validated compliance model representative of these activities

- when monitoring is undertaken, based on the known meteorological conditions, the noise contribution at each of the monitoring locations in Area 1, 2 and 3 can be quantified for the Wambo facilities and CHPP

- the predicted noise impacts for the Wambo operations under a full range of meteorological condition will be documented in the Noise Management Plan, to be prepared if the Project is approved

- the above process will allow the noise impacts from both the SSD Project and the Wambo operations to be quantified to provide a process of determining ongoing compliance with relevant noise limits.

This process will also be developed under the Noise Management Plan to provide a methodology for establishing whether each individual licensee is complying with its respective licence conditions.

b. The EPA has requested that the calculation of the sleep disturbance criteria be revised and amended as necessary. Provide information that demonstrates that the Sleep Disturbance Criteria have been calculated in accordance with the Industrial Noise Policy. Where a review results in a change to criteria, revise the assessment comparing noise levels associated with mining activities that could lead to sleep disturbance with the new sleep disturbance criteria.

A response to this matter has been completed as part of the response to the matters raised by the EPA (refer to **Section 3.4**). As outlined in this response the EPA proposed sleep disturbance criteria will be adopted for the Project. The adoption of these criteria does not affect the overall outcomes of the NIA in relation to sleep disturbance as detailed in **Section 3.4**.

c. The sleep disturbance assessment in the NIA identifies that $L_{A1\ 1minute}$ noise levels at R019 could exceed 55dB(A) due to bulldozer operations and impact noise from heavy objects being dropped into truck trays. Provide the maximum predicted noise level for R019 and the period of time that noise levels at R019 are expected to exceed the sleep disturbance criteria at this receiver.

The $L_{A1\ 1minute}$ noise levels at Residence 19 are predicted to be 56dB(A) under 3 m/s wind from the north-west which represents worse case conditions for the day time period. As outlined in the response to EPA matters (refer to **Section 3.4**), the Project will adopt sleep disturbance criteria for the night time period only.

Under the 4°C/100 metre inversion plus 1.3 m/s drainage flow from the south, which is representative of worst case winter night the Project is predicted to be 54dB(A) at R19 which exceeds the sleep disturbance criteria of 53dB(A) for this receiver area.

Further detail on predicted sleep disturbance impacts is provided in **Section 3.4**.

As discussed in the EIS, Residence 19 has acquisition rights under existing development consents in the area and is expected to be granted acquisition rights for the Project. United has been engaging with the owner of R19 regarding the predicted impacts of the Project.

d. The EPA has requested that the calculation of the construction noise criteria be reviewed and amended as necessary. Provide information that demonstrates that the construction noise criteria have been calculated in accordance with the Interim Construction Noise Guidelines. Where a review results in a change to criteria, revise the assessment comparing noise levels associated with construction activities with the new construction noise criteria.

A response to this matter has been completed as part of the response to the matters raised by the EPA (refer to **Section 3.4**). As outlined in this response the EPA proposed construction criteria will be adopted for the Project. The adoption of these criteria does not affect the overall outcomes of the NIA in relation to construction noise. As detailed in Section 6.3 of the NIA, the $L_{Aeq,15minute}$ noise levels associated with the construction are predicted to not exceed 35 dB(A) at any sensitive receiver. This is well below the construction noise management levels for properties in the region surrounding the Project. As outlined in the EIS, no significant construction noise impacts are predicted as a result of the Project.

e. Check for inaccuracies as per EPA's comments.

As outlined in the response to matters raised by the EPA the identified minor inaccuracies have been reviewed and amended accordingly (refer to **Section 3.4**).

f. The noise management and mitigation measures should provide clear commitments, and avoid ambiguous or hypothetical language. For example, words such as 'would', 'should', 'where possible', 'may' or 'where necessary' are to be avoided or clearly defined.

The proposed noise management measures for the Project are outlined in Section 6.6.11.1 of the EIS. It is considered that wording of the noise management and mitigation measures provide clear commitments and are clearly defined. There are three instances where the proactive measures use the wording 'where practicable' or 'where feasible and practicable'. The intent is that these controls will be implemented, however, there will be particular locations or instances where this may not be practicable due to mine design, engineering constraints, operating scenarios and / or safety issues. In those instances, other measures would be implemented to meet the predicted noise levels. These measures are repeated below together with clarification as to the reasons that language has been used to respond to DPEs comment.

It is also noted that the terms reasonable and feasible are also used. These terminology are widely used in the NSW Industrial Noise Policy (EPA, 2000) and are also defined in DPE's standard conditions for mining developments and therefore do not require further clarification.

In summary, the terminology used in the EIS is considered appropriate.

Noise Management and Mitigation Measures

A combination of proactive and reactive/adaptive controls has been included in the Project design and committed to in the EIS. Proactive control measures to be implemented over the life of the Project include (with explanatory text in italics where required):

- Incorporation of reasonable and feasible noise attenuation on key items of plant and equipment that will be re-used from the current Wambo Open Cut operations or other controls achieving the same overall noise outcome.

- Include reasonable and feasible noise attenuation measures on new plant and equipment that has the potential to contribute to the Project's noise level.

- Using 'silent horns' to communicate with trucks and smart broadband 'Quacker' reversing alarms.

- The inclusion of bunds in strategic locations along haul roads, where practicable, to shield trucks and equipment on exposed sections of the haul road ramps. *In this context where practicable is included as in some areas due to topography there may not be sufficient space to establish bunds or there may be other safety constraints that constrain the design (e.g. sight distance).*

- Locating key haul roads below ground surface or topographical features to maximise shielding to surrounding receiver areas, where practicable. *In this context where practicable is included as in some areas due to topography and mine design it may not be possible or practicable to locate key haul roads below ground surface or topographical features. Achieving this outcome will, however, be considered during designing of haul roads.*

- Designing emplacement areas to create sheltered dumping locations that can be used during adverse weather conditions where feasible and practicable. *In this context where feasible and practicable is included as in some areas due to topography, mine design and where emplacement areas are in exposed locations (e.g. the initial phases of establishment of overburden emplacement) it may not be possible to have sheltered dumping locations for 100% of the duration of mining. However, United will design emplacement areas to have sheltered locations where possible as this increases operational efficiencies as without such locations the period of equipment shutdown due to environmental constraints increases.*

- Managing the drop height of the first load into truck bodies to minimise impact noise from the material.

In addition to the proactive noise control measures above, United intends to achieve the predicted noise levels at private residences through the implementation of a performance based adaptive management approach that focuses on implementing appropriate operational controls and management strategies to meet the noise criteria. The approach will vary during different mine stages and weather conditions, and considering evolving technology and associated equipment noise levels. Outlined below are a range of controls and strategies that will be adopted as required to meet noise performance requirements for the Project. Examples of such reactive/adaptive noise controls and strategies include those incorporated into the noise model to demonstrate each stage of the Project could be managed to meet the noise performance requirements for the Project, including:

- strategic relocation or shut down of acoustically significant equipment during adverse meteorological conditions that could result in noise propagation towards sensitive receivers

- limiting the activities of ancillary equipment in exposed locations

- progressive shut down or relocation of production machines in elevated locations.

In addition to the implementation of noise mitigation strategies during periods of adverse weather conditions, United will implement the following general noise mitigation measures as part of the Project:

- regular inspection and maintenance of noise attenuation systems

- implementation of a process for periodic review of noise performance of the equipment fleet

- implementation of systems that identify adverse meteorological conditions which are likely to result in elevated noise impacts

- the implementation of noise awareness training for key employees to facilitate effective noise management

- offering reasonable and feasible noise mitigation measures, which may include measures such as double glazing, insulation or air conditioning, to landowners in the active noise management zone.

3.1.4 Groundwater

The following responses have been prepared with the assistance of Australasian Groundwater and Environmental Consultants (AGE) which completed the Groundwater Impact Assessment for the Project.

a. The Department agrees with DPI's recommendation for an additional external peer review of the groundwater model. While the Department notes Dr Noel Merrick's experience, Dr Merrick has had significant involvement in the groundwater modelling undertaken at Wambo Mine. Further, the Department notes that Kalf and Associates Pty Ltd was used as an independent peer reviewer for Wambo Mine Modification 12. As such, the Department requests an additional external peer review be undertaken of the groundwater model.

As requested, an additional peer review of the Groundwater Impact Assessment for the Project has been undertaken. Dr Frans Kalf of Kalf and Associates Pty Ltd has completed the additional peer review as agreed with DPE. The peer review is presented in **Appendix 4** along with a response from AGE.

The peer review found:

The hydrogeological description of the region, modelling work, presentation of results and interpretation described in the AGE (2016) report is detailed, comprehensive and has been conducted in a professional manner in my opinion.

The hydrogeological description, conceptualisation, model design, simulations and reporting have been conducted overall in a thorough manner and described in detail. No fatal flaws have been detected in the description or modelling work conducted although improvements to alluvial drawdown predictions have been suggested. Overall drawdown/depressurisation predictions and effects of groundwater capture and influence on stream baseflow magnitudes are nevertheless considered plausible.

The peer review recommended some minor improvements in results presentation for the alluvial drawdown and recommended additional groundwater modelling locations. These recommendations have both been adopted and are addressed in the AGE response in **Appendix 4**.

b. A 6.7m drawdown is expected at bore GW060780. Provide details of any consultation that has occurred with the property owner. Provide details of the management measures to be implemented to mitigate impacts to the property owner.

As discussed in Section 6.8.2 of the EIS, the groundwater modelling results indicate that the Project will contribute to a potential maximum drawdown of 6.7 metres at one private bore (GW060780). This bore is not currently operable and has not been used since 1996, but it is understood to have been installed within the shallow weathered coal measures.

It is noted that the bore is located on a property within the predicted noise affectation zone for the Project and that this property is likely to have voluntary acquisition rights should the Project be approved.

As outlined in Section 6.8.2.2 of the EIS, the groundwater modelling predicts the bore would experience a maximum 6.7 metres decline in groundwater levels, with the Project predicted to account for 6.1 metres of drawdown during active mining. Currently groundwater levels at GW060780 are 6.9 metres above the base of the bore, therefore drawdown during mining is likely to impair the capacity of the bore. Following mining, the groundwater levels are predicted to recover and the maximum drawdown post-mining is predicted to be 3.1 metres below 2015 groundwater levels, of which the Project accounts for 1.8 metres of water level drawdown. It is therefore predicted the bore, if repaired, will remain usable, but with a reduced peak pumping capacity due to the predicted decline in water level.

As discussed in Section 6.8.2 of the EIS, whilst this property remains in private ownership (i.e. should the owner not request to be acquired) the bore will be monitored and if there is any material impact on serviceable water supply from this bore, United will consult with the property owner to determine appropriate make good measures. Make good measures will include ensuring the bore owner has access to a similar quantity and quality of water for the water bore's authorised purpose. This will be achieved through a range of options, including:

- bore enhancement by deepening the bore or improving its pumping capacity
- constructing a new water bore
- providing a supply of an equivalent amount of water of a suitable quality by piping it from an alternative source.

United, on behalf of the Joint Venture, has consulted with this landholder in relation to the predicted impacts from the Project including the potential groundwater drawdown and the proposed mitigation measures.

c. Figure 7-13 of the Groundwater Impact Assessment shows a sharp decline in groundwater level at GDE1 between April 2026 and April 2027. Identify and discuss the mining activity that causes this sharp decline.

GDE1 is a zone of identified Central Hunter Swamp Oak Forest that potentially uses groundwater from the Quaternary alluvium along Redbank Creek and Wollombi Brook. The Project does not directly intersect the Quaternary alluvium within this area, therefore drawdown due to the Project is related to depressurisation of the Permian coal measures.

Figure 7-13 of the GIA shows a significant cumulative impact not attributable to the Project. The adjacent Hunter Valley Operations (HVO) mine owned by Coal and Allied is approved to mine within and adjacent to the alluvium near GDE1. Mining at HVO South Lemington Pit 1 commenced in 1997 to the south of GDE1 and the Wollombi Brook. Mining is also approved at GDE1, north of Wollombi Brook, as part of the approved, but not yet commenced, HVO South Lemington South Pit 2. The model represents mining at South Lemington Pit 1 and South Lemington Pit 2 to account for cumulative groundwater impacts, and this mining contributes to the predicted change in groundwater levels at GDE1. The location of the approved HVO South operations is shown in Figure 7-12 of the GIA.

The predicted sharp decline in groundwater levels at GDE as presented in Figure 7-13 is due to the models representation of previously approved direct mining within the alluvium at South Lemington Pit 2 by HVO. It should be noted that the drawdown levels are a reflection of drawdown through the model cells, irrespective of actual saturated thickness of the groundwater systems. Therefore, the drawdowns simulated can exceed the saturated thickness of the alluvium.

d. Section 7.4 of the Groundwater Impact Assessment described the potential groundwater quality changes in the final void lakes. Further information is required including modelling of salinity in the final void lakes over time and a discussion of the results. A discussion of other potential contaminants that may accumulate in final void lakes and measures to mitigate potential impacts associated with these contaminants is also required.

The quality of water contained within the final void was discussed as part of the EIS Surface Water Assessment, which modelled the change in final void salinity with time. This water balance modelling indicated the salinity will gradually rise over time due to evaporative concentration of salts within the pit lake.

In response to the submission made by the IESC, a further geochemical characterisation program is being undertaken for the Project. The findings of this program and associated discussion on water quality and final void implications, if any, will be provided in Part B of the response to submissions. This issue is also discussed in further detail below in the section on final voids.

United will develop a WMP and groundwater monitoring program for the Project in consultation with DPI Water. The WMP and groundwater monitoring program will outline mine closure planning requirements. This will include ongoing monitoring requirements to develop a robust dataset for predicting final void water quality prior to mine closure.

e. Table A-2 of the Groundwater Impact Assessment should include a comparison of the water quality results across the main groundwater bearing units against the ANZECC (2000) guidelines for other above-ground uses such as drinking water and aquatic ecosystems or otherwise justify why these uses should not be covered.

Table A-2 within the GIA compared groundwater quality to ANZECC (2000) guidelines for irrigation and stock water. This table has been updated to compare groundwater with NHMRC drinking water guidelines and ANZECC (2000) fresh water aquatic ecosystem (slightly-moderately disturbed systems) and is presented in **Appendix 5**. Additional sourced data and summary statistics (median and sample population) are also included in **Appendix 5**.

Comparison of the **Appendix 5** water quality results to the additional guideline levels indicates that surface water (Hunter River and Wollombi Brook) and highly productive alluvial groundwater is generally suitable for drinking water based on the NHMRC health guidelines for available analytes. The surface water and highly productive alluvial groundwater may also meet the NHMRC aesthetic guidelines. However, it should be noted that these waters record average and median total aluminium concentrations of above 0.4mg/L. The NHMRC aesthetic guideline level of 0.2mg/L relates to acid soluble aluminium. Therefore the total aluminium concentrations and acid soluble aluminium trigger cannot be directly compared, particularly with the water generally recording a neutral pH. The difference in average and median total aluminium concentrations also highlights that spikes in total aluminium can occur. It should be noted that in the absence of field and laboratory reports, these results may also relate to sampling, laboratory or data entry error.

Groundwater within the less productive alluvium, Permian coal measures (interburden and coal) and spoil is generally not suitable for drinking water. As outlined in Section 5.5 of the GIA, groundwater use is very limited, with only two private bores installed within the Permian coal measures. Both bores intersect the weathered overburden, with no documented details on Permian groundwater being used for drinking water. This is likely due to the total dissolved solids (TDS), chloride, sodium and sulphate concentrations above the NHMRC aesthetic guideline levels in addition to a range of total metals concentrations above the drinking water guideline levels. However, it should be noted that the NHMRC guidelines are based on dissolved metal concentrations, whereas total metals concentrations have been measured in the monitoring network, therefore direct comparison to the guidelines is not possible.

All surface water and groundwater units record an electrical conductivity (EC) above the ANZECC (2000) guideline level of 120µS/cm – 300µS/cm for fresh water aquatic ecosystem in slightly-moderately disturbed systems. The total aluminium concentration for all units (median and average) is generally above the ANZECC (2000) fresh water trigger of 0.055mg/L for waters with a pH of > 6.5. Median concentrations are recorded above the trigger levels for zinc in all the groundwater bearing units, and above the trigger level for lead in the interburden and less productive alluvium. However, as noted in the ANZECC (2000) guidelines, total metals analyses (instead of dissolved) can overestimate the fraction that is bioavailable.

Refer to **Appendix 5** for the full comparison.

f. Table A-2 of the Groundwater Impact Assessment shows elevated levels of a number of contaminants in interburden and spoil. Provide details on the management measures proposed to mitigate risks of impacts to water resources including details on how interburden/spoil with elevated levels of contaminants will be considered when identifying dumping areas.

The potential movement of groundwater stored within spoil used to infill the mined area was modelled as part of the GIA. The representation of spoil within the model is discussed in Appendix B of the GIA. The groundwater assessment identified that due to extensive depressurisation from approved and the proposed mining, groundwater within the spoil and Permian coal measures is drawn towards the active mine areas. The extent of cumulative drawdown is presented in Figure 7-13 to Figure 7-18 of the GIA report.

As discussed in the EIS, analysis was undertaken by Geoterra Pty Ltd (Geoterra) to assess the acid rock drainage (ARD) potential of the materials to be mined. The study indicated that the vast bulk of overburden, interburden and floor materials represented by the samples tested are unlikely to be acid producing or release significant salinity and will be acid consuming. This is consistent with the current experience within the Project Area, however, the Geoterra laboratory results did identify some small areas of potential acid forming (PAF) material present within the Project Area (1 out of 87 samples collected) and the development of a management approach for this PAF material was discussed in Section 6.13 of the EIS and included selective placement of such materials. As most of the overburden material is acid consuming, the ooperational practice of rapid burial and mixing of any PAF materials with overburden is expected to be sufficient to control any potential for acid generation. This is common practice across Glencore coal mines in the Hunter Valley and provides effective control of PAF material.

As noted earlier a further geochemical characterisation study is being commissioned and will assist in further characterising the quality of runoff from the overburden material.

Should PAF material or other material with elevated levels of contaminants be identified, the following management strategies will be implemented (note that for PAF material further management may not be required where operational blending is determined to be sufficiently effective):

- avoid placing PAF / material with elevated levels of contaminants within five metres of the natural ground level in out-of-pit emplacement areas to isolate it from any water flow along the interface between the overburden and natural ground

- for PAF, mixing of acid neutralising materials (limestone and/or high ANC NAF overburden and interburden) with PAF material to increase lag times before onset of acid conditions

- selective placement and rapid burial of PAF material / material with elevated levels of contaminants at least 100 metres horizontally from the final outer perimeter of the emplacement area with a thick (not less than 20 metre) outer zone of non-acid forming (NAF) materials and for PAF materials, incorporate strategies to limit oxygen transfer to and fluctuating moisture conditions in PAF materials

- selective placement of PAF materials / material with elevated levels of contaminants in-pit below the long term recovery water table to allow inundation at closure and prevent long term exposure to atmospheric oxidation.

A programme of identification and selective handling of the overburden/interburden material identified in the geochemistry studies as being PAF / material with elevated levels of contaminants will be carried out during operations to ensure that the required management measures are undertaken.

g. Provide further information about the source of the data used to provide the water quality summary in Table A-2 of the Groundwater Impact Assessment including the locations and frequency of monitoring used to determine the values in the table.

As outlined in Section A2.2 of the GIA, the summary of water quality statistics was based on historic water quality data collected by Wambo and United, as well as available data from neighbouring mine operations. The data from neighbouring mine operations was sourced from publicly available annual environmental reviews and limited access data sharing agreements. The water quality data that was reviewed has been collected since 2001 as part of groundwater monitoring commitments outlined in WMP's and EMP's developed in consultation with the regulator for United, Wambo and HVO (North and South).

Table A-2 of the GIA has been updated with additional data and statistics, which includes the median values and data population for each analyte within each water bearing unit. The updated table is presented in **Appendix 5**. As shown in **Appendix 5**, the data population varies depending on the geological unit and analyte tested. The greatest number of readings have been collected for EC and pH, with 2,686 pH readings available for monitoring bores installed within coal seams. The location of all current and historic monitoring bores with available water quality data across United, Wambo, HVO North and HVO South is also shown in **Figures 3.3** and **3.4**.

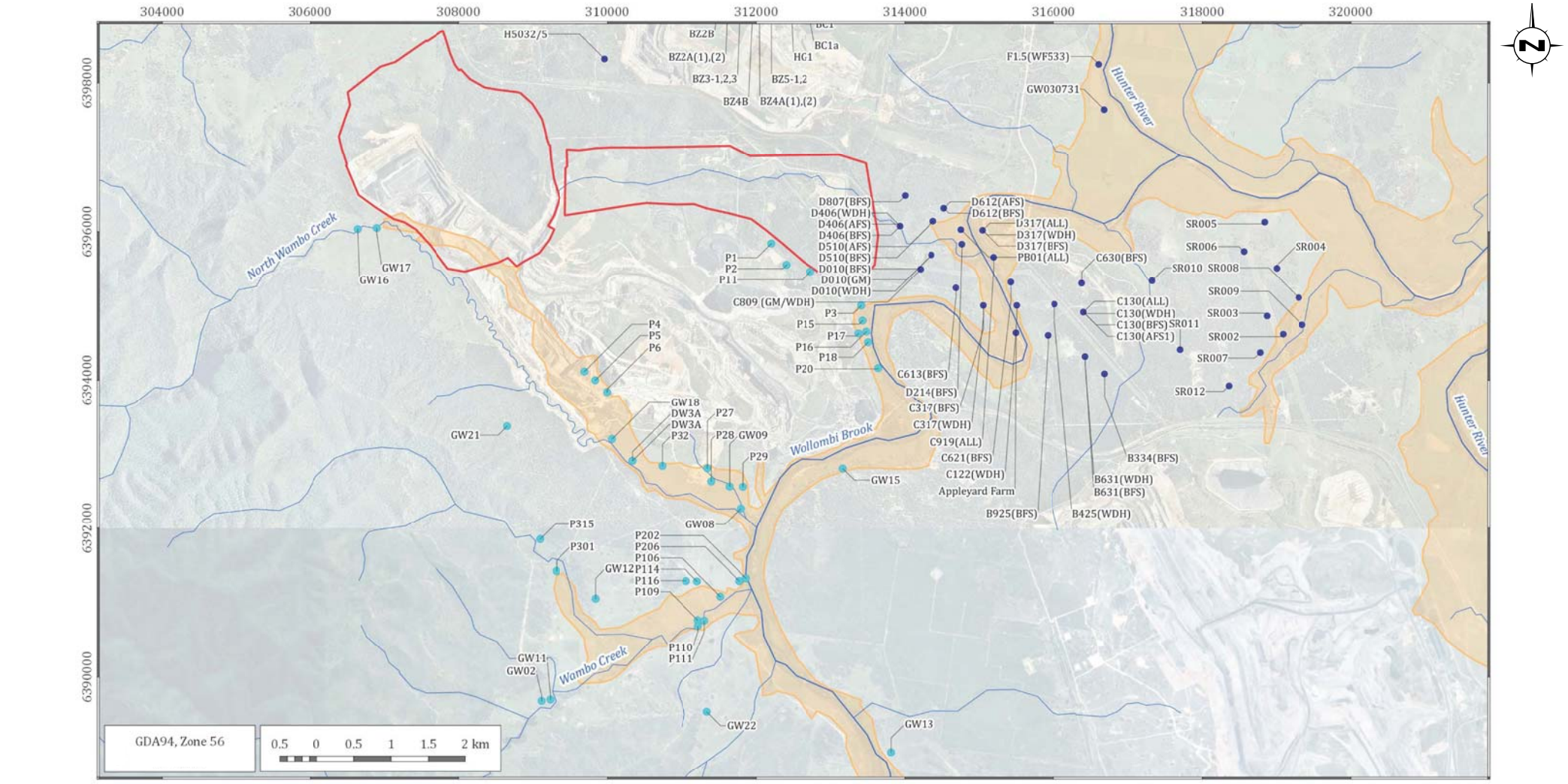


Image Source: AGE Groundwater & Environmental (2017)

Legend

- HVO Monitoring Point
- United/Wambo Monitoring Point
- Major Drainage
- Minor Drainage
- Proposed Extraction Area
- Quaternary alluvium (1:25k AGE)

FIGURE 3.3

Groundwater Monitoring Bores
United and Wambo

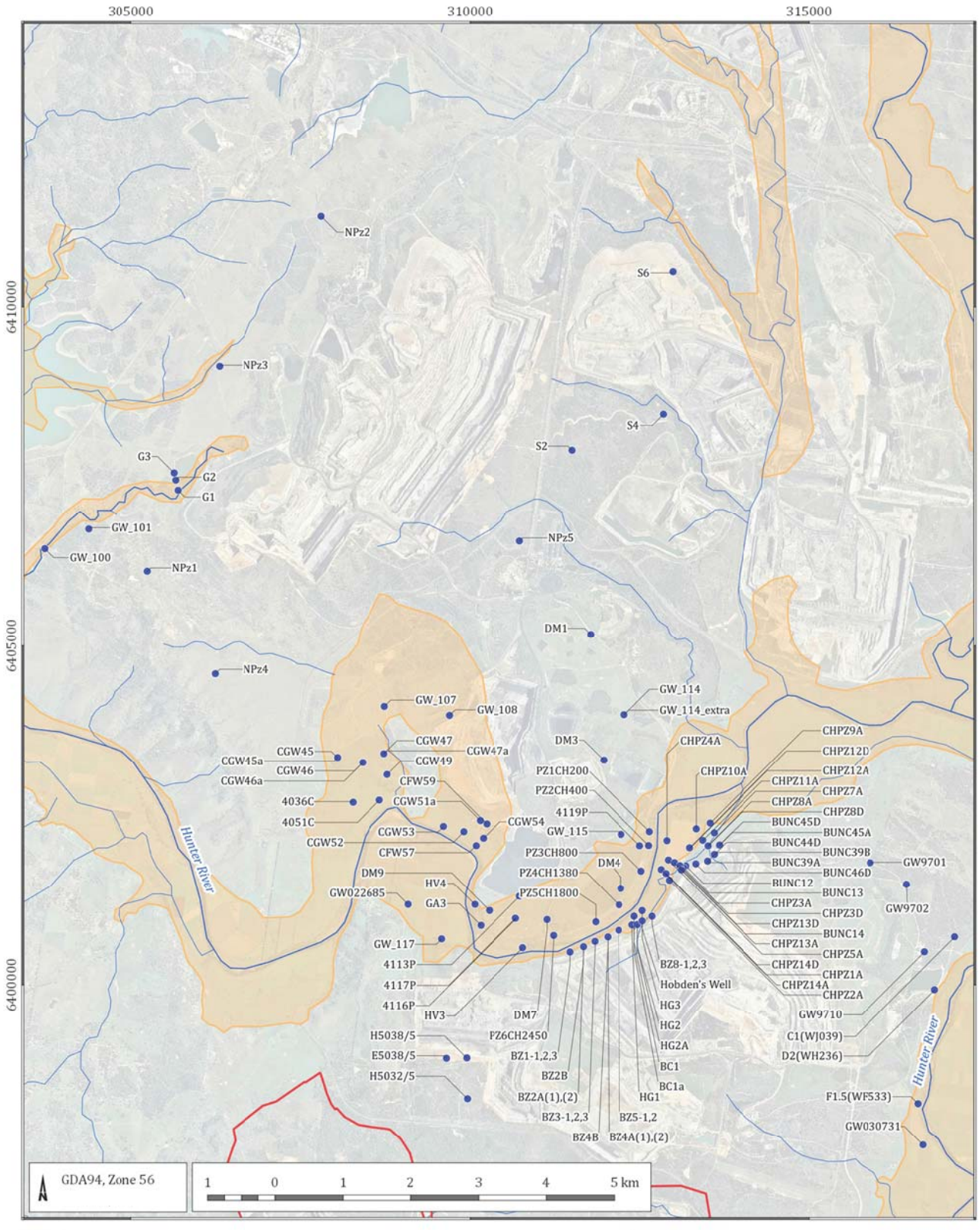


Image Source: AGE Groundwater & Environmental (2017)

Legend

- Monitoring Point
- Major Drainage
- Minor Drainage
- Proposed Extraction Area
- Quaternary alluvium (1:25k AGE)

FIGURE 3.4

Groundwater Monitoring Bores
HVO

h. Appendix E of the Groundwater Impact Assessment – Stygofauna Assessment states that drawdown for all sites that recorded stygofauna is expected to be negligible as they are outside of the area of predicted drawdown, therefore the stygofauna community is unlikely to be adversely affected by drawdown. However, stygofauna surveys were not undertaken in all areas expected to experience drawdown. In particular, monitoring of stygofauna did not occur in the area to the north of the Wambo Open Cut where drawdown in the Hunter River alluvium is predicted. Provide justification for excluding this area from surveys or undertake further surveys that are representative of the predicted groundwater impacts.

Additional stygofauna surveys have been completed in the Hunter River alluvium. The report is provided in **Appendix 6** and found that stygofauna exist in very low diversity within the alluvial aquifer of the Hunter River and are absent at the sites surveyed within the Wollombi Brook Alluvium.

The results of the additional survey indicate that the subterranean ecosystem within the Wollombi Brook Alluvium downstream of the Project Area is unlikely to be impacted by the predicted drawdown levels due to the lack of fauna within the alluvium.

The predicted drawdown of the Hunter alluvium is also predicted to have a minimal, local impact on the stygofauna community due to poorly developed biodiversity, the large extent of the alluvium and the connection with the Hunter River which will aid in long term recolonisation of impacted zones. The potential impact on the stygofauna community in the area of drawdown will be either a small loss of habitat associated with the dropping of water levels and a change in flow direction between the surface water and groundwater.

A risk assessment ranked ecological risk to sites where stygofauna were present as low value/low risk (refer to **Appendix 6**). The remaining bores which did not record stygofauna were ranked as low value/low risk.

i. The groundwater management and mitigation measures should provide clear commitments, and avoid ambiguous or hypothetical language. For example, words such as 'would', 'should', 'where possible', 'may' or 'where necessary' are to be avoided or clearly defined.

As outlined in the EIS, the final groundwater management and mitigation measures for the Project will be detailed within a Water Management Plan to be prepared for the Project. The Water Management Plan will be developed in consultation with DPE and DPI Water and will outline clear commitments to management and mitigation measures, with the final wording of the Plan to be subject to the approval of DPE which will ensure that the above issue raised by DPE is readily addressed. The Plan will be updated during the life of the Project to reflect the specific groundwater issues associated with the current and immediate future mining operations.

In direct response to the above comment by DRE, the proposed measures outlined within the GIA have been revised below, in order to demonstrate the approach to entering into clear commitments during the Water Management Plan development process.

Revised Section 10.7 of GIA

Management of groundwater for the Project involves the establishment of a robust surface and groundwater level and quality monitoring program, for relevant groundwater and surface water sources. Monitoring will also include routine quarterly monitoring of groundwater levels and quality within all potentially affected bores on land not owned by Wambo or United, where access is provided by the

relevant landholder. Results will be reviewed on a quarterly basis for early detection of potential impacts. The results will also be documented within annual reporting for key stakeholders.

Should monitoring indicate the changes in groundwater levels and quality, and surface waters are more extensive or significant than predicted, mitigation measures will be considered. Mitigation measures that will be considered following discussion with relevant government authorities include:

- modifications to the water management systems
- revision to the mine plans and dewatering options
- grouting and cut off measures
- supplying supplementary water from other groundwater and surface water sources
- obtaining additional water licence allocations
- reuse of mine water within the water management system.

If mitigation measures are not feasible, 'make good' measures with affected land owners will be carried out. Make good measures will include ensuring the bore owner has access to a similar quantity and quality of water for the water bore's authorised purpose. This will be achieved through a range of options, including:

- bore enhancement by deepening the bore or improving its pumping capacity
- constructing a new water bore
- providing a supply of an equivalent amount of water of a suitable quality by piping it from an alternative source.

3.1.5 Surface Water

a. The Surface Water Assessment identified that there are elevated levels of metals and metalloids in existing mine water dams. Provide details of how these metals/metalloids will be managed including management and mitigation measures to ensure that there is no overtopping in the event of flooding. Please also discuss the management measures that have been introduced since the mine water dam collapse in January 2016.

The water quality analysis undertaken for the Surface Water Assessment indicated that the presence of metals/metalloids are typically higher in the mine water system as well as the dirty water systems compared to the clean water systems, including the downstream creek systems. As part of the response to submissions to the IESC, United is undertaking additional water quality monitoring and analysis and geochemical investigations to assist in providing a better understanding of the risk of elevated concentrations of metals/metalloids within the WMS. Water within the dirty and mine water management systems will be managed as outlined in the Surface Water Assessment and as described below.

The existing dirty water management system includes a series of catch drains and sediment dams located to capture and manage runoff from disturbed areas. The concept dirty water management system for the Project has been designed in accordance with *Managing Urban Stormwater: Soils and Construction* (the

Blue Book), *Volumes 1 and 2E - Mines and Quarries* (Landcom 2004 and DECC 2008) to manage runoff from the 5 day, 95th percentile rainfall event.

Mine water consists of water that has the potential to be in contact with coal or carbonaceous material, and therefore has the potential to be saline. Mine water also includes runoff from the Mine Infrastructure Areas (MIAs), groundwater inflows and tailings decant water.

Mine water is generally collected and used preferrentially with the majority draining to the open cut. If a storm exceeds the capacity of the mine water dams then the open cut is not dewatered and the water is stored within the open cut; this mitigates the risk of overtopping and the inadvertant release of water into the environment. In practice, water is only released from the mine water dams via controlled releases during flows in the Hunter River in accordance with Hunter River Salinity Trading Scheme (HRSTS).

The concept WMS for mine water management areas has been designed to convey runoff, and to provide sufficient freeboard to contain runoff, from the 1 per cent Annual Exceedance Probability (AEP) 24 hour storm event (sometimes referred to the 100 year 24 hour storm event) within the mine water storage dams. That is, the mine water system has been designed to not overflow in any storm event up to and including the 1 per cent AEP 24 hour storm event; however, as noted above, the storage of water within mining voids is also used to further mitigate the risk of overflow. The water management system within the mine water management areas has been designed to minimise the risk of discharges of mine water, including water potentially containing metals/metalloids to downstream watercourses. In addition, as detailed in the Surface Water Assessment, the mine water management system dams lie outside of the 1 per cent AEP flood extent for the Wollombi Brook and as such will not be impacted by flood waters from Wollombi Brook during such an event.

Feasibility studies undertaken by United have included determining the operating regimes, including levels to maintain sufficient freeboard for storm event management. The preliminary design data is included in **Table 3.4**.

Table 3.4 Operating Volumes for Key Storages

Storage	Minimum Operating Volume (ML)	Target Operating Volume (ML)	Maximum Operating Volume (ML)	Full Supply Volume (ML)
PWD	23.3	130	136	180
Montrose Dam	NA	TBD once constructed	1150	1500
South Dam	NA	650	662	870
MW2	NA	35	37	112
W2	NA	50	203	262

During January 2016, a dam constructed to control sediment mobilisation from future disturbed areas at the existing Wambo mine suffered a dam wall failure during a significant storm event. The failure resulted in approximately 2.5ML of stored water to be released downstream into Waterfall Creek. In regard to the management measures that have been introduced by Wambo since the Wambo dam collapse in January 2016, an update is provided below:

Following the incident, immediate works were undertaken to repair and stabilise the wall of the dam.

Wambo has undertaken an internal incident review with the purpose of identifying business improvement opportunities to ensure that such an event does not reoccur. In its report to DPE and the EPA, Wambo committed to implementing the following actions:

- Undertake a review of Wambo's Erosion and Sediment Control Plan.
- Provide personnel responsible for implementing the Erosion and Sediment Control Plan with relevant education and training.
- Undertake a review of, and further develop Wambo's Erosion and Sediment Control inspection process.
- Develop an Erosion and Sediment Control construction sign off process that includes opportunities for staged inspections and reviews.
- Undertake a review of the site Pollution Incident Response Management Plan (PIRMP) to ensure that additional stakeholders are notified and consulted in relation to relevant environmental incidents.

At the time of writing, Wambo confirmed that all these actions have been implemented. Formal training of relevant personnel is ongoing.

b. Clarify where the HRSTS discharge regime value of 550ML/year is derived in Appendix 11 of the Surface Water Assessment.

The HRSTS discharge value of 550 ML per year is presented in Table 5.1 (Average Predicted Water Balance) of the Surface Water Assessment. The value of 550 ML per year is the average predicted HRSTS discharge based on the water balance modelling over the 121 realizations modelled for the full simulation period.

The Project will discharge water to Wollombi Brook under the requirements of the Wambo Environment Protection Licence (EPL), the HRSTS regulation and also the number of available salt credits. As shown in Section 4.5 of Appendix C of the Surface Water Assessment, the predicted annual HRSTS discharge volumes vary considerably both as a result of the local climatic conditions and discharge opportunities. The water balance modelling demonstrates there is sufficient storage in the system to allow wet years to be managed under the existing HRSTS credits as well as average years.

c. The EIS proposed a number of dams in the final landform. Provide information that demonstrates that United has sufficient water licences for the final landform catchment design.

A detailed response has been prepared to the DPI Water submission regarding surface water licensing (refer to **Section 3.5**). In accordance with the *Water Management Act 2000*, licences are required for all water take associated with the Project beyond that which is in accordance with harvestable rights or exempt from licensing. Water extracted from the Hunter River and Wollombi Brook will occur in accordance with WALs held under the *Hunter Regulated River Water Sharing Plan 2004* and the *Hunter Unregulated and Alluvials Water Sharing Plan 2009* respectively. United will ensure that it holds sufficient water licences as required for the relative scale and stage of the Project. The licensing review indicates that

the Joint Venture currently holds sufficient licences to meet the proposed final landform water licensing requirements. Further details on the final landform water licensing are provided in **Section 3.5**.

It is important to note that the water licensing regime may further evolve between now and mine closure, and obviously the licensing would need to adapt accordingly. That said, the details provided in this response (refer to **Section 3.5**) indicate that the proposed final landform can be appropriately accommodated in the current water licence regime.

d. Provide an assessment of potential impacts to landholders downstream of the project that may access surface water for stock and domestic purposes under basic landholder rights, including discussion on how any identified impact will be managed.

As discussed in the Surface Water Assessment, the majority of land adjacent to Wambo Creek, North Wambo Creek, Redbank Creek and Wollombi Brook immediately downstream of the Project Area is owned by Joint Venture participants or other mining operations. Specifically in regard to each creek:

- the Project will have no impact on Wambo Creek flows volumes or quality
- all land downstream of the Project Area along Redbank Creek is owned by mining companies
- all of the land adjacent to Waterfall Creek downstream of the Project Area to the confluence of the Hunter River is owned by mining operations and there are no known water users downstream on Waterfall Creek
- all land adjacent to North Wambo Creek downstream of the Project Area is owned by mining operations and there are no known private water users
- there are four lots on Wollombi Brook downstream of the Project Area that are owned by private landholders that retain basic landholder rights for domestic and stock use. All other land owners and water users are mining companies.

An analysis of flow gauging data and potential catchment and baseflow impact assessment for the Project indicate that the Project will have minimal impact on annual flow volumes in Wollombi Brook compared to the current approved landform. Water take from clean water catchments will be either managed under Harvestable Rights Provisions or licensed. As such it is considered that both basic landholder rights and licensed extraction volumes on Wollombi Brook will not be affected by the Project.

As discussed above, all of the land adjacent to Waterfall Creek downstream of the Project Area to the confluence of the Hunter River is owned by mining operations. As a result of the predicted increase in catchment area no decreases in water availability to downstream systems and future water users is predicted. The Project will result in a reduction to the catchment area of North Wambo Creek (approximately 7 per cent), however, as there are no private water users that will be impacted by this reduction, as the land adjacent to the creek is all owned by mining operations.

The Project will result in reduction in the catchment area of Redbank Creek (approximately 34 per cent), however there are no private water users that will be impacted by this reduction as the land adjacent to the creek is all owned by mining operations and United has an existing water licence for Redbank Creek.

The predicted impacts on flows in the Hunter River are negligible and in addition, due to the regulated nature of the river, it is considered there will be no impacts on downstream water users in the Hunter River.

As outlined in Section 6.3.3 of the Surface Water Assessment, the Project will have minimal impact on water quality in downstream watercourses. The Project WMS is designed to meet licence conditions within the requirements of the *Protection of the Environment Operations Act 1997* (POEO Act), taking account of both historical and current water qualities in the surrounding watercourses, and current and future downstream water users.

United has committed, as part of implementation of the Project, to develop a Project Water Management Plan (WMP) and associated sub-plans. These plans will include Trigger Action Response Plans (TARPs) for impacts on surface water and groundwater resources affecting private landholders, however, as noted above, adverse impacts on downstream water users are not predicted.

e. Provide information on how geomorphic changes to affected watercourses as a result of project activities will be managed. Also provide information on the rehabilitation measure proposed for affected watercourses.

A detailed response has been prepared to the DPI Water submission regarding geomorphology and watercourse monitoring/remediation measures (refer to **Section 3.4**). In summary the EIS included commitments to develop a Project WMP which will include aspects relating to channel stability and geomorphology, including baseline data and monitoring regimes/trigger values. This plan will cover Project-related potential impacts to North Wambo Creek, Redbank Creek and Waterfall Creek.

3.1.6 Rehabilitation and Final Landform

a. The conceptual mine plans in the Main EIS (Figures 3.11 to 3.16) show the areal extent of rehabilitation across the project. However the area proposed for disturbance is shown to be greater in Figure 1.11 of the Statement of Commitments. Clarify the extent and type of disturbance in the RTS.

Note that there is no Figure 1.11 in the Statement of Commitments; however, the overall issue raised is addressed in the response below.

The conceptual mine plans in the EIS (Figures 3.11 to 3.16) are mine plans showing the conceptual staging of mining for the operation, with conceptual footprints shown for pit development and rehabilitation. The proposed conceptual additional disturbance area for the Project is defined in Section 3.11 of the EIS. As described in Section 3.11 of the EIS, Figure 3.25 identifies the Approved Wambo Surface Development Area as well as the additional disturbance area for the Project. In addition to providing for the proposed mining activity shown in Figures 3.11 to 3.16 of the EIS, the additional disturbance area also includes areas to be affected by construction works or other ancillary activities undertaken as part of the Project. It should be noted that parts of the additional disturbance area contain areas previously disturbed by mining activities associated with the United underground mine.

Section 6.13 of the EIS describes the rehabilitation and final landform for the site. The area of proposed rehabilitation shown on Figure 6.57 of the EIS has been developed based on the combination of the approved Wambo surface development area and the additional disturbance area for the Project (refer to the boundaries shown on Figure 3.25 of the EIS). That is, the conceptual rehabilitation plan for the Project covers both the areas already disturbed by the Wambo Open Cut and the additional areas to be impacted by the Project as shown on **Figure 1.5**.

b. Provide information on how existing rehabilitation at United and Wambo mines will be incorporated into rehabilitation planned for the project. Provide information on impacts to existing rehabilitation at Wambo and United mines as a result of the project.

The Project has also been designed to maximise the use of previously disturbed areas, thereby minimising the additional disturbance area. Figures 3.11 to 3.16 of the EIS show the evolution of the mine, including areas of existing rehabilitation, within the Project Area. The Year 2 mine plan shown in Figure 3.11 is reasonably representative of the current extent of rehabilitation in the approved Wambo surface development area. As can be seen in Figure 3.11, there are two areas of existing rehabilitation, an area in the north and an area to the south east; both areas are in relatively early phases of rehabilitation. As can be seen in Figures 3.12 to 3.13, the northern area of rehabilitation is mined through as part of the United Open Cut; the northern and western parts of the south eastern area is affected by overburden emplacement activities (refer to Figure 3.12-3.13) and parts of the remaining areas of existing rehabilitation may be disturbed in the closure process where reshaping is required to improve the overall landform (refer to Figures 3.14 to 3.16). As can be seen from Figures 3.11 to 3.16, the rehabilitation progressively increases the connectivity between existing rehabilitation areas and the surrounding native vegetation. Thus, while the proposed mine plan (including improved final landform shaping) will impact on the majority of the existing rehabilitation areas at Wambo and United, the progressive rehabilitation associated with the conceptual mine plan will be developed in a manner which retains and improves connectivity with the existing rehabilitation areas until they are disturbed. It is also noted that United will recover topsoil and other ecological resources from existing rehabilitation areas where appropriate.

As discussed in Section 6.13 of the EIS, United has committed to the rehabilitation of mining operations to include ecological rehabilitation conforming to the Central Hunter Valley Eucalypt Woodland and Forest CEEC and areas of native woodland as per the existing Wambo EPBC Approval commitments. The area of ecological rehabilitation conforming to the CEEC will be developed to meet the relevant criteria and the needs of the biodiversity offset strategy. The remaining area of rehabilitation will be developed to meet native woodland end land use. The completion criteria utilised for sign-off of the rehabilitation will be in accordance with the relevant DRE standards and rehabilitation requirements. The vegetation established in areas of existing rehabilitation will therefore be of equivalent or higher ecological value than the existing rehabilitation requirements for these areas.

c. Section 6.13 of the Main EIS provides information to justify the feasibility and achievability of ecological rehabilitation. It is stated that an assessment of the United and Wambo mines rehabilitation areas identified that rehabilitation zones comply with EEC. Detail the assessment methodology used to determine compliance with EEC criteria.

It was identified during biodiversity surveys that areas of rehabilitation on the lower slopes of the Project Area could potentially be consistent with the *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion Endangered Ecological Community* (EEC) listed under the TSC Act as per the final determination for the community (NSW Scientific Committee 2011). An assessment of Vegetation Zone 3 - HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter – Moderate to Good Condition (Plantation) was undertaken to compare its floristic and specific attributes against those identified in the final determination. This assessment was done using detailed floristic plots completed within the Project Area. The results of this assessment identified that it conformed with the EEC, totalling 29.42 hectares. A summary of the assessment is provided below:

- This EEC is characterised by a canopy dominated by four key eucalypt species, namely spotted gum (*Corymbia maculata*), broad-leaved ironbark (*Eucalyptus fibrosa*), grey gum (*Eucalyptus punctata*) and

narrow-leaved ironbark (*Eucalyptus crebra*). The canopy layer of this community was dominated by spotted gum (*Corymbia maculata*) and hickory wattle (*Acacia implexa*), with some occurrences of sugar gum (*Eucalyptus cladocalyx*) totalling less than 5 per cent cover in places.

- This vegetation zone supports a reasonable proportion of species that are in the list of characteristic species for the EEC:
    - 15 out of 44 (34 per cent) native species recorded in this unit are characteristic species in the EEC listing
    - 15 out of 44 (34 per cent) species in the characteristic species list for the EEC were recorded in this unit. However of the 15 species recorded from the characteristic species list, only one species was a mid-storey or shrub species, the remaining species being either a canopy or ground layer species.
- Natural recruitment of spotted gum (*Corymbia maculata*) was recorded within the canopy, midstorey and ground cover layers. This was recorded as part of the biometric surveys of this vegetation zone.

The Central Hunter Valley Eucalypt Forest and Woodland CEEC was listed under the EPBC Act during May 2015, and components of Vegetation Zone 3 were also identified as being consisted with this CEEC. The total area of Vegetation Zone 3 in the Project Area is 29.42 hectares. Of this, 1.17 hectares conforms with the CEEC. The remaining 28.25 hectares of this vegetation zone did not meet the condition thresholds for the community as it had a high proportion of exotic species (greater than 50 per cent perennial exotic understorey), in particular *Acacia saligna*, as well as areas where the introduced sugar gum (*Eucalyptus cladocalyx*) was present.

d. Section 6.13 of the Main EIS references Mt Owen Mine rehabilitation and the lessons that will be built into rehabilitation strategy for the project to ensure recognisable and self-sustaining Plant Community Types are created. Discuss further what these lessons are and how they will inform the rehabilitation strategy for the project.

There are numerous learnings related to rehabilitation techniques from the research at Mount Owen; these are summarised in the *'MOCO Project - Response to PAC Review Report'* (Umwelt, 2016). Appendix 3 of the *'MOCO Project - Response to PAC Review Report'* contains a synopsis of some of the most relevant research into rehabilitation, which has been, and continues to be undertaken at Mount Owen. Appendix 3 of the *'MOCO Project - Response to PAC Review Report'* is attached as **Appendix 7**.

The rehabilitation at Mount Owen, also known as the Ravensworth State Forest Vegetation Complex, was listed as a "highly commended" site on the Global Restoration Network of the Society for Ecosystem Restoration in 2009.

As discussed in Section 6.13.4.1 of the EIS, the rehabilitation strategy for the Project will utilise techniques that simulate natural succession pathway. Sections 5.1.1.2 and 5.1.1.3 of the *'MOCO Project - Response to PAC Review Report'* contain detailed discussions of the consideration of succession pathways and Rehabilitation Research completed at Mount Owen. The learnings from these and other ongoing studies will be transferred to the Project. As discussed in Section 6.13 of the EIS:

> *'Monitoring results from the rehabilitated areas of other Glencore operations (for example, at Glencore's Mount Owen operations) demonstrates that there is a strong trend towards the re-establishment of self-sustaining woodland communities within mine site rehabilitation. It is also noted that areas of mine rehabilitation at United and Wambo Mines and within the additional disturbance area for the Project, although not yet mature, has been assessed as conforming to the*

CEEC. This finding confirms that the CEEC can be re-established through mine rehabilitation on the substrates within the Project Area.'

The Mount Owen Continued Operations Project was approved by the NSW Planning Assessment Commission in November 2016.

e. Section 6.13 of the Main EIS states that the proposed rehabilitation strategy aligns with key commitments previously agreed through the approval of Wambo and United mines. State what these commitments are and provide information on how these commitments are consistent with the Project's rehabilitation strategy. Identify commitments which are not consistent with the proposed rehabilitation strategy.

As discussed in Section 6.13 of the EIS and as reiterated in response to Question b above, previously mentioned commitments made as part of Condition 40 of the Wambo mine development consent states that 1,570 hectares of 'Open Woodland Revegetation' is required as part of the biodiversity Offset Strategy for the approved Wambo mine. The commitment to approximately 1,570 hectares of native woodland was also made in regard to the Rehabilitation Management Plan approved under Condition 2 of Annexure 1 of the EPBC Approval for Wambo and has been retained as part of the rehabilitation for this Project.

As detailed in Section 6.13.1 of the EIS, the rehabilitation strategy retains the commitment to the establishment of approximately 1,570 hectares of native open woodland within the Project Disturbance Area and planned for further approximately 878 hectares of Central Hunter Valley Eucalypt Forest and Woodland CEEC to be established in the rehabilitated landform. However, the final extent of ecological rehabilitation proposed will depend on the final offsetting rules that will apply to the Project as discussed further in Part B of the response to submissions report. The commitment to an area of Central Hunter Valley Eucalypt Forest and Woodland CEEC is directly related to the biodiversity offset strategy proposed to offset the additional ecological impacts associated with the Project. The establishment of approximately 1,570 hectares of additional native open woodland vegetation maintains the existing rehabilitation commitments for Wambo. In all, approximately 2,450 hectares of native woodland (approximately 80 per cent of the total Project Area) will be established in the rehabilitated landform.

Consistent with the rehabilitation commitments for Wambo, rehabilitation will be undertaken progressively throughout the operational phase of the Project. United has committed to provide native vegetation corridors linking surrounding remnant vegetation areas, including future vegetation areas planned on rehabilitated mining land to the north and east. Key linkages will include:

- from the Wollemi National Park through the Project Area to the proposed native rehabilitation areas of HVO South mine to the north
- to the southeast of the Project Area, through to the proposed native rehabilitation area of the Warkworth mine
- to the southeast of the Project Area.

These linkages are consistent with rehabilitation and biodiversity offset commitments for the existing approved Wambo development and align these objectives with strategic regional land use planning objectives (refer to Section 6.13.3 of the EIS)

f. Section 6.13 states that Wambo mine will undertake rehabilitation of the Wambo operations in accordance with its existing conditions. As the two Wambo approvals are subject to modification applications to extend the life of the approvals, the Department may update rehabilitation conditions to reflect current regulatory requirements.

This comment is noted.

g. Section 6.13.4 states that the progressive rehabilitation schedule may change due to changes or delays in the mining schedule. Provide further information on what these changes or delays might be and how this will impact the progressive rehabilitation schedule.

Changes or delays in the mining schedule may occur due to a number of reasons. These include:

- market factors such as variability in coal prices and therefore coal demand
- the dynamic nature of mining operations, including rates of coal mining and production as well as overburden
- changes in geological and geotechnical conditions that may alter mine plans or change the rate of mining.

As a result of the above, mining may progress at a different rate than anticipated in the predicted mining schedule in Section 3.5 of the EIS. As rehabilitation will only be undertaken in areas impacted by mining, the area of rehabilitation may be less or greater than indicated in any of the conceptual mine plan figures for a given year due to areas impacted by mining also being less than shown in Figures 3.11 to 3.15.

Other factors affecting rehabilitation progression also include the time required in the drying / consolidation process for tailings dam emplacements and climatic factors such as extended dry periods which may be unfavourable to vegetation growth. As outlined in the EIS, temporary rehabilitation will be used to stabilise areas and limit dust generation. Should unfavourable climatic conditions exist, temporary rehabilitation may be used to stabilise areas while awaiting favourable conditions for successful final rehabilitation outcomes.

The rehabilitation to be undertaken progressively over each stage of the Project will be detailed in the Mining Operations Plan (MOP) / Rehabilitation Management Plan (RMP) which is currently required to be updated at a maximum of every 7 years. The progression of rehabilitation against MOP / RMP targets will be reported to DRE and DPE through the Annual Review process.

h. Discuss how the key principles of the Strategic Framework For Mine Closure have been considered in developing the proposed rehabilitation and mine closure strategies for the Project.

The Strategic Framework for Mine Closure (ANZMEC & MCA 2000) provides a framework of issues to be considered as part of a mine closure plan. Key objectives from the Strategic Framework for Mine Closure and comments relating to each of the objectives are detailed in **Table 3.5**. As indicated in the table below, the key objectives have been addressed in the closure strategy for the Project.

Table 3.5 Strategic Framework for Mine Closure

Objective	Comment
To enable all stakeholders to have their interests considered during the mine closure process.	A detailed discussion of the stakeholder consultation was undertaken for the Project as discussed in Section 5.0 of the EIS. The stakeholder consultation undertaken in relation to rehabilitation and final landform is discussed in Section 6.13 of the EIS. United has committed to ongoing consultation as part of the Project and specifically in regard to mine closure as part of the detailed mine closure planning process.
To ensure the process of closure occurs in an orderly, cost-effective and timely manner.	The Rehabilitation Strategy in Section 6.13.4 of the EIS details the proposed mine closure planning process including the timely completion of progressive rehabilitation.
To ensure that the cost of closure is adequately represented in company accounts and that the community is not left with a liability.	Rehabilitation and mine closure costs have been considered in the Economic Assessment of the Project (refer to Appendix 19 of the EIS). Under the Mining Act 1992, Security must be provided under the terms of the mining leases to cover rehabilitation obligations under the lease. The security is held by DRE either as cash or bank guarantees in favour of the State of NSW. The value of the security is based on approved rehabilitation and imminent closure costs and provide for the rehabilitation of the site in the event of default by the leaseholder. The security requirements are updated on a regular basis to incorporate changes to operations and are approved by the DRE.
To ensure there is clear accountability and adequate resources for the implementation of the closure plan.	The Rehabilitation Strategy in Section 6.13.4 of the EIS provides for this process. The adequacy of the rehabilitation process is considered in the DRE approval process for MOPs/RMPs and compliance against rehabilitation requirements is regularly reported in the Annual Review.
To establish a set of indicators that will demonstrate the successful completion of the closure process.	Section 6.13.1.4 of the EIS contains preliminary closure and rehabilitation completion criteria for the Project. As outlined in the EIS, the criteria will be refined over time through the DRE MOP / RMP process. Compliance against criteria will be regularly reported in the Annual Review process.
To reach a point where the company has met agreed completion criteria to the satisfaction of the responsible authority.	Discussed in Section 6.13.1.4 of the EIS.

i. A key issue raised in public submission received relates to the two voids proposed as part of the final landform.

3.1.6.1 Final Voids

The issue of final voids has been raised in the DPE, DPI (refer to **Section 3.3**) and some community and interest group submissions (refer to **Section 4.10**). For ease of review, a consolidated discussion relating to final voids is provided below addressing each of the key themes raised in the submissions.

Glencore Approach to Final Voids

Glencore recognises that a proactive approach to mine closure planning and progressive implementation of decommissioning and rehabilitation works concurrently with mining activity will enhance mine closure outcomes, including minimising the extent of final voids. In the context of its Australian coal mining operations, Glencore has identified that open cut coal mining will in most cases end with some residual void, or voids, at the end of the open cut mine life and that completely removing or backfilling all voids is in most cases impractical and would make the mine uneconomic. However, Glencore is committed to minimising risks to the community from any residual voids through effective mine planning and through the development of effective final void designs. Glencore believes final voids should be designed to be safe, stable and non-polluting and that rehabilitation should be designed to support sustainable final land uses into the future.

Glencore recognises that an operation's ability to minimise final void volume and size is set during the course of the mine life rather than just the final phase of mining. Consequently a robust, detailed life of mine plan is an important input into the design of a final void. In achieving its overall aim of minimising voids, the following factors will be considered:

- the ongoing refinement of the life of mine plan needs to consider final void implications at each stage of planning
- the size and/or number of pit voids may be reduced by optimising of backfilling of pits during operations using spoil, tailings and rejects
- each pit void needs to be uniquely assessed when deciding which pits should be left as voids considering factors such as:
    - potential pollution impacts, through seepage or leakage into important or used aquifers, surface creeks or other areas (e.g. will the void be a long-term sink)
    - the potential to create geotechnical risks through voids being located adjacent to important built or natural features
    - land ownership or mining tenure constraints.
- there needs to be recognition that due to the dynamic nature of mining, mine plans will change through time in response to economic, geotechnical and environmental factors. As such, void positions / size / characteristics may change from that initially envisaged in concept mine plans, however, the design of the final voids in each mine plan iteration needs to meet acceptable outcomes

- final voids and rehabilitated mine sites need to consider opportunities for the economic diversification of an area following the cessation of mining. Considering such options as a part of the detailed mine planning process will assist in achieving appropriate final void outcomes.

In summary, Glencore is committed to minimising the scale and potential impacts represented by any residual voids where practicable, through integrated mine planning and environmental analysis, with a target of leaving all pit voids post-mining in a condition that is safe, stable, non-polluting and sustainable. These overarching commitments are further described as:

- Safe – associated with safe access and egress into pits by people and animals, and in the case of specific water quality issues, related to safe access and use of that water (in the pit void).

- Stable – associated with the risk of geotechnical wall failures, slips and similar mass movement or high erosion rates.

- Non-polluting – associated with geochemical risks and water quality impacts on important aquifers, creeks or surrounding ecosystems. The baseline and existing condition of the receiving waters is to be considered when determining acceptable water quality standards.

- Sustainable – associated with the ability to remain a stable system that supports some stabilising vegetation cover (where planned) and can satisfy the desired outcomes of safety, stability or that of not polluting into the future.

United will following these Glencore principles and commitments in the ongoing refinement of the detailed mine plan and during the design of the final voids as part of the planning and implementation of the Project. In response to the submissions received on the final voids, United has developed revised designs for the proposed final voids which provide for improved stability and reduced visual impact from the voids. These revised designs are discussed below.

As discussed in Section 6.13 of the EIS, Glencore, the manager of United, has implemented a proactive approach to rehabilitation and mine closure by developing a protocol that is implemented across its business units. The approach outlined in this protocol is proposed to be implemented for the Project. This approach incorporates planning for closure including design of any final voids as an integrated part of the life of mine planning process. Specific guidance is provided for developing, implementing and reviewing mine closure plans taking into consideration economic, social and environmental factors so that each of Glencore's operations meet statutory requirements and achieves sustainable post-closure land uses.

As discussed in the EIS, Glencore has a number of policies and protocols in place to manage the mine closure and rehabilitation process which will inform mine closure planning for the Project. The Glencore (GCAA) HSEC Protocol for Mine Closure Planning (2015) has been developed to guide Glencore operations to meet the requirements and expectations of the *Glencore Environmental Policy (Policy)* related to closure planning and rehabilitation. The objective of the Glencore mine closure planning process is to establish a process to guide all decisions and actions across the life of the mine such that:

- a post-closure vision is clearly defined up front in the Project life

- the Project is designed, planned and operated in a manner that considers closure obligations throughout the mine life

- closure risks and gaps are identified for the Project and a treatment plan is established

- closure costings and financial provisioning is based on a thorough, transparent and justifiable process to provide for sufficient funds to implement required actions until complete relinquishment is achieved

- at the cessation of mining, the closure liability includes those closure items that could not be undertaken during the operational phase of the mine, as far as practicable

- the post mining land uses for the Project are beneficial and sustainable in the long-term as measured against established rehabilitation objectives and criteria

- adverse socio-economic impacts are minimised and socio-economic benefits are maximised.

The mine closure plan required for each mine includes the scope of mine closure activities required at each phase of mining, with closure planning commencing at the exploration phase, continuing through the operational phase and eventually to sign-off of rehabilitation and successful mining lease relinquishment. The level of detail required in a closure plan increases as the operation proceeds towards the planned closure date. Specifically, the protocol requires that when a mine is within five years of the planned closure date a detailed closure planning process is to be initiated.

A Conceptual Closure Plan will be developed as part of the implementation of the Project. The Conceptual Closure Plan will be incorporated into the Mining Operations Plan (MOP)/Rehabilitation Management Plan and will be developed in consideration of the approach outlined in the EIS and this report, and will include details regarding final land use objectives and closure criteria, rehabilitation and final void management strategies as well as the process for engaging relevant stakeholders in the closure planning process to be adopted throughout the mine life.

The refinement of the Conceptual Closure Plan including the detailed design of the final voids will continue over the life of the Project resulting in the development of the Final Closure Plan for the mine. A Final Void Management Plan incorporating the outcomes of the specific final void groundwater assessments committed to in the EIS (to be prepared in the latter stages of mining when the final void design will be finalised) will be developed and included in the Final Closure Plan. As outlined in the EIS, the detailed final closure planning process will be commenced five years prior to cessation of mining.

Regulatory Controls

The NSW government regulatory and policy regime also provides significant management of the final landform and final void planning process. Rehabilitation of mine sites is regulated by both the development consent issued under the EP&A Act and the MOP required under the terms of the Mining Leases under the Mining Act. The development consent sets the rehabilitation outcomes or objectives while the MOP, which is reviewed at least every seven years, provides details regarding final landform and rehabilitation, including progressive updates to the design of the final voids.

The MOP must be prepared in accordance with guidelines developed by DRE. The guidelines require that the MOP identifies rehabilitation and closure objectives which are specific, measurable and demonstrate that proposed outcomes are achievable and realistic within a given timeframe. The MOP must identify the rehabilitation activities that will be undertaken during the term of the MOP and identify measurable performance indicators and completion/relinquishment criteria for each of the key stages of rehabilitation. The MOP must also identify hazards or threats to achieving the rehabilitation objectives and include trigger action response plans (TARPs) which set out contingency strategies to be implemented in the event that nominated completion criteria aren't achieved. MOPs are reviewed by DRE and must be approved before works can be undertaken under the mining lease. The security deposit held by DRE is linked to the rehabilitation set out in the MOP.

Mine sites are also required to report against compliance with the MOP and progress against criteria in the Annual Review required under the development consent and Mining Leases.

As discussed in the EIS, the stage plans showing the development of the mine are conceptual only and represent the most likely staging of the mine based on current plans, including the conceptual design of the final void. The actual development of the mine within the defined mining and disturbance footprint is subject to a range of factors that may affect the progression of mining development (e.g. geological conditions, weather, commodity prices etc.). The approved MOP will include detailed mine plans covering the term of the MOP (up to seven years) which must be adhered to; these plans must be consistent with the overall Project approved.

The regulatory interplay between the development consent (which defines the overall Project and approved mining and disturbance area footprints, rehabilitation commitments etc.) and the MOP (which contains the detailed mine plan for the term of the MOP as well as proposed rehabilitation works to be undertaken during the term of the MOP) provides a flexible regulatory framework which has regard to the dynamic nature of mining whilst also providing sufficient detail to ensure the mine is developed in an appropriate manner to realise the optimal value from the resources for the State. The progressive approval of MOPs over the life of a project also ensures rehabilitation commitments are implemented in a timely and realistic manner. This regular review of MOPs also enables rehabilitation techniques and performance criteria to be updated (and approved) as further knowledge regarding the constraints and opportunities for rehabilitation of the site is obtained. It also provides for ongoing refinement of the final landform for the Project, including the design of the final voids within the conceptual framework established for the Project as approved by the development consent.

These NSW government processes provide a framework that ensures appropriate final landform and final void outcomes in a dynamic mining environment. The DRE security deposit process also ensures that there will always be sufficient funds available (regardless of the financial status of the owner) to undertake the required rehabilitation and closure activities.

United Project Final Void Design Principles

United has established several design principles which will be applied to the final voids developed as part of the Project. These criteria build on United's overall commitment to make the voids safe, stable, non-polluting and sustainable. The design principles include:

- slopes within zones of weathered strata and final slopes of emplaced materials will be battered to achieve final slopes of 9 to 18 degrees
- highwalls will have slopes between 63.5 and 80 degrees
- regardless of the above slope criteria, all final void rock slope angles will be determined by geotechnical investigations to ensure they are safe and stable
- highwall bench widths of 10 to 20 metres
- within the void, overburden will be placed against all exposed coal seams including those that will ultimately be covered by water within the void
- a safety berm will be established along the top of each highwall
- the safety berm and associated drainage will be designed to prevent runoff flowing over the face of the highwall
- the void slopes and highwall benches will be revegetated.
- final internal corners of the mine highwalls are proposed to be rounded in areas above the final predicted water level to provide a more natural, less geometric form to the void sides.

The Need for Voids as Part of the Project

The existing approved final landform for Wambo contains two final voids. These were shown in Figure 3.9 in the EIS. While the Project will change the location and size of voids, it will not increase the number of approved voids in the final landform compared to currently approved mining operations. As discussed in the EIS, should the United Open Cut have been developed as a standalone mine without the Joint Venture, it would most likely have resulted in three final voids across the United and Wambo mining areas; being the two voids currently approved for Wambo and one new void at United. The Joint Venture provides the opportunity for an improved final landform including maintaining the existing approval for two final voids.

In response to the submissions made regarding the voids for the Project, United has investigated a number of possible options for improving void design, including the potential to reduce the number of voids. Options to remove voids from the final landform completely are not considered by United to be economically feasible for the Project (costing in the order of $450M).

Options involving the creation of one void instead of two voids were also investigated and were also found to not be economically feasible and it was found that there were no substantive environmental benefits considering the long-term salinity sink provided by the void and the additional impacts that would result from seeking to fill it back in.

As an outcome of United's investigations it is proposed to retain two voids in the final landform, however, United has identified the opportunity to provide improved final void designs as shown in **Figure 3.5**. These improvements are consistent with final void designs submitted for the recently approved Mount Owen Continued Operations Project SSD 5850.

The void associated with the Wambo Open Cut will be partly filled with overburden and the sides of the void will be shaped with micro-relief features incorporated. Based on the current conceptual final mine layout and landform design there will be no highwalls associated with the Wambo Open Cut final void due to the design of the Wambo Open Cut which as shown in the EIS, mines back into previously backfilled areas resulting in the removal of the final highwall. If however mining in the Wambo Open Cut does not reach the full extent shown in the EIS due to future economic or technical mining constraints, there may be sections of the highwall that remain *in situ* at the conclusion of mining. These will be treated with the same design principles outlined above. A pit lake will establish in the base of the Wambo Open Cut final void over time as shown on **Figure 3.6**.

As part of the closure process, additional battering of the upper benches of the United Open Cut will also be implemented to improve the visual amenity of the void and reduce highwall height as shown on **Figure 3.6**. This will also improve long term geotechnical stability of the top weathered sections of the highwall. It is not feasible to completely remove the highwall from this final void due to mining lease and land ownership constraints to the north and interaction with the emplacement areas to the west and south. A large portion of the retained highwalls will be below the predicted final water level in the pit lake and there will be minimal vantage points from which the remnant highwall will be visible (particularly once vegetation has been established on adjacent areas) prior to inundation. Berms will be established above the highwalls to prevent inadvertent access and public access to the land post-mining is expected to be limited based on the proposed final land use of native vegetation.

In addition, the final internal corners of the mine highwalls are proposed to be rounded in areas above the final predicted water level to provide a more natural, less geometric form to the void sides. This is also shown in **Figure 3.6**. The widths of the benches formed in the final highwall are proposed to be between 10 and 20 meters wide to provide for long term stability, and opportunities for the establishment of low height vegetation on the benches over time. This will further improve the visual aspects of the void.

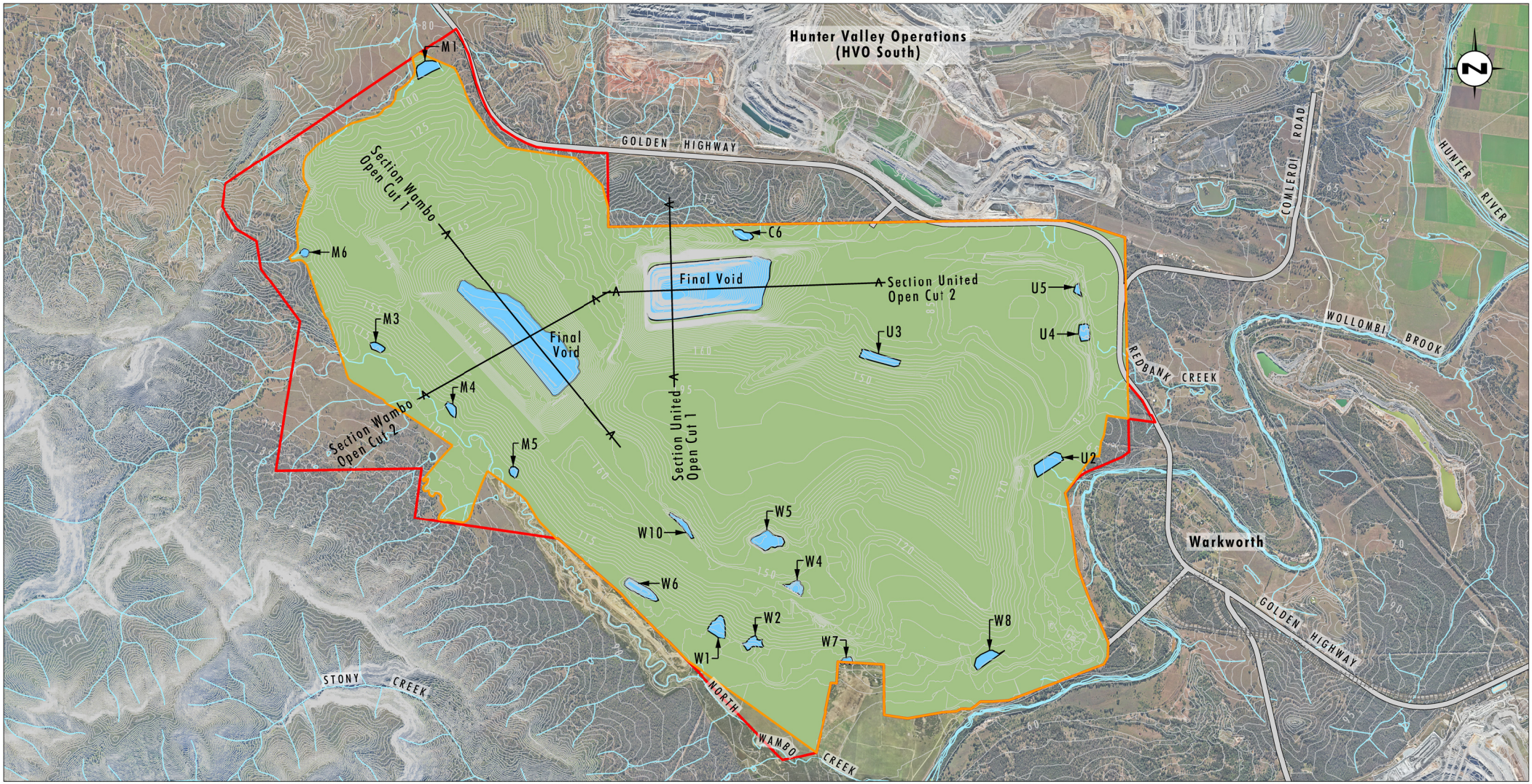


Image Source: United (2016)
Base Data Source: Glencore (2015), LPI (2009)
Note: Contour Interval 5m

0 1.0 2.0 2.5km
1:50 000

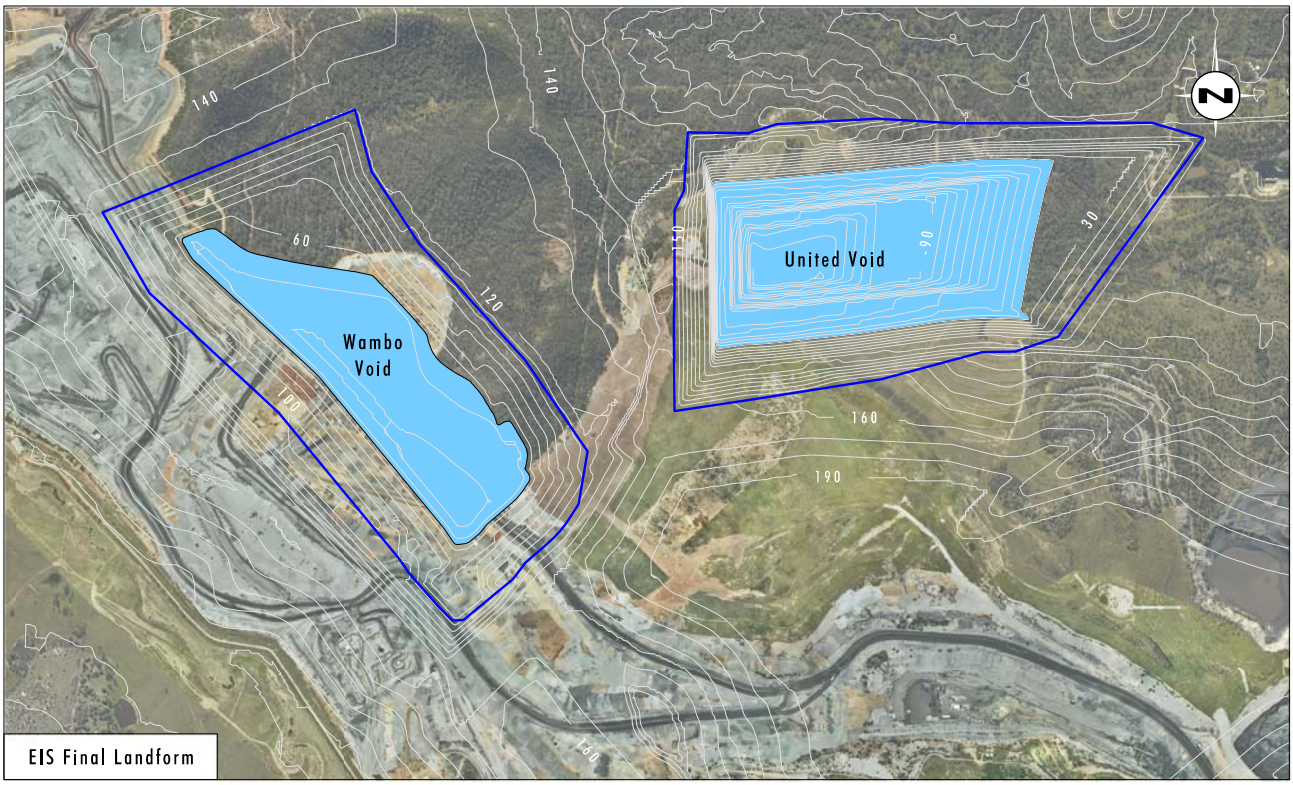
Legend

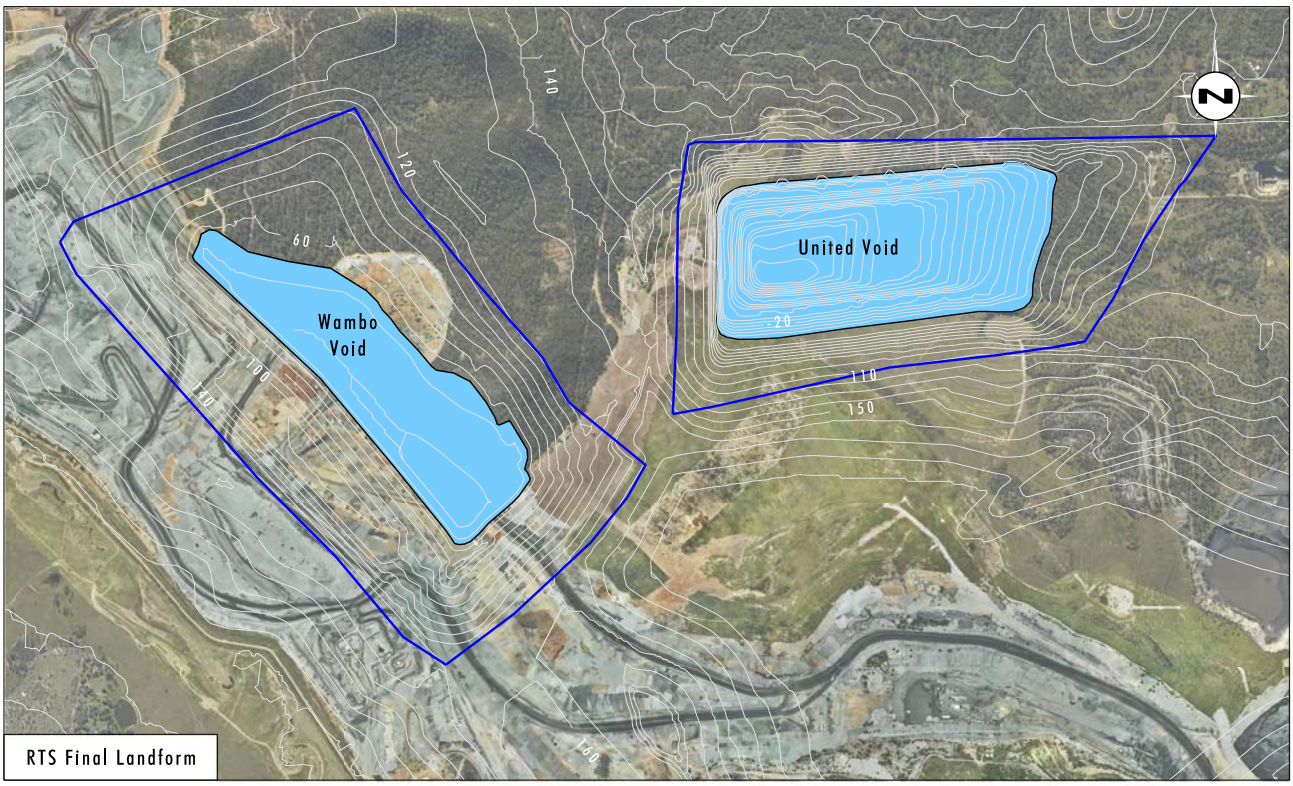
- Revised Project Area
- Revised Conceptual Rehabilitation Boundary
- Rehabilitation
- Dam
- Drainage Line

FIGURE 3.5

Conceptual Final Landform

File Name (A4): R18/3509_515.dgn
20170201 13.23





Legend

- Final Void
- Dam

0 0.25 0.5 1.0km

1:25 000

Image Source: AAM (2012), United (2016)
Data Source: Glencore (2016)
Note: Contour Interval 10m

File Name (A4): R18/3509_535.dgn
20170123 16.45

FIGURE 3.6

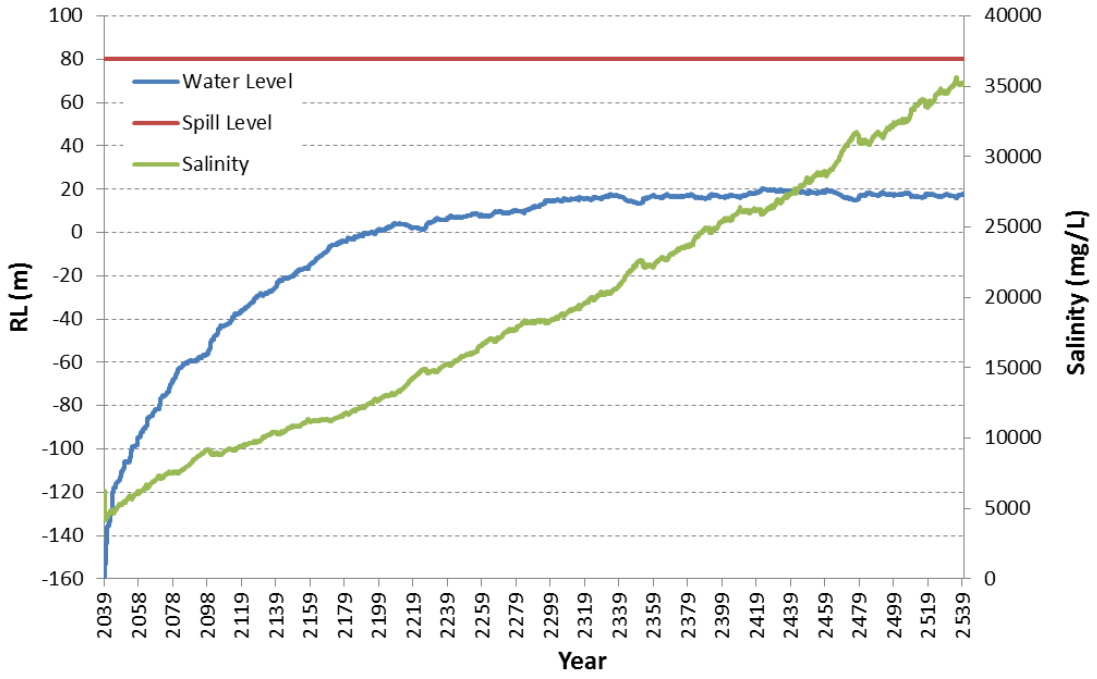
EIS Final Landform and the Revised Final Landform

Final Void Water Level and Quality

The final voids will contain water from a combination of groundwater inflow and surface water capture. To understand the volume and quality of the water predicted to accumulate in the voids over time, long-term modelling of the final void water levels and salinity was undertaken as part of the Water Balance Assessment in the EIS. For ease of reference these results are reproduced below.

The water balance model predictions for the United final void are shown in **Graph 3.1** and indicate that simulated water levels in that void would take a period of approximately 400 years to stabilise at just below RL 20m which is approximately 60m below spill level. This long-term water level would result in continued groundwater inflow into the final void; that is, net groundwater outflow should not occur and the void would be a long-term sink. The long-term predicted equilibrium water volume is less than 50 per cent of the estimated void capacity indicating there is very significant buffer capacity in the void storage and overflow of the voids is not predicted during wet periods.

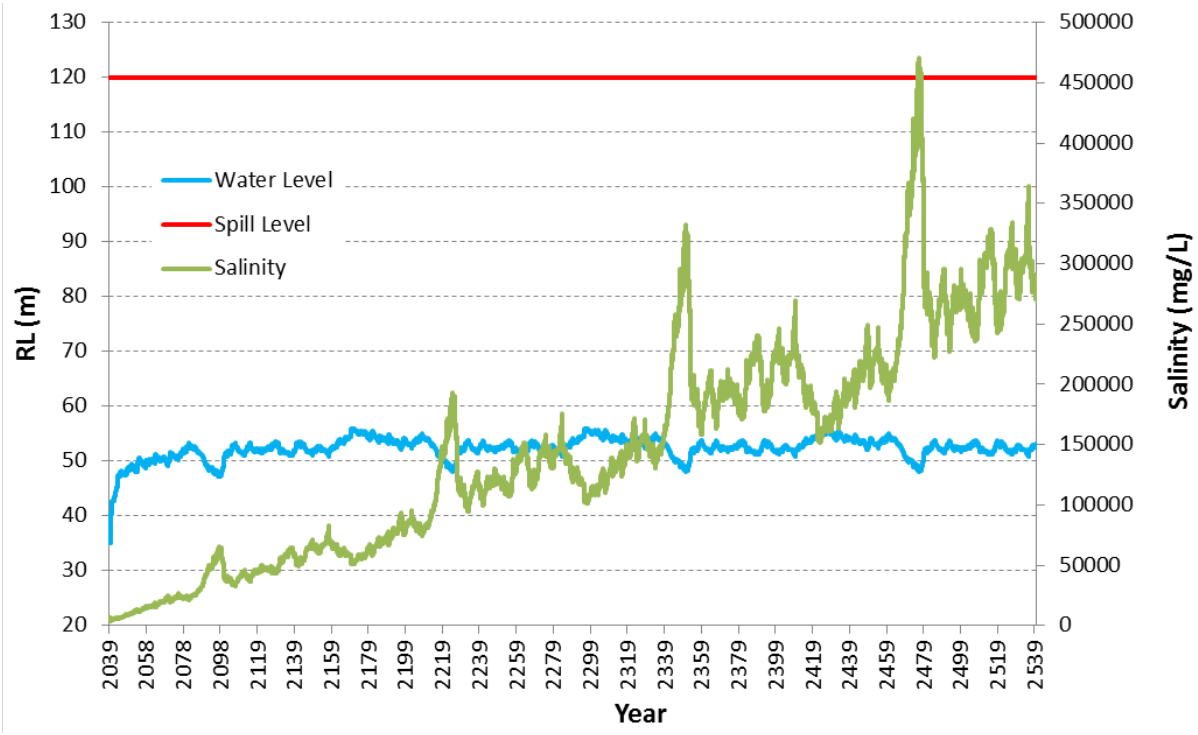
The only loss of water from the void would occur via evaporation and **Graph 3.1** indicates that due to this predicted salinity levels would increase slowly, tending in the very long term towards approximately 35,000 mg/L after about 500 years.



Graph 3.1 Predicted Final Void Water Levels – United Void

The water balance model predictions for the Wambo final void are shown in **Graph 3.2**. The predictions indicate that simulated water levels would take approximately 100 years to equilibrate at just below RL 55 metres which is approximately 65 metres below spill level. The long term predicted equilibrium water volume is approximately 5 per cent of the estimated void capacity indicating that the void would hold only a relatively small amount of water. Modelled salinity is predicted to reach hyper-saline conditions within approximately 50 years and would continue to rise in the longer term. This behaviour is as a result of no loss of water from the void other than through evaporation. This void would also act as a long-term sink. The level of salinity in this void is predicted to be much higher than that of the United final void due in part to the lower surface water inflow to the void and lower overall water volume in the void (<10 per cent of the volume of water predicted to occur in the United void. As part of the detailed design of the final landform and final voids towards the end of life of the mine, this outcome could be changed through

providing an increased catchment area for the final void if this was determined to provide a beneficial outcome.



Graph 3.2 Predicted Final Void Water Levels – Wambo Void

Further work in relation to the geochemistry of water captured within the minewater management system and mining voids is provided in Part B of the response to submissions.

The presence of a pit lake and the evaporation from the pit lake is a means of managing long term surface water and groundwater impacts. In the absence of a pit lake to control groundwater levels through evaporative processes (i.e. groundwater 'sink'), groundwater levels will recover back towards pre-mining conditions. In the absence of a pit lake post mining, the water table would likely rise within the disturbance area (i.e. mounding). This is due to the lack of evaporation at the water table and increased recharge potential through the spoil material, which is more permeable compared to the undisturbed Permian coal measures. The natural quality of water within the Permian coal measures, and contributions from spoil material, would likely result in brackish to saline quality water. With time, the water table could increase to a level where it could form a groundwater source, and interact with the fresher alluvial aquifer and surface water systems. This would lead to potential impacts on the water quality in the alluvial aquifer and receiving creeks, which would in turn impact on GDEs, aquatic biota and other water users. This risk can be managed by retaining voids in the final landform, which can be designed not to spill by balancing losses from evaporation with inflows. It should be noted that pit lakes are included within the approved open cut mine plan. However, these designs have been modified for the Project to ensure a groundwater 'sink' is maintained post mining.

As discussed above and in Section 6.13.1 of the EIS, the closure plan for the operation will be developed and refined over time with the detailed closure plan to be developed 5 years prior to the date of planned closure. As detailed in Section 6.13 of the EIS, the development application is seeking approval for the rehabilitation of most of the site for ecological purposes with some areas of agricultural land. Within this land-use objective, the reshaping and rehabilitation of void areas can be managed to promote the ecological values of the pit lake. In this regard, the higher volume of water and less saline water in the United final void has more options than the lower volume of higher salinity water in the Wambo final void.

While water quality within both voids may not be appropriate for stock or irrigation use, even saline systems can have high ecological value outcomes, with the United void predicting to reach a salinity broadly consistent with seawater after approximately 500 years.

The voids have been positioned in the landscape to be well outside flood affected areas and are not at risk of being inundated during future flooding events.

Post Mining Uses for Voids

The opportunities for post mining land uses for voids will be driven by a range of factors including the surrounding land use (including both adjacent land use and the surrounding region more broadly), the amount and quality of the water within the void, the landform of the void and the needs of the community. In regard to the waterbodies in the voids, based on modelling of the conceptual final void designs as discussed above, the United void will hold a relatively large amount of water (approximately 40,000 ML) and will have water of a quality that gradually approaches the salinity of sea water after approximately 500 years. The Wambo void will hold a relatively small amount of water (approximately 3,000 ML) and will reach hyper-saline conditions after approximately 50 years. Based on these predictions, the United final void which will hold more water and water of a better quality has more options available in terms of future uses.

The conceptual final land use for the majority of the site is native vegetation managed for biodiversity purposes. The currently proposed use of the voids is therefore part of this land use, with a focus on them providing biodiversity habitat. The water based habitats offered by the United final void will be of higher quality than that offered by the Wambo void due to its predicted better quality, however, as noted above, the Wambo void will hold a much smaller volume of water and the majority of the void area will shaped into slopes and planted with terrestrial native vegetation that offer a range of biodiversity values.

Voids and pit lakes also offer a range of options for different uses post mining, potentially including intensive agricultural uses which can utilise higher salinity water, with water with salinity levels up to and including that consistent with seawater theoretically being available for aquaculture. Some alternative other uses may include for recreation (e.g. water based activities, mountain biking, walking trails, rock climbing), industrial use as a water source, use of the voids for emergency services water storage or use of the voids for emplacement activities. Given the proposed 23 year life of mining operations, the potential uses that voids may have at the time of closure may differ significantly to those currently under consideration. For this reason, it is not considered to be appropriate from a planning perspective to definitively identify all potential uses but rather to identify final landforms that will lend themselves to a range of options in the future. This will allow consideration of further options during the detailed mine closure process and, if no alternative options are identified, the default option will apply, being a pit lake managed for biodiversity values within a broader landscape managed for biodiversity purposes. Despite the elevated salinity levels in the pit lakes predicted as part of the final landform proposed, the final landform will meet the core objectives of being safe, stable, non-polluting and sustainable.

The agricultural assessment identified that the majority of the site soils were not suitable for agricultural land use. As a result, only parts of the site are proposed for agricultural land use as part of the final rehabilitation plan (refer to **Figure 3.7**) and therefore the risk of unsuitable water quality in the final void for terrestrial agricultural land use is considered to be minimal. It is noted that the conceptual final landform retains a number of clean water dams which would be available for use for stock water as appropriate.

Should an alternative land use(s) be identified during the mine closure planning process, the detail regarding the locations where rehabilitation woodland is established in and around areas with greatest potential for alternative uses (including voids) needs to have regard to the likely footprint of these potential future uses. These alternative land uses may require some (likely minor) clearing of rehabilitation (e.g.

access roads, transmission lines or pipelines) if already established. Land uses different to the conceptual final land use of native vegetation will be subject to the planning approval processes in force at the time however, based on contemporary requirements, it is anticipated that alternative land uses will require further approval before being implemented. The approval process for any future development will require consideration of any impacts on the biodiversity values of the rehabilitated vegetation impacted and, based on current policies, any residual impacts on biodiversity values would need to be fully offset on a maintain or improve basis. This approach is consistent with the principles of ecologically sustainable development. It is noted that the area of ecological rehabilitation proposed as part of the biodiversity offset strategy for the Project is intended for long-term conservation and this area would not be available for alternate land uses.

When considering suitable future land uses for the site, it should be borne in mind that the pre-mining landscape was primarily low value agricultural land which, consistent with the experience in other areas of the Hunter Valley with lower quality soils, was regenerating back to woodland communities. The indicative final land use identified for the Project is consistent with the pre-mining landscape with the exception of the inclusion of two voids, noting that the approved Wambo Open Cut currently has approval for two voids and the total number of voids in the local landscape will not be increased. The planned final voids will not replace high value land uses and the voids and associated pit lakes increase the diversity of landscapes available at the site and therefore increase the potential land use options available for this land.

The proposed final landform and indicative land use described in the EIS are therefore considered to optimise potential values of the post mining landform.

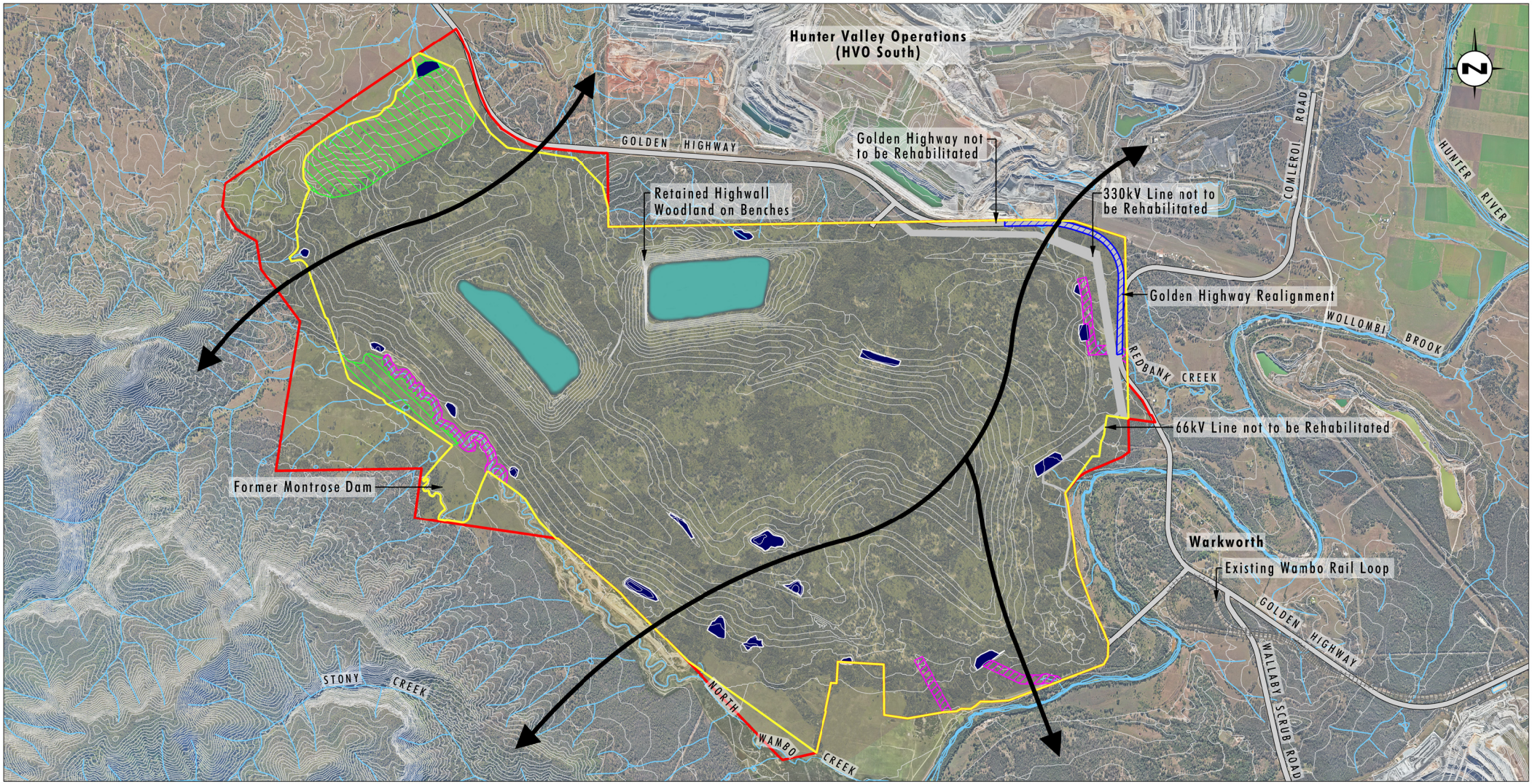


Image Source: AAM (2012), United (2015)
Base Data Source: Glencore (2015), LPI (2009)
Note: Contour Interval 10m

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Conceptual Rehabilitation Boundary
- Habitat Corridors (existing and proposed vegetation)
- Riparian Vegetation
- Grassland (Agricultural)

FIGURE 3.7

Conceptual Final Rehabilitation

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j. A key issue raised in public submission received relates to the two voids proposed as part of the final landform. The Department considers that insufficient justification has been provided for the voids and required the following information:

(i) further information demonstrating that the voids are unavoidable in the final landform design

(ii) a clear description of the area and depth of the voids

(iii) cross-sectional plans of each void

(iv) a comparison of the void dimensions and the dimensions of the voids currently approved at Wambo Mine

(v) a discussion on post-mining land use options for the voids in light of the assessed characteristic of the voids.

i) Information demonstrating voids are unavoidable

Refer to the response in **Section 3.1.6.1**.

ii) A clear description of the area and depth of the voids

Area and depth calculations of approved and proposed void arrangements are set out in **Table 3.6** (refer to point iv below).

iii) Cross-sectional Plans of the Voids

Cross-sections of the revised conceptual final voids for the Project are shown on **Figures 3.8** and **3.9**.

iv) Comparison of void dimensions

Table 3.6 compares the dimensions of the existing approved Wambo Open Cut final voids with the dimensions of the voids assessed in the EIS and the revised conceptual final voids for the Project.

Table 3.6 Comparison of Void Size between Approved and Proposed Conceptual Final Landform designs

Aspect of void	Approved Wambo Final Landform (ha)[#]		EIS Final Landform		Revised Final Landform	
	Void 1	Void 2	Wambo	United	Wambo	United
Depth of void* (m)	144	105	85	230	85	230
Maximum depth of Pit Lake (m)	94^	85^	20	175	20	175
Total catchment (ha)	390 [1]	193 [1]	193	263	223	261
Area of Pit Lake (ha)	28.4	9	41.9	57	39	54

[#] Area calculations for the originally approved Wambo voids (as approved) have been determined from pit floor area and have been digitised from information provided in the 2003 Wambo EIS. This is the area that is assumed to form as a pit lake in the rehabilitated final landform. The calculated pit lake areas of the approved Wambo voids are 28.4 hectares and 9 hectares respectively.

*Depth is taken from lowest point of catchment boundary (being the hypothetical overland spill point) to pit floor and includes areas which will be inundated.

^The recovery level of the pit lake is taken as being RL 50, being the calculated level after 200 years (from 2003 Wambo EIS)

[1]The catchments of the final voids are not defined in the 2003 Wambo EIS. These catchments are based on the final landform assuming that no diversion drains are put in place

It is important to note that the size of the final void is not the only factor that must be considered when assessing environmental impact. Glencore have undertaken significant revisions to the final void arrangements in order to improve stability, safety and environmental outcomes and void geometry, in order to create a more natural looking profile.

v) Discussion on post-mining land use options for the voids

Post-mining land use options for the voids are discussed in the response to issues raised by DRE (refer to **Section 3.3**).

k. Further information is required on the proposed United Open Cut final void highwall including:

(i) justification for retaining the highwall in the final landform

(ii) as assessment of the safety risk posed by the highwall post-mining.

(i) Justification for Retaining Highwall

As discussed above, the proposed configuration of the highwall has been revised in the Response to Submissions regarding final voids. As part of these revisions, the upper benches of the western end of the highwall of the United final void have been battered back to a lower slope. **Figure 3.6** shows the comparison between the highwall of the United Pit void originally proposed as part of the EIS, and the highwall of the United void as now proposed. The retention of the residual area of highwall in the final landform also provides the potential for the void to be used as an access point for potential future underground mining options should future investigations of the surrounding exploration areas indicate that such mining is viable.

(ii) Safety Risks posed by Highwall

The completion criteria specified in Table 6.42 of the EIS include a commitment to slopes being safe and stable.

There are two key hazards associated with highwalls remaining in the final landform:

- highwall stability (i.e. hazards associated with collapse or rock falls)
- falls from the highwall.

The assessment of these hazards and the risks they present are discussed further below:

Highwall Stability

United has undertaken an assessment of the stability of all the high walls associated with the Project from commencement to cessation of mining, including the long term stability of highwalls.

The stability assessment has considered the influence on wall stability due to:

- groundwater
- overburden emplacement areas
- remnant underground workings

- geological structures such as faulting, tuff bands, depth of weathering etc.

The assessment included an analysis of rock strengths of the existing material. The actual material coefficients used in the analysis were conservative and the key findings of the assessment were:

- the analysis found that the overall slope stability was adequate. Localised areas with risk of failure were identified and these localised areas have undergone redesign in order to engineer out the potential for failure, as discussed in **Section 3.1.6.1**, the design of the voids has been modified to include further battering of the weathered zone which will also provide for improved stability

- the design was critiqued and reanalysed for stability and it has been found to be adequate

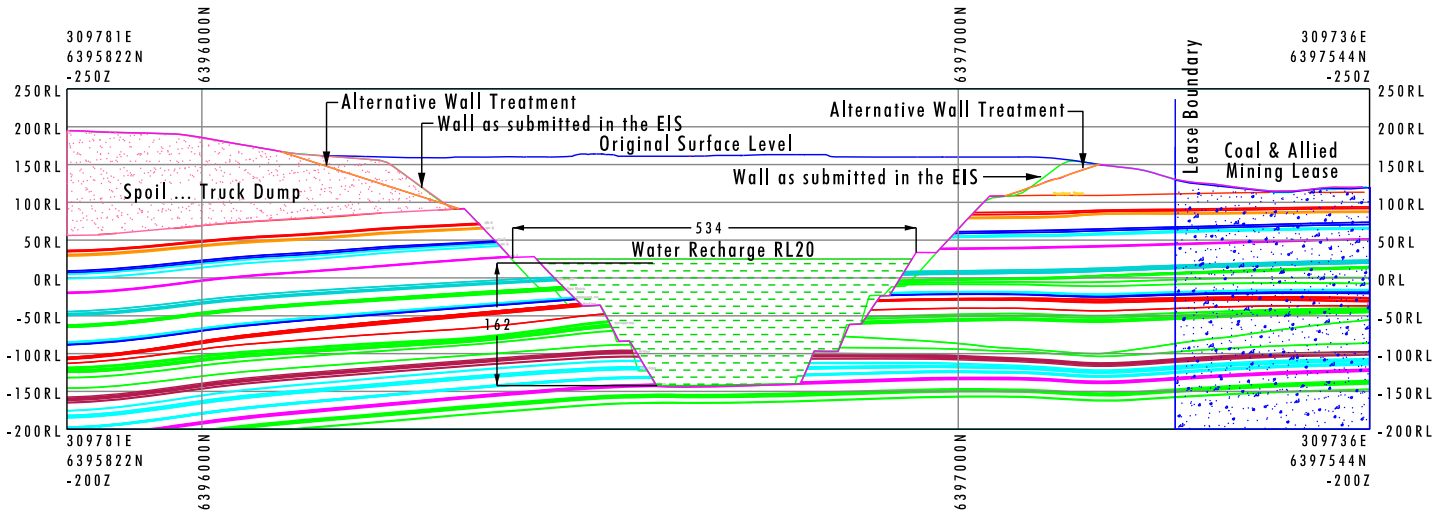
- in accordance with Glencore's internal safety requirements the slope stability analysis will be ongoing during the life of the mine. It is an internal company requirement to produce a Strata Control Management Plan with the plan being reviewed annually. The object of the plan is to identify and address any anomalies that may be encountered during the life of the project. The assessment and control of highwall stability will be ongoing throughout the life of the mine.

The stability analysis and Strata Control Management Plan process indicate that risks associated with highwall stability are manageable and acceptable. Cross sections of both voids are shown in **Figures 3.8** and **3.9**.

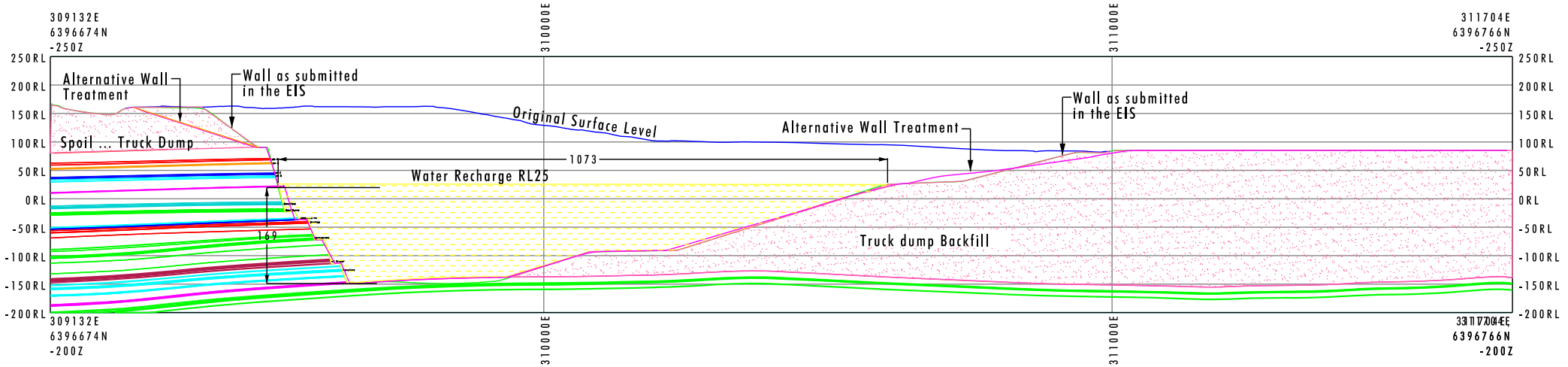
Falls from the Highwall

The risk of fall from highwalls remaining in the landform is similar to those presented by naturally occurring cliff lines in the surrounding areas such as the nearby Wollombi and Yengo National Parks. The main risks in such recreational areas are associated with vehicles or pedestrians inadvertently going over the cliff. As detailed in Section 6.13.2.1 of the EIS, this risk will be managed in the post-mining final landform by the installation of a safety berm along the top of highwalls. Safety berms are preferred over fencing as they require less maintenance and remain effective for an extended period. A well-designed bund is a longer term solution as it does not require maintenance and will provide adequate protection by slowing the progress of people and vehicles in order to warn people of a change in landform and terrain. As the indicative final land use will not result in high levels of public access to highwall areas, the risk of falling presented by highwalls is considered to be low with this control in place.

Furthermore, as shown in the cross sections **Figures 3.8** and **3.9**, the weathered material at the top of the highwall will be battered to 9 to 18 degrees to achieve improved geotechnical stability of this material, which will also reduce the likelihood of persons falling over the highwall.



Section United Open Cut 1



Section United Open Cut 2

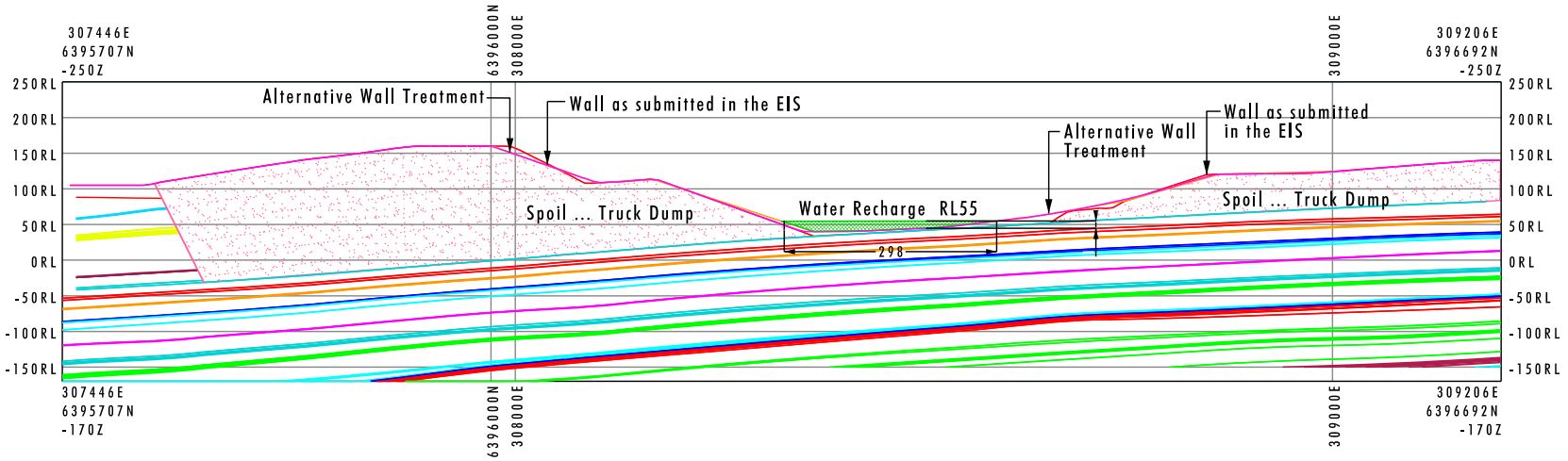
FIGURE 3.8

Void Cross Sections
United Open Cut

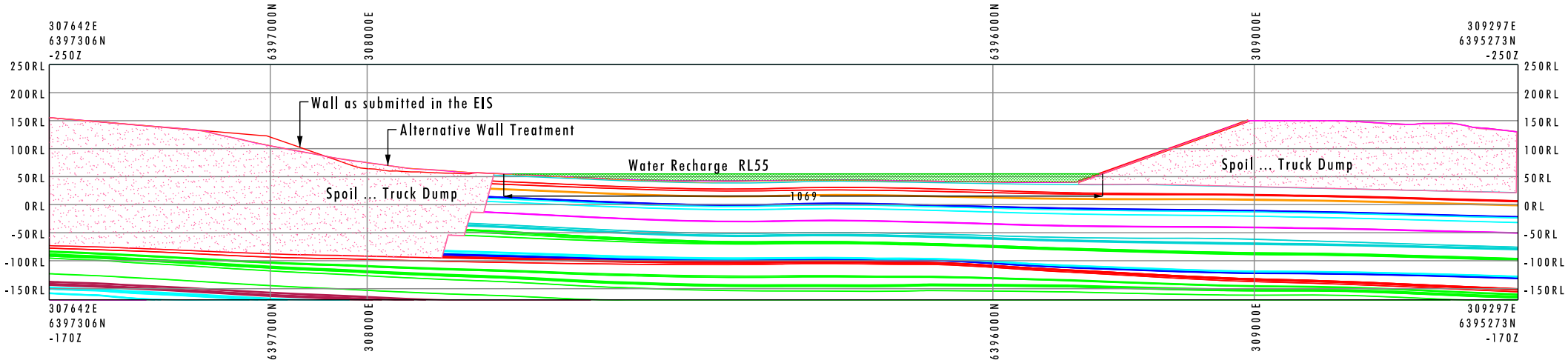
0 100 250 500m
1:10 000

Data Source: United Collieries Pty LTD (2016)

File Name (A4): R18/3509_530.dgn
20170131 13.30



Section Wambo Open Cut 1



Section Wambo Open Cut 2

FIGURE 3.9

Void Cross Sections
Wambo Open Cut

0 100 250 500m
1:10 000

Data Source: United Collieries Pty LTD (2016)

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3.1.7 Economic

The following responses have been prepared with the assistance of Deloitte Access Economics (DAE) which completed the Economic Assessment for the Project.

a. The Department commissioned a peer review of the Economic Assessment (Attachment C). This review identified a number of areas that require clarification and/or revisions for the Economic Assessment to be considered adequate for the assessment of economic impacts. The Department requests that the RTS address and respond to each recommendation in the peer review.

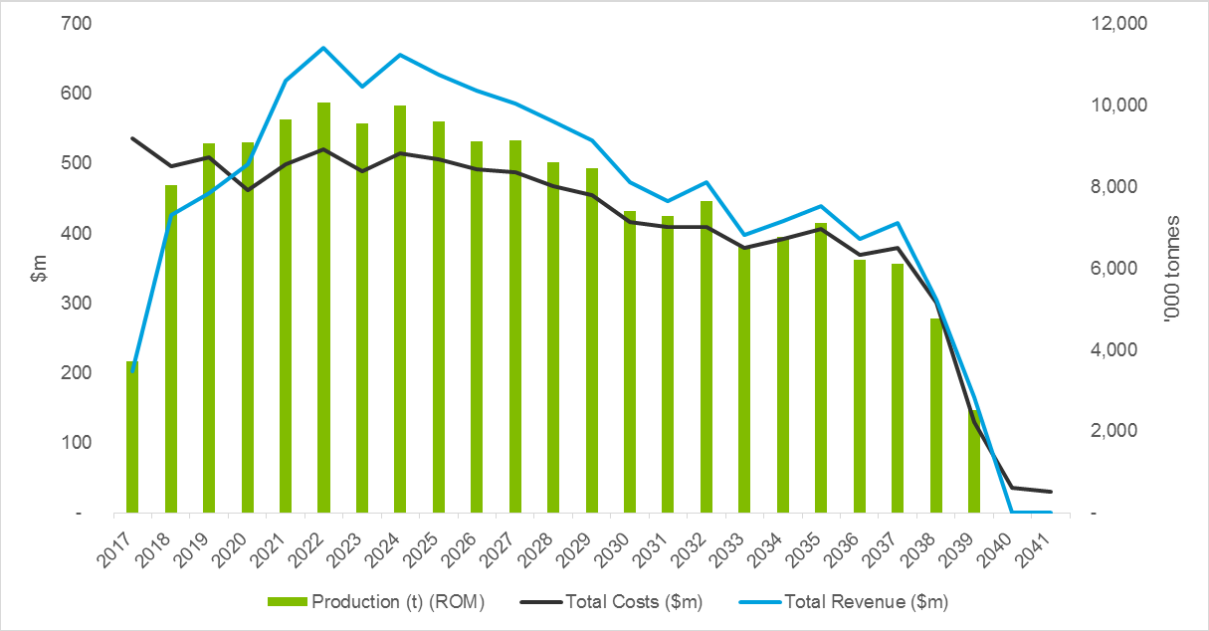
DPE commissioned a peer review of the Economic Assessment by The Centre for International Economics (CIE). The findings of the peer review of the Economic Assessment have been addressed and are presented in **Appendix 8**. The outcomes of the peer review process and the response provided by DAE do not change the key findings of the Economic Assessment as outlined in the EIS.

b. The Economic Assessment makes reference to an assessment undertaken by Pacific Environment – "Economic cost of air quality impacts – United Wambo Open Cut Coal Mine Project. A report prepared for Umwelt (Australia), 17 June 2016 of the likely costs relating to particulate matter emissions from the project" which has not been included in the EIS. Provide a copy of this report in the RTS.

Economic Cost of Air Quality Impacts – United Wambo Open Cut Coal Mine Project prepared by Pacific Environment (2016) is included in **Appendix 9**.

c. Provide a detailed analysis of the level and timing of projected activities and cost and revenue streams associated with the development. Whilst headline numbers (e.g. NPVs and 25 year totals) are presented, year-on-year numbers are not reported and are required for the Department's review of the Economic Assessment.

A year-on-year breakdown of projected activity, cost and revenue streams for the Project are presented in **Graph 3.3**.



Graph 3.3 Year-on-year activity, revenue and costs of the Project

d. Further information in the discussion of supplier surpluses (pp. 14, 254 & 60) is required. The Economic Assessment discusses upstream 'winners' but does not identify if there are any 'losers' from the mine expansion.

The Economic Assessment for the Project considered that there were no net benefits to suppliers (in terms of producer surplus) relative to what they otherwise receive in the base case. The assessment acknowledges that these outcomes are difficult to measure and it conservatively assumed that suppliers earn similar margins relative to what they could have received from other sources under the base case.

The assessment acknowledged that a decline in mining activity in the region could have flow-on impacts for suppliers which could be partially offset by the Project, such that the Project delivers additional benefits for suppliers relative to the base case.

There is not expected to be any significant loss of producer surplus for existing industries. The local effects analysis notes:

> …the Project is not expected to have any material effects on tourism and business travel. The Project involves the continued use of existing mining areas and does not affect any local accommodation providers. Overall the Project is not expected to result in a change in either the supply or demand of tourism or business travel services in the locality.

There may be some local industries affected by wage pressure associated with the Project. The Computable General Equilibrium (CGE) model suggests an increase in annual growth in real wages in the locality, incremental to the base case, ranging from roughly 0.75 per cent to 3.5 per cent per year over the life of the Project (refer to Chart 5.5 of the Economic Assessment). An increase in real wages could create losses for suppliers if they are unable to pass this cost through to prices. As this increase in wages is common to all suppliers it is highly unlikely that such an increase in cost cannot be passed through to consumers. Further, it is important to note that an increase in real wages represents a reallocation of resources between owners of capital and labour and does not represent a cost to the economy or society overall.

e. The local area affects analysis (LEA) lacks detail, and it is somewhat difficult to assess where the numbers come from. The analysis requires more discussion around the costs and benefits to the local area in accordance with the NSW Government's (2015) Guidelines for the economic assessment of mining and coal seam gas proposals.

The local effects analysis (LEA) in the Economic Assessment was presented to consider the likely impact of the development on the locality. The NSW Guidelines (2015) refer to the local area as being consistent with the relevant SA3 Statistical Area as defined by the Australian Bureau of Statistics. In the case of the Project, the local area is therefore defined as the Lower Hunter Statistical Area 3 which is shown in Figure 5.2 of the Economic Assessment.

The LEA translates the Cost Benefit Analysis (CBA) results to determine the scale of changes that will occur at the SA3 level. The three priority local affects determined in the guidelines are:

- effects relating to local employment
- effects related to non-labour project expenditure
- environmental and social impacts on the local community.

The LEA analysed each of these effects.

The direct figures regarding employment numbers and non-labour Project expenditure were sourced from United. As stated in **Appendix 8**, the non-labour expenditure effect assigned to the local area was calculated with reference to the supplier expenditure location data in the United Wambo Open Cut Mine Project: Town Resource Cluster Analysis, January 2016 (Umwelt 2016). Wage figures in the LEA are based on Lower Hunter wage data by occupation sourced from the ABS census data. On the advice of the proponent, it was assumed the Project wages will equal the average mining wage for the local area. This conservatively assumes no wage surplus. In the NSW Guidelines (2015), LEA reportable values such as net income increases per employee are given as averages. Therefore, unlike the CBA results, the results are provided as a yearly average rather than a net present value. LEAs are intended, in part, to help inform local communities; in this context, yearly averages have an advantage of being more easily interpreted by individuals with a non-technical background.

The LEA guidelines state that:

> …in quantitatively and qualitatively analysing [local] effects, an LEA starts with information from the CBA and identifies the relevant local components.

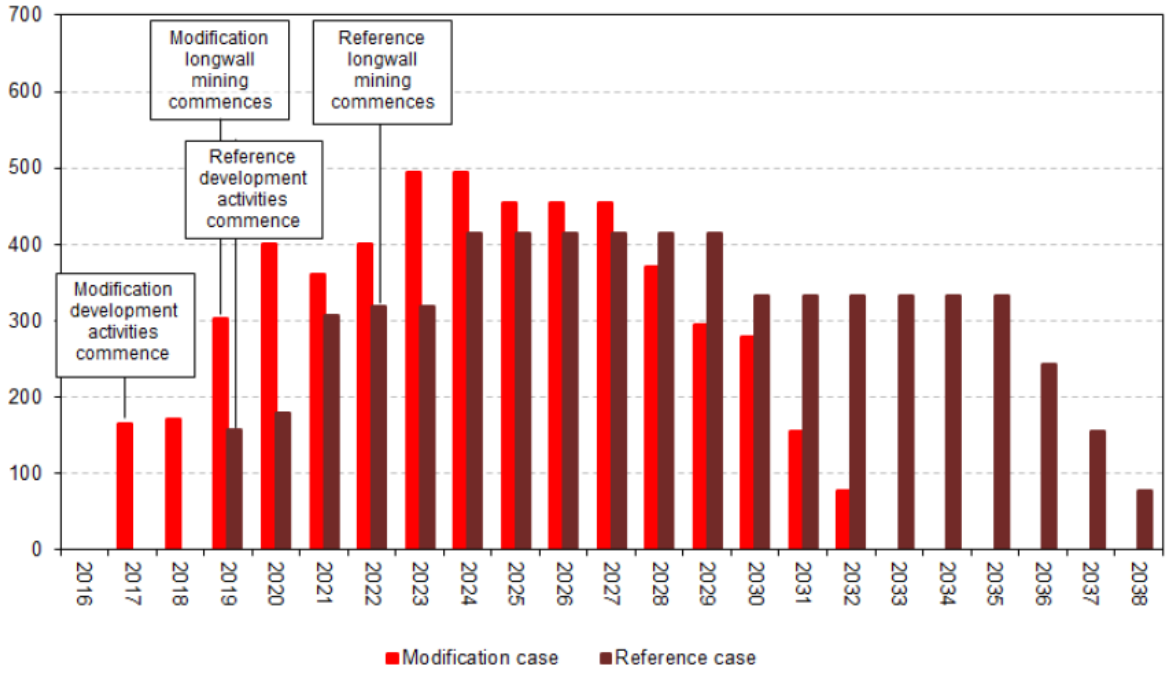
The quantitative environmental and social effects are therefore based on the CBA results. Each cost is attributed as either 'in' or 'outside' the locality. For example, air quality, noise and traffic cost are expected to fully accrue to locals while the cost of greenhouse gas emissions are spread across Australia's population.

The second-round effects such as indirect employment and wages growth are based on the CGE modelling. An acknowledged limitation of CGE modelling is that it is generally complex. However, DAE considers that CGE modelling is the preferred approach to estimating the consequences of major projects such as establishing or expanding a coal mine, since – as noted in the guidelines – IO analysis can overstate impacts.

f. Clarify the relationship between the employment generated under the two existing Wambo Mine development consents, Wambo Mine Modification 12 and the United Wambo project.

The modification of DA 305-7-2003 (Modification 12) was approved on 12 December 2016.

Under Modification 12, employment is expected to increase earlier than under the existing Wambo mine plan. Employment will reach a peak of 500 full time equivalent (FTE) (in 2023-2024) compared to a peak of 410 (in 2024-2029) under the reference case (i.e. without Modification 12). The employment profile under Modification 12 is compared with the Wambo mine without Modification 12 (the reference case) in **Graph 3.4** below. This graph shows the relationship between the employment numbers from the existing Wambo mine and Modification 12.



Graph 3.4 Employment at Wambo mine under Wambo Modification 12 case versus the reference case (no Modification 12 approval)

The Project has no bearing on the employment at the Wambo Underground Mine.

With regard to the operation of the Wambo Open Cut, there are currently approximately 250 full time equivalent employees. Should the Project not proceed these jobs would cease in either 2017 (current Wambo mine consent) or 2020 (should Modification 12 be approved). With the Project there is continued employment for these 250 employees and employment of up to an additional 250 employees.

3.1.8 Agriculture

a. Land to be acquired as a result of air quality and noise impacts will be subject committed to ongoing agricultural land use following purchases by United and Wambo Mines. Ensure that this commitment can be met where the lands purchased are subject to exploration tenements.

Six private rural residential properties (totalling approximately 138 hectares) have been identified as meeting acquisition criteria based on predicted noise and air quality impacts. As discussed in Section 6.3.4.3 of the EIS, the agricultural land on these properties will be subject to ongoing agricultural land uses should the properties be purchased by United or Wambo. Currently two of these properties are used for cattle grazing and one for lucerne and horses.

The Joint Venture would seek to continue agricultural activities on properties acquired under acquisition rights where they are currently viable. Agricultural activities are currently being undertaken on non-operational land owned by Wambo and Glencore has a sound history of undertaking agricultural activities on mining buffer land across its Hunter Valley and Queensland operations. Ongoing agricultural activities may not be pursued on properties that are not currently utilised for agricultural purposes or are not viable.

In regard to the implications of exploration tenements, the future mining of these tenements do not form part of the Project. Should any future land use changes be proposed by the owners of this land or another party at some point in the future, these changes will need to be subject to land use planning considerations and future development approvals if required.

b. Table 6.1 of EIS Main Report provides a table of the LSC Classes assessed across the Project Area and their presence and extent in the Project Area. Please provide in this table the predicted LSC Classes and extent (ha) for the project area post-disturbance.

As discussed in Section 6.3.5 of the EIS, at the conclusion of mining, it is proposed to rehabilitate the land and soil resources to broadly the same mix of land and soil capability. The proposed rehabilitation plan includes returning the northwest corner of the Project Area to soil capability class 4 agricultural land. A second area, along the south-western boundary of the current approved Wambo mine area, is also proposed to be returned to Land and Soil capability Class 4 agricultural land. The exact area of each land and soil capability class in the rehabilitated landform will be determined as part of detailed rehabilitation planning.

The remainder of the site will be rehabilitated to class 5 to 7 land, with a focus on native vegetation and habitats. This is consistent with the Synoptic Plan – Integrated landscapes and Coal Mine Rehabilitation in the Hunter Valley of NSW (Department of Mineral Resources 1999) and with regional biodiversity planning.

Table 3.7 provides the current land and soil classification within the conceptual rehabilitation boundary for the Project, based on regional mapping, and the indicative post closure land and soil classification. As discussed above, it is noted that this is indicative and may be subject to changes due to detailed rehabilitation planning that will be undertaken during life of the Project.

Table 3.7 LSC Classes and their presence in the Conceptual Rehabilitation Boundary

LSC Class	General Information	Present within the Project Area (based on regional scale mapping)	Indicative Post Closure
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)			
1	**Extremely high capability land (very slight to negligible limitations):** Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.	0 hectares	0 hectares
2	**Very high capability land (slight but significant limitations):** Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.	0 hectares	0 hectares
3	**High capability land (moderate limitations):** Land has moderate limitations and is capable of sustaining high impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.	Approximately 12.4 hectares	0 hectares
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)			
4	**Moderate capability land (moderate to severe limitations):** Land has moderate to high limitations for high impact land uses. Will restrict land management options for regular, high impact land uses such as cropping, high intensity grazing and horticulture. These limitations can only be managed by specialized management practices with a high level of knowledge, expertise, inputs, investment and technology.	Approximately 710.5 hectares	Approximately 115.7 hectares

LSC Class	General Information	Present within the Project Area (based on regional scale mapping)	Indicative Post Closure
5	**Moderate- low capability land (severe limitations):** Land has high limitations for high impact uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long term degradation.	Approximately 2006.3 hectares	Approximately 1726.3 hectares
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)			
6	**Low capability land (very severe limitations):** Land has very high limitations for high impact land uses. Land use restricted to low impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environment degradation.	0 hectares	Approximately 759.0 hectares
Land generally incapable of agricultural land use (selective forestry and nature conservation)			
7	**Very low capability land (extremely severe limitations):** Land has severe limitations that restrict most land uses and generally cannot be overcome. On site and off site impacts of land management practices can be extremely severe if limitations are not managed. There should be minimal disturbance of native vegetation.	0 hectares	0 hectares
8	**Extremely low capability land (extreme limitations):** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.	0 hectares	Approximately 102.1 hectares

3.1.9 Impacts on other land users

Section 6.2.6 provides a discussion on land uses outside the project area. The information provided in this section is insufficient to enable the Department to consider the compatibility of the development with other land uses. The Department received a submission from the Hunter Valley Gliding Club raising its concerns with the impacts of the Project. Address the issues raised by the Hunter Valley Gliding Club and consider all other land uses surrounding the Project Area in the discussion of impacts to other land users.

The site context is discussed in Section 1.6 of the EIS, including a land use figure for the Project Area and surrounds (refer to Figure 1.6 of the EIS). Section 6.2.5 of the EIS discusses the existing land use of the Project Area and surrounds. As outlined in both Section 1.6 and 6.2.5 of the EIS, the Project Area exists within a broader area dominated by mining, agricultural and conservation land uses. The Project Area itself is occupied by two existing mining operations and has been subject to heavy disturbance due to extensive open cut and underground mining at the site.

The Project Area is surrounded predominantly by the existing mining activities of Wambo mine (adjoining the Project Area), HVO (adjoining), Mount Thorley Warkworth mine (MTW) (3 kilometres from Project Area) and their associated mine owned lands, with several other mines located further to the north, east and south including Ravensworth Operations (7.5 kilometres), Rixs Creek Mine (8.5 kilometres) and Bulga Mine (9 kilometres)(refer to **Figure 1.2**). Outside of the mining land, the local area is occupied primarily by agricultural land uses, predominantly grazing, with more intensive cropping land located on the alluvial flats associated with the Hunter River and Wollombi Brook. Further detail of the agricultural activities undertaken on land surrounding the Project Area is provided in Section 6.3.1 of the EIS.

Beyond the dominant mining and agricultural land uses surrounding the Project Area, there are a limited number of other land uses present. The land uses surrounding the Project Area are listed in **Table 3.8** along with a summary of the compatibility of the Project with these land uses.

Table 3.8 Land Uses Surrounding the Project Area and Compatibility with / Impacts of the Project

Land Use	Compatibility / Impacts
Mining – Wambo mine	The Project Area is occupied by two existing coal mining operations (United mine and Wambo mine). The Project is therefore considered compatible with the existing land uses within the Project Area. Interactions between the Project and Wambo underground mine will be managed in accordance with the Joint Venture agreement.
Mining – Hunter Valley Operations, Warkworth Mine	Surrounding mining operations are not considered as sensitive receivers when assessing the potential amenity impacts of the Project. However, consideration has been given to blasting interactions which have the potential to impact mining infrastructure and safety. As discussed in Section 6.7.5.3 of the EIS, vibration impacts on Hunter Valley Operations infrastructure can be managed effectively below the applicable vibration criteria. Continued consultation between the Joint Venture and Hunter Valley Operations is proposed to manage ongoing operational interactions between the two sites. The Project is therefore considered compatible with surrounding mining land uses.
Agricultural land uses	As discussed in Section 6.3 of the EIS, a comprehensive Agricultural Impact Statement has been prepared to assess the potential agricultural impacts of the Project, including impacts on surrounding agricultural land uses. The assessment concludes that impacts on surrounding agricultural enterprises will be low as the Project will have minimal impact on the availability of water resources for agriculture and there will be no direct or indirect impact on landforms or soil resources outside the Project Area. The Project is therefore considered compatible with surrounding agricultural land uses.

Land Use	Compatibility / Impacts
Hunter Valley Gliding Club	As discussed in the EIS, the location and function of the Hunter Valley Gliding Club was considered in the design of the Project with the design of the 330kV transmission line relocation modified to avoid impacts on the Hunter Valley Gliding Club. The Hunter Valley Gliding Club has made a submission on the Project raising a range of issues including air quality and amenity impacts and these are addressed in the responses in **Section 4.0**. It is noted that the Hunter Valley Gliding Club has been operating successfully for numerous years adjacent to existing open cut mining operations. It is located adjacent to the Hunter Valley Operations open cut mine and close to Warkworth open cut mine. The location of the Hunter Valley Gliding Club in the vicinity of these mining operations and surrounding mine owned buffer land reduces the risk of the Hunter Valley Gliding Club activities themselves impacting on the community. Given the noise generation from the Hunter Valley Gliding Club when in use, the lack of sensitive receivers due to the surrounding mined owned buffer land is beneficial and with the effective management of amenity impact, the two land uses are compatible. The Project will include mining closer to the Hunter Valley Gliding Club than the current United and Wambo mining operations, with proposed mining being a greater distance from the Hunter Valley Gliding Club than the existing Hunter Valley Operations. In response to the issues raised by the Hunter Valley Gliding Club, United proposes to work with the Hunter Valley Gliding Club to develop a management plan to address the interactions between the Project and the Club's operations. The implementation of this management plan will provide for the effective management of the impacts of the Project on the Hunter Valley Gliding Club, providing for the ongoing coexistence of these two land uses.

Land Use	Compatibility / Impacts
Warkworth Gun Club	As discussed in Section 6.2.5 of the EIS, the Warkworth Gun Club is located to the east of the Project Area near Warkworth. As is the case for the remainder of Warkworth, the site has been subject to significant amenity related impacts from the surrounding mining operations for many years. The location of the Gun Club in the vicinity of mining operations and surrounding mine owned buffer land reduces the risk of the gun club activities themselves impacting on the community. Given the noise generation from the Gun Club when in use, the lack of sensitive receivers due to the surrounding mined owned buffer land is beneficial. The Project is considered compatible with the ongoing use of the site as a gun club for the following reasons: • the site is used intermittently for active recreational purposes and the Project will not affect this use in any way • when in use, the gun club is a significant generator of noise in its own right and the mine owned land negates the potential for impacts on sensitive receivers • the club has operated effectively in proximity to existing mining operations for many years and the overall nature of mining impacts on the site will not change.
Equine veterinary facility	As discussed in Section 6.2.5 of the EIS, an equine veterinary facility is located approximately 2 kilometres northwest of the project area. Potential impacts on amenity at this property have been assessed as part of the EIS (receiver ID: R163). Air quality and blasting impacts are predicted to comply with the relevant criteria, however the property is located within the active noise management zone for the Project where moderate exceedances of the project specific noise levels are predicted. United will implement of a range of proactive and reactive management measures and monitoring in order to adaptively manage mining operations to meet the predicted noise levels. In addition, in accordance with the commitment made in Section 8.0 of the EIS, United will implement reasonable and feasible receiver based noise mitigation measures at this premises upon request. As discussed in Section 6.6.4 of the EIS, the noise impacts at this location will be consistent with the noise impacts experienced from the current Wambo mine.

Land Use	Compatibility / Impacts
Rural residential	An assessment of the potential impacts of the Project on the amenity of residences surrounding the Project Area has been undertaken as part of the EIS (refer to Section 6.0 of the EIS). Where potentially significant impacts on amenity have been identified, despite the implementation of all reasonable and feasible avoidance and mitigation measures, it is anticipated that in accordance with the DPE's Voluntary Land Acquisition and Mitigation Policy, voluntary acquisitions rights would be afforded to these residences. There are six residences that are expected to be granted voluntary acquisitions rights for the Project. The Project is expected to be able to coexist with the remaining residential land uses surrounding the Project Area, however, some impacts will occur including some residences with predicted minor to moderate exceedances of noise criteria. To mitigate the impacts of the Project United will implement a range of proactive and reactive management and mitigation measures (e.g. noise mitigation treatments of properties) and undertake ongoing monitoring which will be used to adaptively manage mining operations as required to minimise impacts. It is noted that associated with some of the rural residential properties there are some ancillary land uses that have been raised in submissions (e.g. family day care, flower growing). These ancillary land uses have been addressed in the specific responses in **Section 4.0**.
National Park	The Project does not involve open cut mining any closer to the National Park than is currently being undertaken. The closest existing mining area (existing Wambo Open Cut) to the National Park is approximately 1 kilometre, with the closest proposed new mining area as part of the Project approximately 3 kilometres from the National Park. As discussed in the EIS the Project will involve continued mining at the existing Wambo Open Cut. There will be no direct impact on the National Park and with the buffer distances in place, as the National Park is upslope (higher in the catchment) of the Project Area, the potential for indirect impacts that affect the values of the National Park is low and will not be changed from that which currently exists.
Critical Industry Cluster - Equine	As discussed in Section 6.2.5 of the EIS, the nearest equine CIC is located approximately 6 kilometres northwest of the Project Area and will not be impacted by the Project. The Project is therefore considered compatible with this land use.
Critical Industry Cluster - Viticulture	As discussed in Section 6.2.5, the nearest viticulture CIC is located approximately 5 kilometres south of the Project Area and will not be impacted by the Project. The Project is therefore considered compatible with this land use.

As discussed in the EIS, based on the assessment of surrounding land uses, Project impacts and the suitability of the site, the Project is considered compatible with surrounding land uses noting that six residences are predicted to be significantly affected by noise and are expected to be granted voluntary acquisition rights for the Project. The EIS assessment concluded that the proposed mining operations are expected to be able to continue to coexist with the surrounding agricultural and non-agricultural land uses in the region. The Project will have minimal impact on existing agricultural activities located outside the Project Area. In particular, the Coolmore horse stud is located approximately 14 kilometres from the Project Area and will not be impacted by the Project. There will be no views of the Project from Coolmore horse stud.

United, on behalf of the Joint Venture, has actively engaged with stakeholders including the local community, to seek to understand the key concerns and issues associated with the Project and to assist with managing these issues through appropriate Project design. Extensive management, mitigation and offset measures have been incorporated into the Project to minimise impacts, including land use impacts and conflicts.

3.1.10 Subsidence

Provide an assessment of the risk of subsidence impacts to any new structures proposed to be constructed in the Project Area.

The Project does not relate to underground mining and therefore no subsidence will be generated by the Project.

New structures to be built within the Project Area will include the proposed Golden Highway realignment, 330kV and 66kV transmission line relocations and improvements to the United and Wambo Mine Infrastructure Areas (MIA). None of these relocated infrastructure will be affected by subsidence from any approved or currently proposed mining at Wambo or United. United has consulted with the MSB regarding the transmission line relocations and the MSB has confirmed that the alignments are unaffected by subsidence (refer to **Appendix 10**).

In regard to the Golden Highway realignment, as noted above the alignment is not affected by underground mining at United or Wambo, however, it is in the general vicinity of the former Lemington underground mine workings. The alignment is expected to be outside the influence of any potential subsidence associated with these old workings, however, this will be confirmed with the MSB once the detailed design is complete. United is currently progressing the detailed design in consultation with the RMS. Once the detailed design has been approved, United will submit the detailed design to the MSB for review and advice regarding any mine subsidence risk.

Part of the Wambo MIA is located above an area proposed to be undermined by Wambo. This is consistent with the existing situation where Wambo manages subsidence impacts on its own infrastructure during mining. These structures comprise steel framed storage and machinery sheds. The office buildings, bath houses, storage sheds, tanks and other ancillary structures are located outside the extents of proposed longwalls. The Wambo MIA, which will be utilised for the Project, will be managed during active subsidence.

United will consult with the MSB as relevant in relation to any new structures proposed within the Project Area.

3.1.11 Heritage

The Heritage Council of NSW has identified that the EIS's Heritage Impact Statement does not adequately address the significance and management of heritage items in the Project Area. The RTS must address the issues raised by the Council.

The Heritage Division submission has been addressed and is presented in **Section 3.6**.

3.1.12 Visual Amenity

Photomontages of all the viewsheds must be provided that also use a colour scheme that is easily distinguished from the natural landscape as well as considered the various key mine sequencing stages.

To assess the visual impacts of the Project a series of radial analyses (viewshed analysis), panoramic photographs and visual montages have been completed for potentially impacted locations surrounding the Project Area (refer to Section 6.12 of the EIS).

Radial analyses were completed based on the potential worst impact year for each relevant viewing location. Typically this was Year 16, where maximum height of the constructed landform is reached and the full progression of the proposed mine footprint is achieved. However, for views from the south, Year 2 was also considered due to topography and the extent of active overburden emplacement visible at this time.

Visual montages were completed for each of the major public viewing locations surrounding the Project Area where potential visual amenity impacts were identified from the assessment process. Visual montages were developed using a panoramic photograph (made using a series of individual photos), 3D topographic information, and electronic data files pertaining to the proposed Project. Constructing visual montages of 'before and after' scenarios illustrates the existing landscape and provides a comparison landscape including the Project and its visual amenity management measures. In the 'after' scenarios the visible mining areas were coloured using tones that were representative of the expected visibility. For example, unrehabilitated overburden areas were coloured using a colour taken from photos of the Wambo mine which had unrehabilitated overburden.

Based on the request from DPE, additional photomontages have been completed at four representative viewsheds to show each of the mine stages (i.e. key mine sequencing stages) at those locations. These photomontages have also used the non-natural colour schemes used in the conceptual mine plans presented in the EIS (refer to Figures 3.11 to 3.16 of the EIS) to distinguish from the natural landscape. The additional photomontages are presented in **Appendix 11**.

3.1.13 Peabody's Financial Status

The Department requests that the RTS provide an update on the current status of Peabody Energy Australia and discussion regarding any implications this may have for ongoing mine site management.

The following statement regarding Peabody's financial status has been provided by Wambo. Also refer to recent Wambo project approval SSD 6764 Draft Assessment Report for PAC Review and DA 305-7-2003 Modification 12 Determination PAC Report.

Peabody Energy voluntarily filed petitions under Chapter 11 for the majority of its United States (US) entities in the United States Bankruptcy Court for the Eastern District of Missouri on 13 April 2016. No Australian entities are included in the Chapter 11 filings and Peabody Energy plans for its Australian operations to continue as usual. The Australian operations have access to separate funding arrangements enabling it to continue operations at Wambo.

Peabody Energy has made available to its Australian platform a committed US$250 million revolving Intercompany Loan Facility. The Intercompany Loan Facility is designed to provide additional liquidity to support the ongoing operations of the Australian business during Peabody Energy's Chapter 11 re-organisation, with draw amounts being tied to operating budgets and subject to certain availability restrictions.

As such, the circumstances surrounding the Chapter 11 bankruptcy protection sought by Peabody Energy Corporation and related US entities will not impact on Wambo's ability to meet its financial obligations.

Strictly speaking, DPE (or a local Council) is not required by the EP&A Act to consider the financial viability of any applicant in determining a development application. This is because, the development consent relates to 'land', rather than a 'person'. It is noted that the Mining Act 1992 requires that applicants for mining leases must satisfy a 'fit and proper person' test. Further, there are mechanisms in place to ensure that the site is effectively rehabilitated. DRE holds substantial security deposits for the rehabilitation of every operating mine in NSW, including Wambo. The security deposit is designed to cover the full cost of undertaking rehabilitation, and may be 'called in' by DRE in the event that a leaseholder fails to meet rehabilitation requirements set by the Mining Act 1992 and within the relevant mining lease. Wambo has lodged a security deposit for its Wambo mining operations which addresses all mining operations covered by its current Mining Operations Plan.

3.1.14 Agency and public submissions

The Department requests the RTS consider and respond to all agency and public submissions received, including advice presented and recommendation made therein.

This Response to Submissions report responses to all agency and public submissions received. The remainder of **Section 3.0** of this report addresses agency submissions, while **Section 4.0** of this report addresses interest group and community submissions.

3.2 Singleton Council

Singleton Council provided an interim submission on the Project on 21 September 2016. However, Council later advised DPE that no further submission would be made on the Project and therefore the points raised in the interim submission are discussed below.

1. **Impacts of proposed project on air quality in terms of environmental health issues.**
2. **Noise impacts particularly towards the Singleton town ship.**
3. **The extent of biodiversity offsets.**
4. **Visual impacts from major vantage points.**

Air Quality Health Impacts

As discussed in the EIS, PM_{10} and $PM_{2.5}$ are the components of air borne particulate matter which are relevant to human health impacts and the NSW government has set criteria for PM_{10} and $PM_{2.5}$ that are intended to protect human health. The key assessment findings against these criteria are outlined below.

Cumulative annual average PM_{10} concentrations with the Project are predicted to comply with the EPA cumulative air quality criteria of 30 $\mu g/m^3$ at all surrounding private residences, with the exception of one private residence in Warkworth. This residence (R19) has current acquisition rights and is expected to be afforded voluntary acquisition rights for the Project.

Cumulative maximum 24-hour PM_{10} concentrations are expected to continue to exceed the EPA's 50 $\mu g/m^3$ criterion on at least one occasion each year for most of the modelled locations, as is currently occurring. The number of days above 50 $\mu g/m^3$ is expected to increase at Warkworth and remain well above the recommended goal of 5 days per year during the life of the Project.

The EIS identified that one additional private residence located to the northwest of the Project Area may experience a short term increase in the number of days above 50 $\mu g/m^3$, however, this residence has since been purchased by the Joint Venture and therefore is no longer a sensitive receiver for the Project.

Cumulative maximum 24-hour $PM_{2.5}$ concentrations are predicted to comply with the NEPM advisory reporting goal at all surrounding private residences, with the exception of the one private residence (R19) in Warkworth. All other private sensitive receiver locations are predicted to comply with both the 24-hour and annual average advisory reporting goals for $PM_{2.5}$.

The potential health risks associated with the existing air quality environment in Warkworth have been acknowledged in the development consents for the surrounding mining operations, with all of the residences within Warkworth being either mine owned or subject to acquisition rights. United will work with the mines that own these residences to provide for appropriate management of risk to the tenants of these properties, including ongoing monitoring of air quality in Warkworth. This will include providing tenants and owners with information regarding the dust levels in proximity to the residence and for properties owned by United, including within the rental lease appropriate clauses relating to the tenants ability to terminate the lease without penalty should the dust criteria be exceeded.

In regard to minimising air quality impacts, as discussed in the EIS and **Section 3.1** of this report, United has committed to the implementation of a comprehensive air quality management program as part of Project that is consistent with best practice dust management for coal mining operations.

Noise Management

The Council comment specifically mentions noise towards Singleton township. The Project is located a significant distance from Singleton township (approximately 16 kilometres) and no noise impacts on the township or surrounds are predicted.

In regard to the potential impacts of the Project on residences closer to the Project Area, operational noise impacts are predicted to significantly affect six private residences (expected to be granted acquisition rights) and have moderate impacts at 18 private residences (forming the active management zone for the Project). As outlined in the EIS, a comprehensive noise mitigation and management program has been proposed as part of the Project and changes have been made to the design of the Project to minimise noise impacts. Consultation has occurred, and is ongoing, with the residences predicted to be affected by noise impacts and a monitoring program will be implemented so that actual noise impacts are monitored and the results used to assist in the active management of the mining operation to reduce impacts. The monitoring results and measures in place to minimise impacts will be reported to the community and relevant government agencies.

Biodiversity Offsets

As outlined in the EIS, United has committed to the implementation of the biodiversity offset strategy for the Project under the Upper Hunter Strategic Assessment. Further details regarding the proposed offset strategy is provided in Part B of the response to submissions.

Visual Impacts

Further assessment of the visual impacts of the Project was requested by DPE and has been provided in **Section 3.1** of this report.

3.3 Division of Resources and Energy

Clarification is required from the proponent(s) regarding:

- **Post-mining uses for the final voids - as water quality is assumed to not be suitable for agricultural uses as the voids act as a groundwater sink from saline aquifers, and evaporation over time is expected to increase the level of salinity.**

The post mining uses for voids and the proposed final land use for the site are discussed in **Section 3.1.6.1**.

- **Clarify the final land use for the area in vicinity of the Wambo Homestead and North Wambo Creek - this is shown as being outside of the rehabilitated area Figure 3.16, EIS Main Text, however the same area is shown as rehabilitation woodland in Figure 6.57, EIS Main Text.**

Figure 3.16 of the EIS is limited to the mining area to demonstrate progression of mining associated with the Project. Areas outside of the mining area will require rehabilitation and have been included in the rehabilitation strategy for the Project for context, as shown in Figure 6.57. The area surrounding the Wambo Homestead is outside of the Project Area and is the ongoing responsibility of Wambo under its existing development consents and is not part of the Project. Some sections of the land along North Wambo Creek that are within the Project Area are proposed to be available for agriculture (as shown on Figure 6.57) with the remainder being native woodland. Only part of the land along North Wambo Creek is in the Project Area. The current MOP (2015) for Wambo Mine identifies plans for rehabilitation of the

North Wambo Creek Diversion. The MOP identifies the end land use for the area as pasture or mixed pasture / woodland. The rehabilitation proposed in the EIS is consistent with this commitment.

- **Topsoil resources available to meet final land use objectives - a significant proportion of the proposed open-cut mine has thin soils or has been previously rehabilitated. In addition, past agricultural pursuits may have resulted in the loss of topsoil. The EIS does not discuss alternative growth media that may be required to be imported / developed.**

A topsoil resource assessment has been commissioned by Glencore to assist in rehabilitation planning at United. The results of the assessment will provide a detailed understanding of the soil balance for the site. Based on the understanding of the soil balance, the suitability of site soils for rehabilitation works and any requirement for the importation of soils will be determined. It is noted that the availability of topsoil was considered in the conceptual final land use planning process with the ability for better quality topsoils to be prioritised for rehabilitation works in these areas.

Research at Mount Owen has identified that rehabilitation of overburden without topsoil addition is achievable, particularly where soil biota/vegetation relationships are encouraged. It should also be noted that much of the woodland areas to be disturbed by the Project (and indeed most of the remnant woodland in the Hunter Valley) has regenerated from former agricultural land that has very little topsoil present. Based on rehabilitation experience at Mount Owen, and anecdotal experience from regeneration of woodland communities in highly degraded farming land in the Hunter Valley leads to a high degree of confidence that woodland communities can be established in areas disturbed by mining even where there is little or no topsoil resources available. Where deemed appropriate as part of detailed rehabilitation planning alternative growth media may be imported to the site to aid rehabilitation outcomes.

Recommended Conditions of Approval

The Division recommends that the following conditions be incorporated into the Development Consent, if granted: …….

The conditions recommended by DRE are noted and are broadly consistent with recent approval conditions for similar mining projects in the Hunter Valley and with the proposed approach to rehabilitation and closure for the Project as outlined in the EIS.

Additionally, it is noted that the EIS seeks approval for exploration within mining leases CCL775 and ML1572, and a portion of A444 within the project area to be converted to a mining title. DPE should clarify that approved exploration activities within CCL775 and ML1572 would be limited to the development consent project boundary.

As discussed in Section 3.7 of the EIS, exploration drilling will continue to be undertaken within the mining lease areas (including CCL775, the portion of A444 within the Project Area which will be converted to a ML for the Project and ML1572) to obtain further information regarding the resources to be mined as well as define geological and geotechnical information relevant to the mining and construction activities that will be undertaken. Additional drill holes to install groundwater and gas monitoring bores may also be required.

The exploration activities covered by the EIS are limited to the Project Area. Exploration activities are also approved under the Wambo mine development consent (DA 305-7-2003) within the area covered by this

consent. Any exploration activities to be undertaken in areas outside of the Project Area or the area covered by the Wambo mine development consent would need to consider the requirements of the relevant exploration tenements.

3.4 Environment Protection Authority

Noise Impact Assessment

The EPA has identified issues in regards to the application of noise criterion and regulatory conditions for the Project as well as the remaining area and facilities to be licensed under the current Wambo Colliery Environmental Protection Licence (EPL) 529.

The EPA is currently unable to support the project or provide recommended conditions of approval based on the noise impact assessment for the proposal.

The most significant issue with the Project in regard to noise impacts is that the information in the EIS does not sufficiently allow the EPA to assess and determine noise criteria and associated conditions for the separate United Wambo Open Cut Coal Mine and Wambo Coal Mine if approval is granted.

The EPA review of the NIA has resulted in a slight misinterpretation of the results presented in the EIS. Consistent with the approach agreed with DPE and EPA, the NIA for the Project provided separate assessments for the State Significant Development Application (SSD) and for each of the proposed modifications. Specifically, the results in Table 6.1 and 6.2 and Appendix F Table F.1 of the NIA are for the SSD Project only (i.e. the United Open Cut and the Wambo Open Cut only under United's management). The NIA also provides an assessment of the extension of life of the Wambo CHPP and the Wambo train loading facility. No changes are proposed to either of these facilities and therefore there will be no changes to their noise generation, with the only changes being an increase in the duration of use. The NIA did not present project specific contributions for the Wambo train loading or CHPP infrastructure or for the Wambo underground mine, although the contribution from these noise sources was included in the cumulative assessment. As outlined in the EIS, the Wambo Underground Mine is not part of the Project.

In response to the EPA comment about being able to assess and determine noise criteria for the Project, the project specific results in Table 6.1 and 6.2 and Appendix F Table F.1 of the NIA are for the SSD Project only and provide the necessary information for the United Wambo Open Cut. In regard to providing the EPA with project specific noise predictions for the Wambo mine (including the Wambo infrastructure and underground mine), a compliance model has been developed to identify the contribution of the Wambo infrastructure and underground mine. This model has been completed to inform the process of setting relevant compliance criteria under respective EPLs.

In response to the matters raised by the EPA and as agreed in further discussions with DPE and EPA a compliance noise model has been developed to identify the contribution of the Wambo operations (without the approved Wambo Open cut operations) on the areas surrounding the Project. This has been completed to inform the process of setting relevant noise criteria under respective EPLs. The findings are presented in **Appendix 3**.

On the basis of the compliance model results presented in **Appendix 3**, it is envisaged that criteria for the Wambo mine (less the operation of the Wambo Open Cut) that would apply from commencement of the Project will be developed in consultation with DPE and the EPA.

Also as outlined in **Section 3.1.3**, the proposed approach to the ongoing management of noise across the Project and ongoing Wambo operations has been detailed. This process will be further developed and detailed in the Noise Management Plan for the Project, and supporting reporting processes (such as a PIRMP for the operations) which would be prepared in consultation with the EPA in accordance with any conditions of the development consent.

Attachment A

Assessment and application of noise conditions / limits for the separate licensed premises

The NIA has not been prepared in strict accordance with all guidelines within the NSW Industrial Noise Policy. However, the EPA's view is that this is not likely to significantly affect the outcomes of our assessment and we consider the NIA and BIA to be technically adequate for our assessment of potential noise and blasting impacts from the Project.

The comments from the EPA in relation to the sound technical basis of the NIA are noted.

While the EPA considers the NIA and BIA to be technically adequate, the EPA cannot support the proposal as currently put forward in the NIA.

The proposal seeks to combine open-cut operations at both United and Wambo mines under United's management. The EIS notes the intention that Wambo retains management of the operation of the associated mining infrastructure (including the Wambo MIA, CHPP, train loading facility and other ancillary infrastructure).

The NIA, however, does not align with this approach and only assesses the combined impact of the open cut operations together with the associated mining infrastructure. This means that the EPA is unable to derive recommended noise conditions / limits for the open cut operations under United's management, and the associated mining infrastructure under Wambo's management, separately.

The also does not propose a suitable method to determine whether each individual licensee (United or Wambo) is complying with its respective licence conditions under this proposal, and if any non-compliance is identified at a sensitive receiver location, how the licensee(s) responsible for the non-compliance would be identified.

As outlined above, the EPA review of the NIA has resulted in a slight misinterpretation of the results presented and separate noise assessments are provide for each of the three applications (the SSD application and the two modifications). Specifically, the results in Table 6.1 and 6.2 and Appendix F Table F.1 of the NIA are for the SSD Project only (i.e. the United Open Cut and the Wambo Open Cut only under United's management).

As also discussed above, project specific noise predictions for the Wambo mine (including the Wambo infrastructure and underground mine after removing the open cut operations) have been developed to identify the contribution of the Wambo infrastructure and underground mine.

As outlined in **Section 3.1.3**, the proposed approach to the ongoing management of noise across the Project and ongoing Wambo operations has been detailed. This process will be further developed and detailed in the Noise Management Plan for the Project, and supporting reporting processes (such as PIRMP for the operations) which would be prepared in consultation with the EPA in accordance with any conditions of the development consent.

As a way forward, the EPA proposed the following options:

1. **Revise the EIS and NIA so that a single legal entity will be responsible for the management of all surface activities at the Project, and accept the inclusion of noise conditions / limits for all surface activities on its EPL.**
2. **Revise the EIS and NIA so that the predicted noise emissions for the combined open cut operations at United and Wambo mines, and the predicted noise emissions for the associated mining infrastructure are presented separately. Under this option, the proponent is to also either:**

a. **provide a methodology for establishing whether each individual licensee is complying with its respective licence conditions, and if any non-compliance is identified at a sensitive receiver location how the licensee(s) responsible for the non-compliance would be identified, or**

b. **accept that if a non-compliance is identified at any sensitive receiver location in Area 1 or Area 2 (Figure 4.2 of NIA) that non-compliance will be attributed to the associated mining infrastructure under Wambo's management as proposed, and if a non-compliance is identified at any other sensitive receiver location in Figure 4.2 of the NIA, that non-compliance will be attributed to the combined open cut mining operations under United's management as proposed.**

As outlined in **Section 3.1.3**, the proposed approach to the ongoing management of noise across the Project and ongoing Wambo operations has been detailed. This process will be further developed and detailed in the Noise Management Plan for the Project, and supporting reporting processes (such as PIRMP for the operations) which would be prepared in consultation with the EPA in accordance with any conditions of the development consent.

Sleep disturbance criteria

Table 4.5 of the NIA provides sleep disturbance criteria for the day, evening and night-time periods as some surrounding residences are shift workers. The EPA recommends adopting only the sleep disturbance levels for the most stringent night-time period, with a minimum LA1(1 minute) level of 45 dBA.

The origins of some of the sleep disturbance criteria in Table 4.6 of the NIA are unclear (for example, the night-time criteria for Areas 3, 4 and 5 are not 15 dBA above the respective Rating Background Levels in Table 4.1 for those areas). These criteria should be reviewed and amended, if necessary.

The comments from the EPA in relation to the adoption of sleep disturbance in the night time period are noted. The application of sleep disturbance criteria across other time periods was in response to previous issues raised on similar projects and was undertaken in order to provide a comprehensive assessment of potential impacts for the surrounding area, which includes a number of shift workers. As noted by the EPA sleep disturbance criteria for the night time period will be adopted for the Project as detailed below.

The sleep disturbance criteria developed through the NIA was designed to identify conservative criteria for the Project considering the Industrial Noise Policy (INP) and draft Industrial Noise Guideline. Based on the EPA's submission, sleep disturbance criteria based on the application of 15dB(A) above RBL as per the INP, will be adopted for the Project as detailed in **Table 3.9**.

Table 3.9 Sleep Disturbance Criteria to be adopted for the Project

Residential Receiver Locations	Sleep Disturbance Criteria LA1,1minute Night
Area 1 and 2 South Wambo/North Bulga	47
Area 3 Warkworth Village	53
Area 4 Maison Dieu	51
Area 5 Moses Crossing	48
Area 6 Redmanvale Road	45
Area 7 Jerrys Plains	46

Based on these updated criteria, an updated sleep disturbance assessment is provided in **Table 3.9**. This also takes into account the EPA recommendation that the Sleep Disturbance Criteria should only be assessed for the night time period.

As shown in **Table 3.10**, the Project is predicted to comply with the sleep disturbance criteria at all locations with the exception of at R19. This finding is consistent with the findings in the EIS. At R19, under the 4°C/100 metre inversion plus 1.3 m/s drainage flow from the south, which is representative of worst case winter night the Project is predicted to be 54dB(A) which exceeds the sleep disturbance criteria of 53dB(A) for this receiver area.

Table 3.10 Update to Table F.4 – Predicted Sleep Disturbance Noise Level, dB(A)

Receiver Location	Criteria	Year 2			Year 6			Year 11			Year 16		
		Calm	SE [1] 3m/s	Inv plus [1] 1.3m/s S	Calm	SE [1] 3m/s	Inv plus [1] 1.3m/s S	Calm	SE [1] 3m/s	Inv plus [1] 1.3m/s S	Calm	SE [1] 3m/s	Inv plus [1] 1.3m/s S
Area 1 – R003	**47**	< 30	< 30	32	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30
Area 2 – R025	**47**	< 30	< 30	33	< 30	< 30	32	< 30	< 30	30	< 30	< 30	< 30
Area 2 – R035	**47**	< 30	< 30	32	< 30	< 30	31	< 30	< 30	< 30	< 30	< 30	< 30
Area 3 – R019 [2]	**53**	48	51	**54**	48	51	53	47	51	53	46	51	52
Area 4 – R485	**51**	< 30	< 30	37	< 30	< 30	36	< 30	< 30	31	< 30	< 30	31
Area 4 –R497	**51**	< 30	< 30	34	< 30	< 30	34	< 30	< 30	34	< 30	< 30	32
Area 5 – R039	**48**	33	45	45	< 30	41	40	31	42	43	< 30	43	42
Area 5 – R040	**48**	< 30	43	43	< 30	38	37	< 30	40	41	< 30	39	39
Area 5 – R050	**48**	< 30	42	42	< 30	39	38	< 30	37	38	< 30	38	38
Area 6 – R033	**45**	< 30	44	43	< 30	33	30	< 30	37	38	< 30	36	35
Area 6 – R046	**45**	< 30	42	41	< 30	35	33	< 30	34	36	< 30	35	34
Area 6 – R346	**45**	< 30	34	33	< 30	30	< 30	< 30	33	32	< 30	35	33
Area 7 – R144	**46**	< 30	37	36	< 30	33	33	< 30	31	32	< 30	32	31

Note 1: 3 m/s wind from the south east and 4°C/100 metre inversion plus 1.3 m/s drainage flow from the south representative of worst case winter night time.
Note 2: Residence already subject to acquisition rights under an existing consent

Construction Noise Criteria

In Section 5.2 of the NIA, the text states that the 'outside standard hours' construction scenario is based on the use of half of the machines that would be used during 'standard hours'. It is unclear which items of plant and equipment constitute the half, or whether a numerical adjustment was used in the analysis – this should be clarified in the text.

The origins of some of the construction noise criteria in Table 4.8 of the NIA are unclear (for example, the night-time criteria for Areas 3, 4 and 5 dB above the respective Rating Background Levels in Table 4.1 for those areas). These criteria should be reviewed and amended, if necessary.

As outlined in Section 4.7 of the NIA, the majority of construction activities for the Project will be undertaken within DECC *Interim Construction Noise Guideline* (ICNG) (DECC 2009) standard hours, with some activities (e.g. some works associated with the realignment of the Golden Highway) potentially required outside of the ICNG 'recommended standard hours' to minimise disruption to the public. It is noted that the ICNG provides noise management criteria for construction activities, which are intended to guide the need for, and the selection of, feasible and reasonable work practices to minimise construction noise impacts.

Accordingly, consistent with the implementation of the ICNG, the assessment of noise associated with outside of standard hours was based on an arithmetic reduction of 50 per cent of the sound power level of the construction machinery utilised during standard hours which is equal to a 3 dB reduction in the sound power of construction machinery. The assessment does not specify which specific machinery would be reduced to achieve this, rather identifies the overall sound power requirements in order manage potential impacts for construction works that need to be undertaken outside of recommended standard hours in accordance with the ICNG.

The construction noise criteria developed through the NIA was designed to identify conservative criteria for the Project. Based on the EPA's submission construction criteria, based on the application of 10dB(A) for standard hours and 5dB(A) for non-standard hours above the RBL, will be adopted for the Project as detailed in **Table 3.11**.

Table 3.11 Construction Noise Criteria to be adopted for the Project

Residential Receiver Locations	Construction Noise Criteria $L_{Aeq, 15minute}$	
	Standard hours (based on day-time RBL)	Outside Standard Hours (based on night-time RBL)
Area 1 and 2 South Wambo/North Bulga	40	37
Area 3 Warkworth Village	49	43
Area 4 Maison Dieu	47	41
Area 5 Moses Crossing	46	38
Area 6 Redmanvale Road	40	35
Area 7 Jerrys Plains	44	36

As detailed in Section 6.3 of the NIA, the $L_{Aeq,15minute}$ noise levels associated with the construction are predicted to not exceed 35 dB(A) at any sensitive receiver. This is well below the construction noise management levels for properties in the region surrounding the Project. Therefore, no significant construction noise impacts are predicted as a result of the Project.

Night–time period

In Section 5.1.7 of the NIA, the night-time period appears to be erroneously identified as from 6am to 7am, this should be checked and amended if necessary.

This section has been reviewed and this reference is 6am to 7am is erroneous. The text has been amended as outlined below:

> As a 24 hour 7 day per week operation, activities associated with the Project would be essentially the same during the day-time, evening and night-time. That is, the location and number of machines operating are independent of the time of day and the day of the week. Therefore, under normal operating conditions achieving the night-time PSNLs would normally result in the day-time and evening PSNLs also being achieved. However, due to differences in the influence of meteorological conditions depending on time of day and season, the probability analysis methodology investigates the potential noise impacts during the day-time (all season combined), non-winter evenings, non-winter nights and winter evening/night-time periods (referred to as winter night encompassing the period from **6.00pm** to **7.00am**).

It is noted that the night time period is generally defined as 10pm to 7am and 8am on Sundays and Public Holidays under the INP. However when considering the winter inversion conditions the INP notes that night is defined as the period from 1 hour before sunset to 1 hour after sunrise, taken to be 6 pm to 7 am (INP 2000 pg12). Therefore, when considering the potential worse case impacts associated with inversion conditions from the development during winter night time, the period from 6pm to 7am was assessed as winter night time in the NIA.

Rail noise

Section 6.5 of the NIA relates to rail noise levels and states "*Wambo's current coal train movements on the Main Northern Rail Line contribute 0.4 dB to noise levels generated by coal train movements".* It is unclear what the 0.4 dB refers to, and this paragraph should be clarified, preferably with reference to overall rail noise levels and the relative noise contributions of both Wambo and external rail traffic. A table may assist in presenting the information in this section.

Wambo currently has approval for the transport of 15 Mtpa along the Main Northern Railway Line, which currently carries a total of 170 Mtpa. Based on these total volumes on the Main North Railway Line, the removal of Wambo's approved volume would result in the following reduction in noise:
10 x log ((170 Mtpa – 14.7 Mtpa)/170 Mtpa) = -0.39 dB or 0.4dB.

Air Quality

The following responses have been prepared with the assistance of Jacobs which completed the AQIA for the Project.

Diesel emissions

Emissions estimation has taken care to explicitly consider emissions from diesel-powered equipment, but did not include these estimates in the emissions for dispersion modelling. Rather, the AQIA proposes that as explicit estimation results in an increase to PM_{10} emissions of less than 5%, there is no need to revise the emissions estimates.

The EPA's position is that diesel emissions area predominantly $PM_{2.5}$ and the relative contribution from diesel for this size fraction will be significantly higher than that found for PM_{10}. Section 3 of the Approved Methods requires a sound and thorough emissions inventory. This implies using the best available estimates. The EPS advises that controls for this source need to be nominated.

The emissions inventory used for dispersion modelling needs to include the explicit estimates for diesel emissions, for both PM_{10} and $PM_{2.5}$, and to nominate controls for this source.

Table 3.12 provides initial estimates of PM_{10} and $PM_{2.5}$ emissions due only to diesel exhausts. Emission factors for "Industrial off-road vehicles and equipment" from the EPA's 2008 Air Emissions Inventory (EPA 2012) were used for the calculations. These factors relate to diesel exhaust and evaporative emissions.

Table 3.12 Estimate of PM_{10} and $PM_{2.5}$ emissions from diesel engines

Year	Fuel consumption (L/y)	Emission factors (kg/kL)		Emissions (kg/y)	
		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Year 2	55,252,654	2.84	2.75	156,918	151,945
Year 6	48,734,531	2.84	2.75	138,406	134,020
Year 11	42,302,025	2.84	2.75	120,138	116,331
Year 16	40,643,667	2.84	2.75	115,428	111,770

As noted by the EPA, the AQIA considered emissions from diesel-powered equipment. These emissions were included in the dispersion modelling and the results showed that the predicted particulate matter concentrations were typically over-estimated when compared to the measured concentrations. This provided evidence that the emissions were not underestimated, and that significant particulate matter sources associated with the existing and proposed mining activities were not excluded.

Section 8.7 of the AQIA provided a discussion of diesel exhaust emissions. The discussion on diesel exhaust particulate matter (Section 8.7.1) was primarily to address a potential concern that the assessment may underestimate diesel particulate emissions by applying a control factor of 85 per cent to the emissions from haulage. The testing of assumptions in Section 8.7.1 was not intended to be inferred that emissions were underestimated. On the contrary, the AQIA maintains that the emission factors, including with control factors, are based on measured emissions which include diesel particulates in the form of both PM_{10} and $PM_{2.5}$. This is the main reason why the emissions data used in the modelling were not modified. Additional

discussion to this issue is provided in **Appendix 2** (response to Ramboll Environ peer review comments, refer to response to 3.3).

In regards to controls for diesel related particulate matter emissions, United has considered the practicalities of exhaust after-treatment technologies for in service non-road diesel engines. Consideration has been given to the emission reductions, capital costs, maintenance costs and operational costs. The proposed mitigation measures to manage diesel combustion emissions aim to address the equipment maintenance and engine replacement strategies from the *NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions"* (EPA 2014). Specifically, the measures proposed by Glencore include:

- servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance
- targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle
- defining failure modes, effects and criticality which helps to minimise equipment failure
- constructing timelines for downtimes.

These controls relate to the effective maintenance of equipment to ensure that they operate effectively and that emissions from the vehicles are thereby minimised.

As noted in **Section 3.1** (refer to response air quality response (g.)) the $PM_{2.5}$ quantification has necessarily had to rely on several assumptions which led to increased uncertainty in the $PM_{2.5}$ assessment. These uncertainties have mainly arisen from an absence of relevant monitoring data. Glencore is therefore proposing a campaign of $PM_{2.5}$ monitoring to provide additional clarification to this issue. Details of the monitoring are provided in **Section 3.1**.

Assessment against 24-hour PM_{10} criterion

The AQIA adopts a variant criterion for 24 hour PM_{10} concentration. It's noted that exceedances of the criterion for twenty-four hour PM_{10} are expected as a result of background concentrations. Treatment of these elevated background concentrations is stated as "the trigger for whether a receptor is predicted to be impacted was defined as the Project only contribution greater than 50 µg/m^3".

The AQIA adopts a criterion for the number of days on which cumulative PM_{10} concentration exceeds 50 µg/m^3 of 5. This was taken from the National Environment Protection (Ambient Air Quality) Measure.

The AQIA does not appear to have followed the guidance in the Approved Methods regarding treatment of elevated background concentrations. Section 5.1.3 of the Approved Methods sets out in that where background concentrations are elevated, the criterion is that "no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity".

Thus assessment should present maximum cumulative concentration. Where this is greater that the criterion (50 µg/m^3 for 24-hour PM_{10}), further analysis should be presented assessing whether emissions from the project cause additional exceedance days.

Appendix E of the AQIA provided model results for all monitors and residences including maximum cumulative concentrations. Appendix E also included predictions of the number of days above 50 µg/m^3 for PM_{10}, which was used to identify additional exceedances. From examination of these results there are two private residential properties which are predicted to experience additional days above 50 µg/m^3:

- Residence 19
- Residence 28 (note: has recently been purchased by the Joint Venture).

Both of these properties were identified in the AQIA, specifically in Table 23. A copy of the relevant section of this table is shown below in **Table 3.13**. The criterion has been corrected.

Table 3.13 Locations with potential additional exceedances of PM_{10} criteria

Residence ID	Cumulative					Criteria
	2014	Year 2	Year 6	Year 11	Year 16	
Number of days above 50 µg/m^3						
19	4	52	64	41	13	No additional exceedances
28	3	6	3	3	3	

Residence 19 has existing acquisition rights and as discussed earlier in this document Residence 28 has now been purchased by the Joint Venture. It is assumed that Residence 19 will be afforded acquisition rights for the Project, if approved.

Impacts on receptor 28

Receptor 28 is assessed as potentially experiencing additional days exceeding the twenty-four hour PM_{10} criteria for, at least, year 2 of the Project.

Section 2.4.4 of the Approved Methods requires that where impact assessment criteria are not met, "the assessment must be revised to incorporate additional control or mitigation measures".

The assessment needs to include discussion of additional control or mitigation measures to manage the risk of exceeding impact assessment criteria at Receptor 28.

As noted above, Residence 28 is within the noise affectation zone for the Project and has been purchased by the Joint Venture since the public exhibition of the EIS. Therefore it is no longer a sensitive receiver and a further response to this issue is not required.

Surface Water

Licence conditions currently on EPL 529 require a flow of 550 ML/day in Wollombi Brook (measured at the Bulga gauging station) before any HRSTS discharges are permitted. Wollombi Brook is the initial receiving environment for HRSTS discharges from Wambo Colliery. If approval is granted the EPA proposed to maintain this requirement for any future discharges associated with the Project.

Noted. No changes were proposed to the existing Wambo discharge limits as part of the Project, however, should a change be proposed in the future it would be in consultation with the EPA and a full analysis of the potential impact would be undertaken.

The EPA does not predict any issues associated with the proposed use of the existing Wambo HRSTS discharge infrastructure and controls. If approval is granted the EPL for the Project (which is proposed to be a varied version of the existing United Colliery EPL 3141) can be amended to incorporate the current conditions and requirements associated with this discharge point.

Noted. It is anticipated that the existing discharge point would remain licensed under EPL 529, subject to further discussions with the EPA.

Licence boundaries and transfer of materials / equipment

The EIS describes the proposed separation of the existing Wambo Colliery EPL 529 (to remain in force applicable for the Wambo underground mine and surface facilities) and amendments to the existing United Colliery licence (EPL 3141) to apply to the United Wambo Open Cut Coal Mine.

The Project includes the transfer of materials and equipment across two sites, including but not limited to water, coal, tailings and coal fines, and potentially overburden material.

The EIS does not appear to specifically identify the proposed Environmental Protection Licence premise boundaries for the United Wambo Open Cut Coal Mine, or any boundary amendments to the existing Wambo licence boundary. It's unclear if the 'project area' identified throughout the EIS (for example as shown on Figure 4.1) is proposed as the EPL premises boundary for the Project, or if the EPL boundary will be determined at a later stage.

The EPA understands the intention is for the existing Wambo EPL 529 to apply to the Wambo underground operations and surface facilities, including but not limited to the Wambo CHPP, mine infrastructure area, and rail loop facilities. This is indicated in the EIS at Section 1.2 as "Wambo will continue to manage its underground mining operations which do not form part of the Joint Venture or this Project. The existing mining infrastructure including the CHPP and train loading facility will be used for both the Project and Wambo's underground operations, and it is anticipated that they will continue to be managed by Wambo (subject to any changes in the commercial arrangements that exist between United and Wambo)".

The Project Area identified at various points in the EIS covers an area which appears to overlap part of the existing Wambo surface facilities subject to EPL 529, including the Wambo CHPP as noted in Section 3.8.1 of the EIS.

While the EIS refers to the intention and anticipation that the Wambo surface facilities will remain the responsibility of Wambo and subject to EPL 529 it is not specifically confirmed at this stage. Additionally the reference to 'subject to any changes in the commercial arrangements that exist between United and Wambo' further indicated that this matter is yet to be finalised or determined.

To allow the EPA to accurately assess any potential issues relating to the transfer of materials and equipment between the proposed United Wambo Open Cut Coal Mine and the Wambo Colliery, the EPA recommends the proponent includes the predicted premises boundaries associated with the Project and Wambo Colliery if approval is granted. This will allow the EPA to identify the responsible parties for all components of the site and accurately identify potential noise, water and air quality from the Project.

The Project Area covers the area pertaining to the development application. This does not necessarily correlate with the future EPL boundaries for the site.

EPA's understanding of the proposed management of the Wambo and United operations is accurate. United will manage the open cut operations, while Wambo will operate the CHPP, rail loop and their underground operations. As the EPA has identified, the transfer of materials and equipment across the United and Wambo managed areas will be required.

United, on behalf of the Joint Venture, has continued to consult with the EPA in relation to the EPL boundary matter. United will continue to consult with the EPA to resolve this issue prior to mining operations commencing associated with the Project.

3.5 Department of Primary Industries – Water

Impacts to other water users

The EIS indicates that one private groundwater bore may be affected by drawdown greater than 2 m as a result of the proposed project. In addition the assessment identifies that landholders downstream of the project may access surface water for stock and domestic purposes under basic landholder rights. A water management plan should be developed for the project, which should incorporate consultation with potentially affected water users and the development of a trigger action response plan to identify and manage potential impacts to water availability for these users, including make good provisions in the event of impacted supply as a result of the proposal.

In regard to the one private groundwater bore predicted to be affected by a drawdown of greater than 2 metres, as discussed in **Section 3.1**, the affected bore is not currently serviceable and is located on a property within the noise affectation zone for the Project. This property is expected to be granted voluntary acquisition rights as part of any approval for the Project.

As outlined in Section 6.8 of the EIS, a Project WMP will be prepared to guide the overall management of water as part of the Project. This plan will also consider the integration of the water management of the Project with Wambo. The Project WMP and associated sub plans will be developed in consultation with DPI Water and DPE. Subject to the requirements of the conditions of consent, the WMP will include:

- a water balance including details of water supply, use, management and transfers
- an Erosion and Sediment Control Plan that is consistent with the requirements of Managing Urban Stormwater: Soils and Construction – Volume 1 and Volume 2E Mines and Quarries, or its latest version
- a Surface Water Management Plan, including:
    - relevant baseline data on channel stability and water quality
    - a description of the water management system on site including design objectives and performance criteria
    - trigger levels for investigating any potentially adverse impacts
    - a surface water monitoring program.
- a Groundwater Management Plan.

The WMP will include a trigger action response plan. The aim of the trigger action response plan is to provide mine management with an early warning mechanism that identifies water trends departing from historical values allowing a response to be initiated.

In regard to impacts on private water users, if impacts occur and mitigation measures to resolve the impacts are not feasible, 'make good' measures with affected private land owners will be carried out (subject to any future purchase of this property by the Joint Venture), potentially including:

- ensuring the bore owner has access to a similar quantity and quality of water for the water bore's authorised purpose for example by:
    - bore enhancement by deepening the bore or improving its pumping capacity
    - constructing a new water bore
    - providing a supply of an equivalent amount of water of a suitable quality by piping it from an alternative source.
- carry out a plan to monitor the water bore, for example, by undertaking periodic bore assessments.

Impacts to surface water sources (geomorphology)

The assessment indicates the proposal will result in changes to catchment areas and flows for watercourses during and post-operations. The water management plan should outline monitoring and management measures, including reach scale rehabilitation measures as required, for the affected watercourses. In particular, Waterfall Creek requires a detailed geomorphic assessment and management program to address the risk of bed incision, channel expansion and sediment slug release as a result of increased discharge.

Section 9.1 of the Surface Water Assessment outlines United's commitment to developing a Project Water Management Plan (WMP) and associated sub plans as part of the implementation of the Project. The commitment includes a Surface Water Management Plan, including:

- relevant baseline data on channel stability and water quality
- a description of the water management system on site including design objectives and performance criteria
- trigger levels for investigating potentially adverse impacts
- a surface water monitoring program.

This this plan will cover Project-related potential impacts to North Wambo Creek, Redbank Creek and Waterfall Creek.

The DPI Water submission specifically requests, for Waterfall Creek, a detailed geomorphic assessment and management program to address the risk of bed incision, channel expansion and sediment slug release as a result of increased discharge.

It should be noted that no discharges are proposed to occur to Waterfall Creek as part of the Project. In addition, the assessment determined that the catchment runoff volumes will be decreased during the

Project and will be increased with the Project final landform (based on an assessment of catchment area changes).

As part of the surface water assessment a one-dimensional hydrodynamic model was developed of Waterfall Creek. Modelling was undertaken for two landform scenarios: pre-mining; and Project final landform. It is proposed to use this model, along with a site inspection undertaken by qualified water/soil engineers/scientists to meet the requirements of the Surface Water Management Plan as committed to in the Surface Water Assessment (refer to dot points above). The surface water monitoring program will include measures to monitor potential changes to scour/erosion and sediment deposition within the creek channels as requested by DPE in its submission.

Impacts to groundwater dependent ecosystems

The Groundwater Impact Assessment identifies that, as a result of the cumulative impact of existing operations and the proposed project, groundwater drawdown will impact upon a groundwater dependent vegetation community consistent with the Endangered Ecological Community (EEC) Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregion. The proposal is expected to expedite the timing of the impact (brought forward by 1 year) without affecting the magnitude of the impact.

The impact is inconsistent with the water management principles of the Water Management Act 2000 which state "water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored" (section 5(2)(a)) and "the carrying out of aquifer interference activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated" (section 5(8)(a)). DPI recommends the identified impact be considered in assessment of the proposal, with appropriate consultation with the Office of Environment and Heritage as required.

As discussed in the EIS, the alluvium near GDE1 is predicted in the groundwater modelling to become unsaturated due to cumulative impacts from approved mining at HVO South, Wambo and MTW. This desaturation occurs due to the existing approved mining, without the Project. Based on the conceptual timing of the Project, the Project may result in this effect occurring approximately 1 year earlier, however, this depends on a range of factors and the timing of any approval for the Project and is highly uncertain. Therefore, the Project is not considered likely to result in impacts beyond those currently approved for GDE1.

As discussed in **Section 3.1**, GDE1 is a zone of identified Central Hunter Swamp Oak Forest that potentially uses groundwater from the Quaternary alluvium along Redbank Creek and Wollombi Brook. The Project does not directly intersect the Quaternary alluvium within this area, therefore drawdown due to the Project is related to depressurisation of the Permian coal measures.

Figure 7-13 of the GIA shows a significant cumulative impact not attributable to the proposed modification. The adjacent HVO mine is approved to mine within and adjacent to the alluvium near GDE1. Mining at HVO South Lemington Pit 1 commenced in 1997 to the south of GDE1 and the Wollombi Brook. Mining is also approved at GDE1, north of Wollombi Brook, as part of the approved, but not yet commenced, HVO South Lemington South Pit 2. The model represents mining at South Lemington Pit 1 and South Lemington Pit 2 to account for cumulative groundwater impacts, and this mining contributes to the predicted change in groundwater levels at GDE1. The location of the approved HVO South operations is shown in Figure 7-12 of the GIA.

In regard to DPI's recommendation about consultation with OEH, detailed consultation with OEH on biodiversity matters has occurred throughout the Project and is ongoing. This consultation has considered the range of impacts on biodiversity including impacts on GDEs.

Additional comments

- **DPI notes that the relocation of the 330 kV transmission line may include traversing a watercourse. Works on waterfront land should be conducted in accordance with the DPI Water Guidelines for Controlled Activities (2012). It is recommended that any riparian vegetation which requires clearing is appropriately offset (consistent with the guidelines) in consultation with DPI Water.**

Waterfront land is defined by the *Water Management Act 2000* and includes the bed of any river, lake or estuary and any land within 40 metres of the river banks, lake shore or estuary mean high water mark. The proposed alignment of the 330 kV transmission line will traverse both the main channel of Redbank Creek (4th order watercourse at the crossing location) and two minor (one 1st and one 2nd order) tributaries of Redbank Creek.

The works activities associated with the relocation of the 330 kV transmission line will likely be undertaken over an approximate 6 month timeframe, of which the following aspects have the potential to impacts on watercourses:

- tree clearing
- fence modifications
- access track construction/maintenance
- tower construction
- tower erection
- wire stringing.

The detailed design for the 330 kV transmission line is currently being undertaken in consultation with TransGrid. It is proposed that none of the towers for the transmission line will be located within waterfront land. As part of the construction and for future inspections/maintenance an access track will be required to be constructed along the alignment of the transmission line. Similarly the transmission line easement will need to be fenced in areas for safety.

As discussed in Section 8.1 of the Surface Water Assessment, erosion and sediment control measures to be implemented as part of the Project will be described in the Project Erosion and Sediment Control Plan (ESCP). These measures will be undertaken in accordance with the Blue Book (Volumes 1 and 2) (Landcom 2004 and DECC 2008). As requested by DPI Water the measures will also consider the published guidelines for controlled activities for works within waterfront land. The Project ESCP will provide a framework for the management of erosion and sedimentation for the Project.

The ESCP that will be prepared to meet the specific works requirements for the 330 kV transmission line relocation will consider the following stages/aspects, in accordance with the requirements of the Blue Book:

- installation of controls (i.e. erosion and sediment controls)
- waterway crossings
- construction
- inspections and maintenance as required.

It is considered that the proposed measures (i.e. in accordance with the Blue Book (Landcom 2004 and DECC, 2008), in consideration of the detailed design requirements, are sufficient to minimise the impacts of the relocation of the 330 kV transmission line.

A detailed ecological assessment, including consideration of impacts on riparian zones, was completed as part of the EIS for the Project (refer to Appendix 13 of the EIS). The 330kV transmission line will span the creek and riparian zones and therefore there will be no direct impact on the riparian zones. The impacts of the Project will be appropriately offset.

- **DPI notes that the independent peer review of the groundwater model was conducted by Dr Noel Merrick, and concluded that the model was fit for purpose. It should be considered that the Groundwater Impact Assessment identifies that the numerical model was based on the existing Wambo model, that previous groundwater assessments and numerical models for Wambo Coal mine have been developed by Dr Merrick, and that Dr Merrick provided input into several stages of the modelling process. DPI recommends consideration of an additional external peer review of the groundwater model.**

As requested, an additional peer review of the Groundwater Impact Assessment for the Project has been undertaken. Dr Frans Kalf of Kalf and Associated Pty Ltd has completed the peer review. The peer review is presented in **Appendix 4** along with a response from AGE.

The peer review found:

The hydrogeological description of the region, modelling work, presentation of results and interpretation described in the AGE (2016) report is detailed, comprehensive and has been conducted in a professional manner in my opinion.

The hydrogeological description, conceptualisation, model design, simulations and reporting have been conducted overall in a thorough manner and described in detail. No fatal flaws have been detected in the description or modelling work conducted although improvements to alluvial drawdown predictions have been suggested. Overall drawdown/depressurisation predictions and effects of groundwater capture and influence on stream baseflow magnitudes are nevertheless considered plausible.

The peer review recommended some minor improvements in results presentation for the alluvial drawdown and recommended additional groundwater monitoring locations. These recommendations have both been adopted and are addressed in the AGE response in **Appendix 4**.

Water licensing

DPI recommends consultation between the proponent and DPI Water to ensure accurate determination of water licensing requirements. To facilitate discussion DPI requests the proponent provide the following information:

- **A table containing all proposed water storages during mining and proposed for retention in the final landform, with details of capacity, stream order, purpose, proposed licence status (for example licensed, exempt, harvestable rights) and proposed nominated access licence (where applicable);**
- **Details of proposed clean water diversion measures, including details of storage and transfer works (including capacity, stream order, purpose, and proposed licence status), management protocols (including discharge frequency), and outlet structure design;**
- **Partitioning of projected take from the porous rock groundwater source between the approved and proposed projects and clarification of the proposed licensing approach for the projected 37 ML of surface water take from the Wollombi Brook (Table 7-1 of the Groundwater Impact Assessment).**

The proponent is to ensure that all necessary licences and entitlement are obtained to account for take of surface water and groundwater prior to this take occurring. Where projected take exceeds entitlement held the proponent is to adjust the scale of operations to match the available entitlement. These requirements apply throughout the project life cycle, including post-operations.

General

As stated in Section 9.4 of the Surface Water Assessment, the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* applies to the Wollombi Brook. The *Water Sharing Plan for the Hunter Regulated River Alluvial Water Source 2004* applies to the Hunter River.

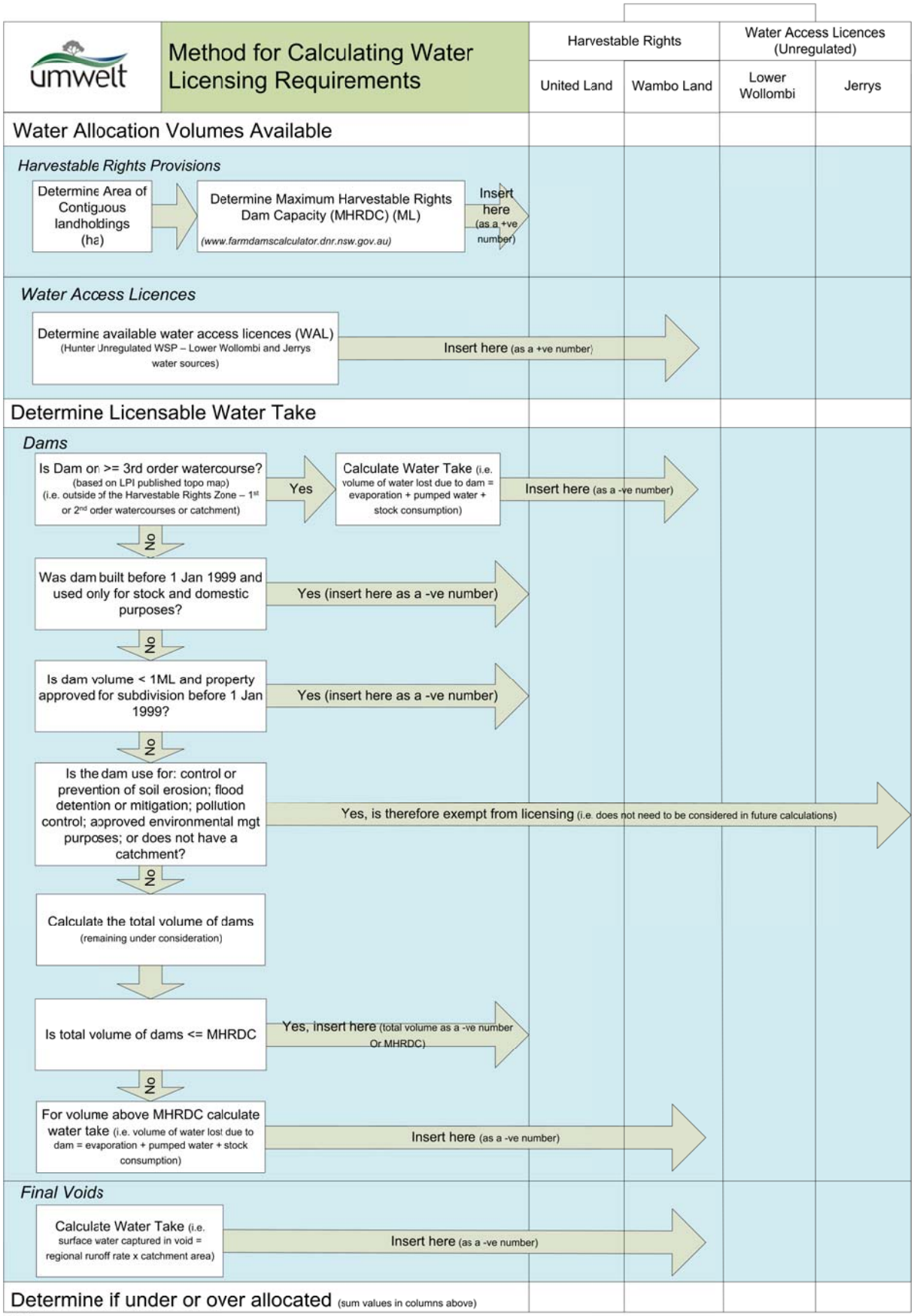
All water take for the Project beyond that which is in accordance with harvestable rights or exempt from licensing will be licenced. Water extracted from the Hunter River and Wollombi Brook will occur in accordance with Water Access Licences (WALs) held under the *Hunter Regulated River Water Sharing Plan 2004* and the *Hunter Unregulated and Alluvials Water Sharing Plan 2009* respectively.

In response to the request for further information from DPI Water, a refined method for calculating the water licensing requirements for the Project has been developed in consultation with DPI Water and in accordance with Harvestable Rights Orders (gazetted 31 March 2006 http://www.nsw.gov.au/sites/default/files/pdfs/2006/31st_March.pdf#page=36) and Water Access Licensing requirements (refer to http://www.water.nsw.gov.au/water-licensing/about-licences/new-access-licences), and is presented in **Figure 3.10**.

This refined approach has been used to address water licensing requirements for proposed water storages both during mining and associated with the final landform.

Specific responses to the DPI Water requests in regard to proposed water storages during mining; water storages proposed for retention in the final landform; and clean water diversions measures are included below.

Also included is a summary of the licensing requirements for the Project as it applies to the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*.



References:

Water Management Act 2000 Section 53 - Harvestable Rights and Section 54 Harvestable Rights Order

Water Management Act 2000 -Order Under Section 54, Harvestable Rights – Eastern and Central Division- NSW Government Gazette 40 dated 31 March 2006 (pages 1628 to 1631)

FIGURE 3.10

Water Licensing Schematic

Proposed Water Storages during Mining

Included below in **Table 3.14**, are all the proposed water storages during mining for the Project. Included in the table are: capacity; stream order; purpose; proposed licence status; and nominated access licence. It should be noted that, as outlined in **Table 3.14**, there are limited access licences nominated for the water storages during mining. This is due to the fact that the majority of the water storages proposed during mining are pollution control dams (i.e. dams for the purposes of managing dirty water or mine water not located on watercourses) and as such don't require licensing.

The proposed clean water management dams are designed to assist in managing clean water runoff around the Project and will not be used to permanently store water for use within the Project. Therefore, for licensing purposes, the amount of water take shown in **Table 3.14** below is limited to evaporative losses.

Table 3.14 Proposed Water Storages during Mining

									Harvestable Rights		Water Access Licences	Not Required	Reason
									Peabody	United	Lower Wollombi		
Land area (ha)									**5284.0**	**951.7**			
Harvestable Rights Provisions (ML)									**369.9**	**66.6**			
Water Access Licences (ML)											**300**		
				Purpose									
Dam	**Capacity (ML)**	**Stream Order**	**Land ownership**	**Year 2**	**Year 6**	**Year 11**	**Year 16**	**Water Source**					
W1	13.8	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
W2 (West Cut)	13.2	N/A	Wambo	Mine	Mine	Mine	Mine	Lower Wollombi				x	Pollution control dam
W3	48.9	N/A	United	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
W4	9.4	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
W5	32.2	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
W6	46.6	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
W7	19.2	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
W8	88.2	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
W9	8.2	N/A	Wambo	Dirty	-	-	-	Lower Wollombi				x	Erosion control dam
W10	9.4	N/A	Wambo	-	-	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
M1	22.6	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Jerrys				x	Erosion control dam

									Harvestable Rights		Water Access Licences	Not Required	Reason
									Peabody	United	Lower Wollombi		
M2	124.4	N/A	Wambo	Mine				Lower Wollombi				x	Pollution control dam
M3	22.9	N/A	Wambo	Dirty	Dirty	Clean	Clean	Lower Wollombi	-22.9				Exempt up to Year 11, then harvestable rights
M4	12.3	N/A	Wambo	Dirty	Dirty	Clean	Clean	Lower Wollombi	-12.3				Exempt up to Year 11, then harvestable rights
M5	11.3	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
M6	14.1	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
U1	33.4	N/A	United	Dirty	Dirty	Dirty	-	Lower Wollombi				x	Erosion control dam
U2	77.6	N/A	Wambo	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
U3	77.6	N/A	United	Dirty	Dirty	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
U4	28.7	N/A	United	-	-	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
U5	4.8	N/A	United	-	-	Dirty	Dirty	Lower Wollombi				x	Erosion control dam
C1	34	2nd	United	Clean	-	-	-	Lower Wollombi			-14.4		
C2	43.8	3rd	United	Clean	Clean	-	-	Lower Wollombi			-20		
C3	120	3rd	United	Clean	Clean	-	-	Lower Wollombi			-41.4		

									Harvestable Rights		Water Access Licences	Not Required	Reason
									Peabody	United	Lower Wollombi		
C4	59.9	3rd	Wambo	Clean	Clean	Clean	Clean	Lower Wollombi			-59.9		
C5	103.4	2nd	United	-	Clean	Clean	-	Lower Wollombi			-34.2		
C6	66.1	2nd	United	-	-	-	Clean	Lower Wollombi		-66.1			Harvestable rights
MW1	15.2	N/A	United	Mine	Mine	-	-	Lower Wollombi				x	Turkeys nest
MW2	0.4	N/A	United	Mine	Mine	Mine	Mine	Lower Wollombi				x	Turkeys nest
Total	**1161.6**								**334.7**	**0.14**	**130.1**		

Notes:

1 Capacity is deemed to be equivalent to the settling zone volume

2 Stream order taken from LPI topographic maps; N/A refers to water storages which are not located on watercourses

3 Clean: Runoff from undisturbed or established rehabilitated areas

Dirty: Runoff from disturbed areas

Mine: Runoff from areas exposed to coal, groundwater inflow or water used in coal processing or from coal stockpile areas

4 Sediment and pollution control dams and turkey nest dams are exempt from licensing.

Water Storages Proposed for Retention in the Final Landform

As stated in Section 9.4.2.3 of the Surface Water Assessment, it is important to note that the licensing requirements associated with the final landform will be dependent on the ownership of the land and the licensing arrangements in force at the time of closure. Licensing will be considered through the development of the detailed Closure Plan, five years prior to mine closure in consultation with DRE and DPI Water. That said, the details provided below indicate that the water storages associated with the proposed final landform can be appropriately accommodated within the current water licence regime.

Table 3.15 provides the details of the water licencing for the conceptual final landform for the Project.

Dams may be required in the final landform for a number of reasons with the two primary purposes being:

- long term management of drainage in the final landform (for example, their ongoing use as detention areas to reduce flow velocities downslope and continue the operation of the established clean water management systems whilst maintaining drainage and creek line stability)

- environmental purposes (for example, the retention of dams with developed ecosystems will provide biodiversity value in the final landform).

Dams may also provide opportunities for stock watering for those areas proposed for agriculture.

Table 3.15 Proposed Water Storage in Final Landform

					Harvestable Rights		Water Access Licences	Not Required	Reason
					Peabody	United	Wollombi		
Land area (ha)					**5284.0**	**951.7**			
Harvestable Rights Provisions (ML)					**369.9**	**66.6**			
Water Access Licences (ML)							**300**		
Dams									
Name	**Capacity (ML)**	**Stream Order**	**Land ownership**	**Water Source**					
W1	10	N/A	Wambo	Lower Wollombi	-10				
W2 (West Cut)	10	N/A	Wambo	Lower Wollombi	-10				
W4	9	N/A	Wambo	Lower Wollombi	-9				
W5	15	N/A	Wambo	Lower Wollombi	-15				
W6	20	N/A	Wambo	Lower Wollombi	-20				
W7	10	N/A	Wambo	Lower Wollombi	-10				
W8	40	N/A	Wambo	Lower Wollombi	-40				
W10	9	N/A	Wambo	Lower Wollombi	-9				
M1	20	N/A	Wambo	Jerrys	-20				
M3	10	N/A	Wambo	Lower Wollombi	-10				
M4	10	N/A	Wambo	Lower Wollombi	-10				
M5	10	N/A	Wambo	Lower Wollombi	-10				
M6	10	N/A	Wambo	Lower Wollombi	-10				
U2	20	N/A	Wambo	Lower Wollombi	-20				
U3	40	N/A	United	Lower Wollombi		-40			
U4	10	N/A	United	Lower Wollombi		-10			
U5	4	N/A	United	Lower Wollombi		-4			
Total	**257**				**166.9**	**12.6**	**300**		

Notes:

1 Capacity is deemed to be equivalent to the settling zone volume

2 Stream order taken from LPI topographic maps; N/A refers to water storages which are not located on watercourses

3 Clean: Runoff from undisturbed or established rehabilitated areas

Dirty: Runoff from disturbed areas

Mine: Runoff from areas exposed to coal, groundwater inflow or water used in coal processing or from coal stockpile areas

4 Sediment and pollution control dams and turkey nest dams are exempt from licensing.

As noted in Table 9.4 of the Surface Water Assessment Dam C6 forms an erosion control dam in the Project final landform to control runoff velocities. As such this dam is exempt from licensing under Harvestable Rights Provisions. Dam C6, will spill into the proposed United Open Cut final void, and has been considered in the licensing discussion of water take associated with the Project final voids in Section 9.4.2.3 of the Surface Water Assessment.

Clean Water Diversion Measures

There are six proposed clean water dams for the Project (Dams C1 to C6). Only one of these dams is proposed to remain as part of the Conceptual Final Landform (Dam C6). The proposed retention of Dam C6 in the final landform is to minimise the risk of erosion to land downslope by assisting in managing flow rates from the upslope catchment area into the United final void. 100 per cent of the runoff from the catchment area of Dam C6 will be captured into the United final void after mining and has been considered in the licensing calculations included in Section 9.4 of the Surface Water Assessment for final voids.

As discussed in Section 4.1.1 of the Surface Water Assessment, as mining progresses, clean water controls will be maintained by the construction of new drains and dams as needed. Clean drains will be sized to safely convey the 1 per cent AEP storm event flows and proposed pump flows from upstream clean water dams to each of the respective clean water catch dams or downstream receiving catchment area. All clean drains will be constructed to enable design flow velocities to be non-scouring. Rock protection and energy dissipation structures will be installed at the downstream outlets, where required, to prevent runoff causing scour or erosion in downstream drainage systems, including in natural tributaries and constructed channels.

The purpose of these dams is to intercept clean water runoff from undisturbed areas upslope of the mining operations so that the clean water runoff can be kept separate from the mine water management system and returned to downstream catchment areas.

The clean water dams enable the Project to minimise the volume of clean water runoff captured and also to reduce the potential impacts on downstream watercourses. A summary of the proposed clean water diversion measures is provided in **Table 3.16**.

Table 3.16 Proposed Clean Water Diversion Measures

Dam name	Storage and Transfer Works Details				
	Capacity (ML)	Stream Order	Surface Area (ha)	Purpose	Licence Status[1]
C1	34.0	2nd order	0.80	Management of clean water runoff	WAL 18445
C2	43.8	3rd order	1.11	Management of clean water runoff	WAL 18445
C3	120	3rd order	2.30	Management of clean water runoff	WAL 18445
C4	59.9	3rd order	1.58	Management of clean water runoff	WAL 18445
C5	103.4	2nd order	1.90	Management of clean water runoff	WAL 18445
C6	66.1	2nd order	1.20	Management of clean water runoff	Harvestable rights

Refer to **Tables 3.14** and **3.15** for dam volumes/licensed water take.

It is proposed that all of the clean water dams listed will be pumped out to the downstream water catchments. The proposed flow release location is on the downstream side of the proposed flood levee on Redbank Creek. The detailed design of the outlet structure is currently being undertaken and will consider both the requirements of the Blue Book (Landcom, 2004) and DPI Water Guidelines for Outlet Control Structures on Waterfront Land.

Water will only be released to the downstream systems during and following rainfall events (i.e. when runoff is captured in the dams due to rainfall events). The maximum pump rate will be set to be 60 per cent of the flow capacity of Redbank Creek with flow release to not increase peak flood levels in downstream systems or impact on accessibility (e.g. the Golden Highway).

Partitioning of groundwater take

The predicted take from the porous rock groundwater source is presented graphically within the GIA in Section 7.1.1, Figure 7-1 for the approved and proposed operations, with the peak groundwater volumes requiring licensing within Table 7-1.

The data presented graphically in Figure 7-1 of the GIA is tabulated within **Table 3.17** below.

Table 3.17 Predicted take from porous rock

Model year	'Water take' (ML/year) North Coast Fractured and Porous Rock WSP				Proposed and approved
	Proposed Wambo Open Cut	Proposed United Open Cut	Approved open cut operations	Approved underground operations	
1 (2016)	10	0	456	684	1151
2	0	94	414	620	1127
3	0	282	392	704	1378
4	0	406	371	917	1694
5	0	582	359	836	1778
6	0	567	349	758	1674
7	75	558	89	704	1426
8	76	508	34	677	1295
9	33	326	33	726	1119
10	15	274	33	783	1105
11	13	263	32	834	1143
12	14	259	32	891	1196
13	14	166	32	936	1148
14	15	139	32	838	1023
15	15	126	31	1238	1411
16	6	152	31	994	1184
17	3	172	31	745	952
18	4	142	31	555	732
19	5	119	31	478	633
20	6	104	31	469	610

Model year	'Water take' (ML/year) North Coast Fractured and Porous Rock WSP				Proposed and approved
	Proposed Wambo Open Cut	Proposed United Open Cut	Approved open cut operations	Approved underground operations	
21	10	32	31	462	535
22	17	0	31	457	494
23	17	0	31	452	489
24	23	0	31	449	492
Maximum	76	582	456	1238	1778

Predicted groundwater inflows for the approved mine plan are highest during the initial 6 years due to the structure of the geology, hydraulic properties and mine progression. In the initial 6 years the approved mine intersects shallow and saturated coal measures. This strata typically has a higher hydraulic conductivity compared to the deeper strata, as a result of weathering and secondary porosity.

When considering the above predictions for water take from each of the water sources it is important to understand the methodology used to determine this. The model predicts the flow of water between model cells that represent the various geological units (i.e. alluvium and Permian coal measures) and river cells (i.e. Wollombi Brook). Model scenarios were run for the currently approved operations, proposed modification and a scenario with no future mining at United and Wambo (null run). The predicted 'water take' was calculated as the difference in flow into and out of cells. Direct take occurs within the mine pit footprint where there is greater flow out of a model cell due to the presence of mining, which was represented with drain cells. Indirect take occurs outside the mine footprint within the drawdown zone where there is less flow into a cell as a result of direct take elsewhere in the model.

This process is illustrated in Figure 7-11 of the GIA, which shows that the Project directly intercepts up to 633ML/year (Year 7) of groundwater from the Permian coal measures. There is no direct interception of alluvium as part of the Project. However, depressurisation of the Permian coal measures indirectly reduces upward seepage to the alluvium by up to 40ML/year. This in turn results in up to 37ML/year less alluvial groundwater flowing to the Wollombi Brook as baseflow. As the reduction in baseflow is directly related to the reduction in upward seepage from the Permian coal measures to the alluvium, this should not be accounted for twice with water licenses. To prevent 'double accounting', the licensed volume under the Hunter Unregulated WSP is based on the take from alluvium where it is higher than baseflow loss.

It should be noted that the estimated take above does not include direct extraction of surface water.

Licencing Summary During Operations

The approach to be undertaken for licensing of water take is:

- Direct extraction from river – licence 100 per cent water abstracted from the Wollombi Brook and the Hunter Regulated River (using WAL18437 of 350 units for Wollombi Brook, and WAL10541 of 300 high security units and WAL718 of 1,000 high security units for Hunter Regulated River).

- Clean water management system dams – one clean water dam (Dam C6) is located on a 2nd order tributary and fits within the MHRDC for United owned lands. For all remaining clean water dams the net water take (i.e. the evaporative losses) will be licensed as the remaining water will be diverted around the mine.

- Dirty water management system dams – no licensing required as all of these dams are located off 3rd or higher order watercourses and are used for pollution controls and as such are exempt from licensing and/or harvestable rights provisions.

- Direct capture of clean water runoff – no licensing required as the clean water catchments flowing directly into the WMS (i.e. those catchments not captured within clean water management system dams) are within the harvestable rights provisions.

- Baseflow losses – to be licensed.

The Joint Venture currently holds sufficient licences to meet the water licensing requirements for the Project.

A summary of the estimated future licensing requirements for the Project during the operational period for each water source is included in **Table 3.18**.

Table 3.18 Licensing Summary – Operations – Lower Wollombi Water Source – Hunter Unregulated and Alluvial Water Sources Water Sharing Plan

Aspect	Licensable Volume (ML)			
	Year 2 (2019)	Year 6 (2023)	Year 11 (2028)	Year 16 (2033)
Evaporative Losses from Dams C1 to C5	136	156	60	60
WMS dams[2]	0	0	0	0
Baseflow losses[3]	136	196	183	233
Maximum total licensable volume	309	419	338	455

Notes:

1. Water extraction figures sourced from Table 5.1 Average Predicted Water Balance of the Surface Water Assessment (Umwelt, 2016)
2. All WMS dams that don't require licensing due to function and/or harvestable rights provisions.
3. Baseflow losses sourced from Table 7-1 Groundwater Impact Assessment for the project (AGE Consultants Pty Ltd, 2016) and Table 20 South Wambo Underground Mine Modification (Hydrosimulations, 2016)

A summary of the existing licences held is included in **Table 3.19** and a water licencing summary for operations is included in **Table 3.20**.

Table 3.19 Existing Water Access Licences / Surface Water Licences for United and Wambo

Licence No.	Source	Holder	Type	Volume (ML)
WAL18549	Lower Wollombi Brook	United	Unregulated	100
WAL18445	Lower Wollombi Brook	United	Unregulated	200
WAL18437	Lower Wollombi Brook	Wambo	Unregulated	350[1]
WAL23897	Lower Wollombi Brook	Wambo	Unregulated – Aquifer Access	70
WAL10541	Hunter River	United	High Security	300
WAL718	Hunter River	Wambo	High Security	1,000

Note:

1. Licence conversion from *Water Act 1912* to *WM Act 2000* resulted in loss of high flow component. Request forwarded by Wambo to DPI Water to rectify this translation error. Licence to be a total of 750 units.

Total licences for Lower Wollombi Brook Water Source equates to 720 ML (unit shares), without the high flow component of WAL18437.

Table 3.20 Licensing Summary – During Operations

Aspect	Wollombi Brook Water Source - Licensable Volume (ML)
Maximum total licensable volume	Year 16 - 455
Current total licences[1]	720 total (1120 with high flow component of WAL18437)
Licensing requirements met with current licences?	Yes The remaining licensable volume will be utilised in meeting water supply requirements as per the predicted site water balance

As indicated in **Table 3.20**, based on the updated analysis of water licences, during operations the Joint Venture has sufficient licences for the Project.

Licencing Summary Final Landform

The approach to be undertaken for licensing of water take for the final landform is:

- Final voids - Direct capture of clean water runoff - license 100 per cent of take from clean water catchment flowing into final voids and the runoff associated with the area of catchment included in the final void.

- Final landform dams – All of the dams retained within the final conceptual landform (refer to **Figure 3.5**) are located off 3rd or higher order watercourses with total volumes that lie within the MHRDC for the relevant landholder. As such all of these dams fall under harvestable rights provisions.

- Baseflow losses – to be licensed.

A summary of the estimated future licensing requirements for the Project conceptual final landform is included in **Table 3.21**.

Table 3.21 Licensing Summary – Conceptual Final Landform

Aspect	Wollombi Brook Water Source - Licensable Volume (ML)
Final voids[1]	339
WMS dams[2]	0
Baseflow losses[3]	80
Maximum total licensable volume	391
Current total licences	720
Licensing requirements met with current licences?	Yes

Notes:

1. Final void volumes sourced from Table 9.5 Surface Water Assessment for the Project (Umwelt, 2016)
2. All WMS dams exempt from licensing due to function and/or harvestable rights provisions.
3. Baseflow losses sourced from AGE Consultants Pty Ltd
4. Assumed that WAL18437 is available post closure for licensing

As indicated in **Table 3.21**, based on the updated analysis of water licences, for the conceptual final landform the Joint Venture has sufficient licences within the Wollombi Brook Water Source.

The site water balance does not appear to account for water requirements for rehabilitation of disturbed areas. DPI recommends the model and assessment be updated to reflect these potential requirements, together with analysis of water supply security for dust suppression purposes when the available water determination for high security entitlement is less than 100% demonstrated.

The site water balance model was developed with the aim of assessing future site water balance behaviour and water supply reliability for the Project. The rehabilitation of disturbed areas will be undertaken progressively throughout the life of the Project and completed once mining activities have concluded. The rehabilitation aims to be self-sustaining and not requiring ongoing water requirements and for this reason rehabilitation areas are rarely watered using water from the site water management system. Should targeted watering be required, it would mostly likely be done using imported clean water in a water tanker (more suited to irrigation of rehabilitated areas) and would therefore have no effect on the overall balance of the site water management system.

Any water usage for rehabilitation works would be very minor in comparison to the operational water requirements for the Project.

As discussed in the Water Balance report, there is no provision in the Hunter Water Sharing Plan for reductions of high security entitlement available water determinations below 75 per cent. However, if dam levels fall substantially, the Minister responsible could act to reduce high security entitlement available water determinations to preserve water for local water utilities licences (town water), major utilities licences, stock and domestic licences, basic landholder rights and Environmental Contingency Allowance. The Water Sharing Plan does not however detail how high security entitlement available water determinations could/would be reduced in such circumstances. An algorithm was devised and used in the water balance model in the EIS to simulate reductions in high security entitlement available water determinations below 75 per cent.

This approach is considered to address the high security entitlement issue raised by DPI Water.

The Project is not anticipated to be reliant on high security entitlement for dust suppression activities. It is also noted that in the event that water availability was reduced, United would investigate further opportunities to reduce water demand such as chemical additives or binders to reduce demand or would secure alternative water sources.

Recommended conditions

DPI recommends the following be incorporated into conditions of consent, should the project be approved:

- **A consolidated Site Water Management Plan must be developed for the project, in consultation with DPI Water. The plan is to include:**
- **Expansion of groundwater monitoring in the alluvium and shallow regolith;**
- **Prescriptive Trigger Action Response Plans for impacts on alluvial aquifers and private users; and**
- **Rehabilitation measures for watercourses impacted as a result of the project.**

The DPI's recommended conditions are noted and are broadly consistent with the commitments made in the EIS.

3.6 Office of Environment and Heritage

Aboriginal Cultural Heritage Assessment

OEH has reviewed the Aboriginal Cultural Values Assessment Report (ACHM 2016) and the archaeological management recommendations (OzArk 2016 (EIS – Umwelt 2016 Appendices 14 and 15 respectively)). Based on this review OEH is satisfied that the management measures proposed are adequate and appropriate given the nature of the archaeological record and the range of activities to be undertaken within the operations footprint of the mine. OEH has no additional concerns with respect to Aboriginal cultural heritage management. Recommended consent conditions for the Aboriginal cultural heritage management of the project area are as follows:

Recommended conditions of consent for Aboriginal cultural heritage management:

1. **The proponent must consult with and involve all registered Aboriginal parties in the on-going management of the identified Aboriginal cultural heritage values associated with the project area. Evidence of this consultation must be collated and provided to the consent authority upon request.**

The OEH's recommended condition is noted. United has committed to ongoing consultation with the registered Aboriginal parties for the Project subject to Aboriginal cultural custom and lore protocols regarding restriction on the sharing of culturally sensitive knowledge with Aboriginal persons who have a historical or contemporary connection with the area, by Aboriginal persons who have a cultural connection to the area, or regarding the gender sensitivity of some cultural knowledge.

2. **The proponent must update the existing United Collieries Aboriginal Cultural Heritage Management Plan (ACHMP) to reflect the results and management recommendations detailed in the archaeological assessment undertaken for this project area (OzArk 2016: Section 10.4) and the results and management recommendations detailed in the Aboriginal Cultural Values Assessment Report (ACHM 2016: Section 8). This process must be undertaken in consultation with the registered Aboriginal parties prior to commencing any ground disturbance or development works subject to the development.**

As outlined in Section 6.10.7 of the EIS, United proposed to review the existing United Aboriginal Cultural Heritage Management Plan (ACHMP) within 12 months of the approval of the Project to outline all Aboriginal heritage management measures for the Project, responsibilities of all parties and the timeframe for required heritage works.

The ACHMP will include a staged approach to the required research and salvage works to ensure that areas required for earliest disturbance are completed as a priority.

3. **The revised ACHMP must outline detailed procedures to be followed in the event that any Aboriginal burials, skeletal material or previously unidentified Aboriginal objects are identified throughout the life of the project.**

The OEH's recommended condition is noted.

4. All Aboriginal sites impacted by the project must have an Aboriginal Site Impact Recording form completed and submitted to OEH's AHIMS Register within three months of being impacted.

The OEH's recommended condition is noted.

Flooding and Floodplain Management

The Wollombi Brook Flood Study BMT WBM July 2015 has since been commissioned by Singleton Council and includes the area covered by the Umwelt analysis. The methodology and results of the two studies have been compared to determine if the Umwelt study has provided sufficient information for assessment and has been carried out with the required technical detail……

The outputs of the Umwelt study, although not in accordance with the BMT outputs, are therefore considered to be conservative and may be used for assessment of the project.

OEH references the *Wollombi Brook Flood Study BMT WMB July 2015*, which has been commissioned by Singleton Council. No reference could be publically found to this study and the study was not available at the time the Flooding Assessment Report was completed. A copy of the study was received from Singleton Council upon request as part of preparing this response to submissions. The copy received is titled *Wollombi Brook Flood Study – Draft Report for Public Exhibition* and is dated July 2016 (the last date in the revision history is 25 July 2016). The Project was submitted to DPE for exhibition on 8 August 2016.

It is noted that the aims and objectives of the BMT Draft Flood Study and the EIS Wollombi Brook Flooding Assessment are different. The BMT Draft Flood Study is a flooding assessment of the whole Wollombi Brook catchment while the EIS study relates to the vicinity of the Project Area and assesses local changes and impacts on the flooding regime. It is therefore reasonable that different modelling approaches were taken for these two different studies.

The purpose of the EIS Wollombi Brook Flood Assessment was to determine flooding regimes (and associated flood planning aspects as requested by OEH via the SEARs) and potential impacts of the Project in relation to flooding in Wollombi Brook. As such the focus of the assessment is only on the reaches of Wollombi Brook immediately upstream of the Project Area, adjacent to the Project area and downstream of the Project Area to the confluence of Wollombi Brook and the Hunter River. The upstream and downstream boundaries of the modelling were selected respectively: at a natural constriction in the floodplain; at the confluence of the Hunter River, and at locations sufficiently far away from the area of interest to remove any boundary effects of modelling on the assessment. The modelling approach taken was conservative to, as such; estimated the worst case impacts of the Project on flooding in Wollombi Brook.

Upon review it is noted that the key differences driving the differences in the peak flows rates into of the models appears to be in regards to changes to rating curves that were derived in the BMT Draft Flood Study and application of tailwater levels and profiles.

The flooding assessment undertaken for the EIS has been noted by OEH as conservative and appropriate for assessment purposes. It is considered that the new data that has come to light since the commencement of the Flood Assessment (i.e. new rating curve by DPI Water for Warkworth gauge and rating curve analysis/estimates undertaken for the BMT Draft Flood study) should be considered as part of the flood

model updates for future design works for the proposed flood levee and highway alignments. This approach is generally consistent with the recommended conditions from OEH.

A further detailed response to the specific comments made by OEH in regards to the flooding assessment is included in **Appendix 12**.

Recommended conditions of consent for flooding / floodplain management:

1. **Detailed design of the flood levee and Golden Highway diversion is to include updated flood modelling.**

OEH's recommended conditions are noted and due to the updated rating curves associated with the recent flood work undertaken for Singleton Council updating the flooding model as part of the detailed design process would be appropriate.

2. **Flood modelling is to demonstrate no increase in flood attenuation of the highway or privately owned lands.**

Noted. The majority of Project infrastructure associated with the highway realignment is outside of the flood prone land.

3. **If the flood levee and highway diversions are to be constructed at different times the impact of each in isolation should be modelled in addition to the final form of the development.**

OEH's suggested approach to separate modelling scenarios is noted. This request would only be relevant to the parts of these infrastructure components that are located in flood prone land.

4. **Detailed design of outlet works for flood diversion channels is to include appropriate energy dissipation to protect natural waterways from erosion.**

There are no flood diversion channels proposed as part of the Project. Therefore this proposed condition is not considered necessary.

3.7 Office of Environment and Heritage – Heritage Division

General Comments

The report does not adequately address the significance and management of the heritage items in the project area. The significance assessments for all identified sites are unclear with not all items identified being subject to a significance assessment. For example, the former Warkworth Public School is considered to be of 'potential' local significance, but this is not confirmed or discussed in the significance assessment section. Also, the assessment of State significance for the Dog-leg Fence is not appropriately justified in either the heritage impact assessment or the accompanying appendix and requires updating.

The Historic Heritage Impact Statement examines the historical (non-Aboriginal) heritage and archaeological issues associated with the Project with the aim of assessing and evaluating the potential heritage impacts associated with the Project. The report identifies the historical heritage sites contained within and in the vicinity of the Project Area and assesses the significance of any impacts on these sites potentially resulting from the Project.

In general the significance assessment of the report focused on those items for which a significance assessment has not previously been prepared. Items such as the Warkworth Public School, Montrose Property, Springwood, the Piggery and Butcher's Hut, Abandoned Homestead A and Moses Crossing over the Hunter River have all been subject to previous reports and various levels of significance assessment. As these sites/items have previously been identified and assessed as having some level of heritage significance they were not re-assessed as part of the Historic Impact Statement for the Project; particularly as the majority of these sites/items are outside of the Project Area and not at risk of being impacted.

It is envisaged that the significance assessment of the Dog-leg fence will be updated as part of the required detailed survey and archival recording of the fence. As part of this the Heritage Impact Statement recommends additional research be undertaken which may provide further historical documentation to support the proposed State significance of the fence or amend the significance assessment as appropriate.

It is not proposed to update the Heritage Impact Statement as the report was finalised and exhibited as part of the EIS, however, clarification of the question posed in the Heritage Division's submission is provided below.

Additionally, items which are not considered to be of heritage significance, for example a well and windmill site have been included in strategies for management and mitigation, which is considered to further reduce the clarity of the report. Items which are not impacted by the project should be removed from management and mitigation sections to reduce confusion.

There are instances where identified potential sites may have been assessed as having no significance or no research potential; however, management measures may have been included in the Heritage Impact Statement for completeness. For example, for the well and windmill site raised in the Heritage Division submission no further management was proposed other than leaving the site *in situ* for as long as possible and the recording already undertaken for the Project was considered to be sufficient.

The Heritage Division's preference for the removal of items not considered to be of heritage significance and items not impacted by the Project from management and mitigation section is noted for future reference. To address this issue a summary table of sites that require management measures and details of the commitments are presented in **Table 3.22**. This table has been updated with additional management commitments associated with the responses to the Heritage Division's submission as discussed later in this section.

Table 3.22 Listed and Potential Heritage Items and Proposed Management

Item Name	Proximity to Project Area	Management Commitments
Wambo Homestead	Adjacent to Project Area	• No additional management measures are required in relation to Wambo Homestead as part of the Project, with the existing management regime in place under the Wambo mine development consent providing for the ongoing effective management of the site.
St Philips Church, Warkworth	1.2 kilometres outside and to the east of the Project Area	• No additional management measures required for the Project
Site of Former Queen Victoria Inn – Ruins Archaeological Site	1.8 kilometres outside and to the east of the Project Area	• No management measures required for the Project
Dog-leg fence	Within the Project Area	• A detailed survey and photographic/archival recording is planned to be undertaken in accordance with Heritage Division, OEH guidelines *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006) • As part of the archival recording additional research will be required to attempt to identify (if the information is available) an exact date of construction and who may have built the fence; research may provide further historical documentation to update the heritage significance assessment of the fence • An interpretation strategy will be developed for the Dog-leg fence

Item Name	Proximity to Project Area	Management Commitments
Former House Site	Within the Project Area	• Prior to the commencement of works that impact on this site, including ground preparation/clearing works, archaeological investigation of the Former House Site will be undertaken to relevant professional standards • An archaeological methodology and research design will be prepared and submitted to the Heritage Division for approval prior to works progressing on site (as part of the Heritage Management Plan)
Shearing Shed and Creamery	Within the Project Area	• A photographic/archival recording of the shearing shed and creamery will be undertaken in accordance with Heritage Division, OEH guidelines • The potential for the site to contain archaeological relics will be investigated and appropriate archaeological mitigation included in the Heritage Management Plan
Montrose Property	450 metres outside and to the north of the Project Area	• A photographic/archival recording of the shearing shed associated with the Montrose Property will be undertaken in accordance with Heritage Division, OEH guidelines • Further research will be undertaken to further understand the history of occupation and use of the property • The main house on the Montrose Property has been recorded as part of the preparation of the Historic Heritage Assessment and this is considered to be a sufficient record

Item Name	Proximity to Project Area	Management Commitments
The former Warkworth Public School	480 metres outside and to the east of the Project Area	• Blast sizes will be managed to 5 mm/s for this building via the application of lower charge masses to negate the risk of vibration impacts, except where agreed otherwise with the owner and/or based on a structural assessment that identifies an alternate acceptable vibration level. • Ongoing blast vibration monitoring will be undertaken as part of the Project to monitor compliance with the relevant criteria
Springwood (formerly Abandoned Homestead B)	640 metres outside and east of the Project Area	• No additional management measures for the Project
Piggery and Butcher's Hut	730 metres outside and east of the Project Area	• No management measures for the Project

Further to **Table 3.22**, a number of additional preventative management measures will be implemented as part of the Project. These measures are outlined in Section 6.11.5 of the EIS.

The archival recording of Montrose Property is not considered to adequately manage the potential impacts to this site from blasting works. A condition report prior to blasting should occur for this site and for all heritage sites potentially impacted by blasting in addition to a photographic archival recording.

The Montrose Property is located to the northwest of the Project Area; approximately 450 metres outside the Project Area boundary, approximately 750 metres from proposed extension to the northwest corner of the approved Wambo Open Cut and over 3 kilometres from the proposed United Open Cut. The Montrose Property is owned by Wambo.

In 1991 EnviroScience's assessed the Montrose Property house as a site of potential heritage significance (EnviroScience's, 1991: 59). The homestead and associated outbuildings were noted as being in good condition by EJE in 2003 and assessed:

...to be slightly significant in terms of its heritage and the ability to yield information that might contribute to the cultural history of the wool industry in the early part of the twentieth century (EJE 2003:CC-15).

The EJE report considered no specific mitigation measures were required for the Montrose Property as part of the approved Wambo Development Project. It is noted that the Wambo Open Cut is approved and impacts are predicted to the Montrose Property regardless of the Project.

The maximum predicted level of ground vibration for the site is 14 mm/s. The Montrose Property may be susceptible to damage from ground vibration. The Project is not proposing to mitigate the impacts from blasting at the Montrose Property. As such, a photographic/archival recording of the shearing shed associated with the Montrose Property is proposed in accordance with Heritage Division, OEH guidelines prior to any blasting being undertaken as part of the Project that may exceed 5 mm/s.

The main house on the Montrose Property has been recorded as part of the preparation of the Historic Heritage Assessment and this is considered to be a sufficient record. It is not proposed to undertake a condition report for the Montrose Property as the site has already been exposed to blasting from the current approved Wambo Open Cut operations.

It is proposed to undertake further recording of the shearing shed located at the Montrose Property. In addition to archival recording the Heritage Impact Statement recommends further research will also be undertaken of the Montrose Property to ensure that its history of occupation and use is properly understood and that a full understanding and record of the site will be available for future generations.

The use of photographic recording for the Shearing Shed and Creamery is not considered to adequately mitigate the removal of these elements. Archival recording of these properties which includes, recording of views to and from the site as well as drawings and plans of the site should occur prior to their removal commensurate with their significance as a local landmark. The photographic recording as part of the current assessment should also be updated to provide a map of where the photographs were taken, in accordance with Heritage Council guidelines.

The proposed archival/photographic recording of the Shearing Shed and Creamery will include a record of the views to and from the site as well as drawings and plans. This methodology will be discussed in the Heritage Management Plan for the Project, if the Project is approved.

Please note that the photographs taken as part of the survey undertaken during the preparation of the report were not intended to comprise a photographic recording of every item / or site in accordance with Heritage Council guidelines. The photographs were included as an appendix to the report to provide as much information on sites as available, particularly those sites identified in the report as not being impacted or not of heritage significance. All sites that were considered to warrant a recording in accordance with the guidelines were identified as requiring one and as such will be discussed in any Heritage Management Plan for the Project.

The report also does not make recommendations for the updating of a Historic Heritage Management Plan for the project, include links to the management plans previously prepared for the Collieries, provided a clear understanding of the heritage management systems currently in place at either site or provide information the mitigation measures previously completed. This information would have provided a useful understanding of the current management of heritage items at these properties and how all heritage items will continue to be managed in the joint venture.

A Heritage Management Plan does not exist for the Project, therefore it cannot be updated. It is proposed to develop a Heritage Management Plan for the Project, should the Project be approved. Any Heritage Management Plan for the Project is anticipated to be developed in consultation with the Heritage Division.

Wambo has an existing management plan for the Wambo Homestead Complex. The Wambo Homestead is outside of the Project Area and will remain the responsibility of Wambo. The Project does not change the predicted impacts to the Wambo Homestead.

It is noted that the Conservation Management Plan for Springwood was not available for review while preparing the Heritage Impact Statement for the Project.

The Statement of Heritage Impact for Wambo Homestead clearly shows the site will not be subject to further impact as a result of the project. This conclusion is considered to be supported and no additional management measures for Wambo Homestead are currently required however it is noted that the site is subject to ongoing conservation works and should continue to be managed according to the CMP for the site and previous project conditions of consent.

Noted. As discussed above the Wambo Homestead is outside of the Project Area and will remain the responsibility of Wambo.

Archaeological Comments

One archaeological site; the Former House site will be impacted as part of the project. The proposal for archaeological monitoring of excavation at the Former House site is considered to be appropriate, however the mitigation measures provided did not include sufficient detail including an archaeological research design or method as to the size and scope of the proposed archaeological excavation. This information should be completed and forwarded to the Heritage Council for approval prior to works progressing on site.

Noted.

As outlined in Section 6.3.2 of the Heritage Impact Statement in relation to the Former House Site:

Prior to archaeological works commencing an archaeological work method statement detailing the proposed works is proposed to be provided to the Heritage Division, OEH.

The preparation of a detailed archaeological research design and methodology is outside the scope of the Heritage Impact Statement which identified the site as having archaeological potential and as such would require archaeological investigation. The Heritage Management Plan will provide further details of the required archaeological management of the site which will include the requirement for a methodology and research design to be prepared in consultation with the Heritage Division prior to works progressing on site.

Overall, the assessment of archaeological potential across the project area lacks sufficient detail. A number of heritage items including; the Shearing Shed and Creamery, the Why not Homestead, the former Warkworth Public School, the Springwood Homestead, Montrose Property and Abandoned Homestead B have historical and site visit information which may indicate archaeological material associated with the standing structures may be present. While they may not all be subject to impacts as part of the current project the potential for these areas to contain archaeological relics should be appropriately investigated and included in any Historic Heritage Management Plan for the project. Archaeological aspects of the heritage items should also be subject to similar controls such as fencing to ensure the entire heritage item is appropriately protected.

Noted.

With the exception of the Shearing Shed and Creamery site, all these sites are a considerable distance from the proposed United Open Cut or outside the Project Area altogether.

Why not Homestead is within the Project Area however it is located outside the disturbance area for the Project. The former Warkworth Public School, the Springwood Homestead, Montrose Property and Abandoned Homestead B are all outside the Project Area. As such, as no subsurface impacts are proposed at these sites an assessment of archaeological potential is not considered valid for the Project.

It is not practicable or reasonable to fence all heritage items, as listed by the Heritage Council, as they are either still in use or located on land not under the control of the Joint Venture. Controls such as fencing for items within the Project Area that are not expected to be impacted can be considered in the Heritage Management Plan for the Project.

The potential for the Shearing Shed and Creamery site to contain archaeological relics can be investigated and appropriate archaeological mitigation included in the Heritage Management Plan for the Project, if required.

Recommended Conditions

It is recommended that the project adopt the following conditions regarding historic heritage and archaeology:

- **A Historic Heritage Management Plan for the project must be prepared in accordance with the guidelines in the NSW Heritage Manual that clearly indicates all heritage items in the vicinity of, and in the project area, provides a statement of significance for each item and a list of the impact mitigation and management strategies for each item. This document must also address the project's compliance with the conditions of previous approvals, and any requirements in the Conservation Management Plans for Wambo and Springwood Homesteads. This document should be provided for Heritage Council approval prior to any works commencing on site.**

It is anticipated that any development consent for the Project would require a Heritage Management Plan to be prepared. It is proposed that the Heritage Management Plan would be prepared in consultation with the Heritage Division, to the satisfaction of the Secretary, prior to any work being undertaken that may damage any identified heritage sites.

The Historic Heritage Management Plan will address those issues relevant to the Project and its operations; issues falling outside this (for example the archaeological assessment and management of sites located outside the Project Area) are not considered to be relevant to this Project and are not proposed to be included as part of the Heritage Management Plan.

Please note that the Wambo and Springwood Homesteads are managed by Wambo and Coal and Allied, respectively, under relevant management plans. There will be no change to this as a result of the Project.

- **An updated Statement of Significance for the Dog-Leg Fence site must be prepared as part of the Response to Submissions Report (RtS). This update should clearly indicate the significance of the site and provides appropriate management measures based on significance.**

As discussed above the significance assessment of the Dog-leg fence is proposed to be updated as part of the required detailed survey and archival recording of the fence as part of Project implementation. The detailed survey (which will further detail the condition and integrity of all sections of the fence), archival recording (with additional research) and interpretation strategy proposed for the fence will allow for the update of management measures as required based on its assessed significance. Additional management measures, if required, would be identified in the Heritage Management Plan for the Project.

- **An updated archaeological assessment must be prepared as part of the RtS. It should include archaeological potential for all heritage items within and in the vicinity of the Project Area.**

As discussed, the potential for the Shearing Shed and Creamery site to contain archaeological relics can be investigated and thus the appropriate archaeological mitigation included in the Heritage Management Plan for the Project.

The former Warkworth Public School, the Springwood Homestead, Montrose Property and Abandoned Homestead B are all outside the Project Area. As no subsurface impacts are proposed at these sites an assessment of archaeological potential is considered to be unnecessary and outside the scope of the current assessment.

- **A Research Design including an Archaeological Excavation Methodology must be prepared in accordance with Heritage Council guidelines for the areas proposed for archaeological excavation prior to commencement of works. Those documents should be prepared for the approval of the Director-General, Department of Planning & Infrastructure upon receipt of advice from the Heritage Division of the Office of Environment & Heritage.**

As discussed in the Heritage Impact Statement, an archaeological work method statement, including a research design, detailing the proposed archaeological works will be provided as part of the Heritage Management Plan prior to archaeological works commencing.

- **An archaeological consultant shall be nominated for the works. The consultants shall have appropriate qualifications and experience commensurate with the scope of the Major Project works. The name and experience of these consultants shall be submitted to the Director-General for approval prior to commencement of works.**

Noted.

- **After any archaeological works have been undertaken, a copy of the final excavation report(s) shall be prepared and lodged with the Heritage Council of NSW, the Council and the Department of Planning & Infrastructure. The proponent shall also be required to nominate a repository for the relics salvaged from any historical archaeological excavations.**

Noted.

- **All heritage items potentially subject to vibration and blasting impacts must be subject to a baseline condition assessment prior to blasting as part of the project. This assessment must be included in the Historic Heritage Management Plan and be updated annually when blasting occurs within 5 km of the site during any given year.**

A detailed Blasting Impact Assessment has been undertaken for the Project. The Blasting Impact Assessment provided the predicted range of ground vibration resulting from blasting associated with the Project. The predicted range of ground vibration would be less than 3 mm/s at 2 kilometres from the proposed blasting. As 3mm/s is well below the conservative level of 5mm/s (below which there is predicted to be no vibration impacts), it is suggested that 2 kilometres from the Project Area is an appropriate distance to trigger baseline condition assessments.

- **All heritage items required to be removed in whole or part by the project must be subject to archival recording in accordance with the Heritage Council publication 'How to prepare archival records of heritage items' and should include drawn base plans of the item and its components and detailed photographic recording in accordance with the Heritage Council publication 'Photographic Recording of Heritage Items Using Film or Digital Capture' (2006). The archival recording for the Shearing Shed and Creamery must also include views to and from the item due to its significance as a social landmark for the community. Archival records must also be submitted to relevant local Council libraries.**

Noted.

The appropriate methodology for archival recording will be discussed in the Heritage Management Plan and will be in accordance with the Heritage Council Guidelines.

- **A historic heritage induction for the site must occur for all personnel.**

Noted.

The required content relating to historic heritage to be included in the site induction will be discussed in the Heritage Management Plan. It is suggested that the induction will be for all relevant personnel rather than all personnel regardless of position and role on the Project.

- **Historic heritage items within the project area that will not be impacted by the project must be appropriately fenced and information on their locations shown on project mapping.**

Noted.

Appropriate fencing methodology will be discussed in the Heritage Management Plan for relevant items.

- **Any interpretation strategy prepared as part of the project must be completed in consultation with the Heritage Council of NSW.**

Noted.

The appropriate methodology for the preparation of the interpretation strategy will be discussed in the Heritage Management Plan, which will be prepared in consultation with the Heritage Division.

3.8 Transport for NSW

It is noted that the proposal refers to a re-alignment of a two kilometre section of the Golden Highway. The Golden Highway is a Classified Road and the concurrence of Roads and Maritime Services needs to be obtained. The proponent should continue to liaise with Roads and Maritime Services Hunter Region.

TfNSW interests appear to be adequately covered for the remainder of other transport issues raised.

United has undertaken substantive consultation with RMS regarding the Project to date and will continue to liaise with RMS Hunter Region on the proposed realignment of the Golden Highway.

3.9 Finance Services and Innovation – Mine Subsidence Board

In consideration of the MSC Act and EIS for this development, note the following comments:

- **There is no mention of any structures likely to be impacted by mine subsidence. Therefore, the MSB requires confirmation there is no risk of mine subsidence effecting surface improvements.**
- **Any proposed improvements associated with this development including the relocated Transmission Line and Golden Highway require the MSB's approval. Details of these developments together with an assessment of the mine subsidence risk should be formally submitted for MSB's consideration.**
- **It is unclear whether there is any intention to backfill any open cut areas. Please note where backfilling is inadequately compacted, it is unlikely the MSB will allow future development without firstly requiring the elimination of mine subsidence risk.**

The Project relates to open cut mining. There is no underground mining associated with the Project and no predicted mine subsidence effects to surface improvements.

As discussed in **Section 3.1**, part of the Wambo MIA will be subject to subsidence associated with Wambo's operations. This will be managed at the time of active subsidence in a manner consistent with other infrastructure at the mine.

As also discussed in **Section 3.1**, United has consulted with the MSB regarding the transmission line relocations and the MSB has confirmed that the alignments are unaffected by subsidence (refer to **Appendix 10**). In regard to the Golden Highway realignment, the alignment is not affected by underground mining at United or Wambo, however, it is in the general vicinity of the former Lemington underground mine workings. The alignment is expected to be outside the influence of any potential subsidence associated with these old workings, however, this will be confirmed with the MSB once the detailed design is complete.

Backfilling of all open cut areas in the Hunter Valley occurs as a part of the normal open cut mining method, and will be undertaken as part of the Project. MSBs comments in relation to future development requiring the elimination of mine subsidence risk are noted. As outlined in the EIS, the conceptual final land use is native vegetation and agricultural land. Based on these land uses, the risk of subsidence due to backfill compaction is low. As outlined in Section 6.13 of the EIS, detailed mine closure planning will be undertaken at each phase of the Project so that closure needs are considered as part of ongoing operations. When the mine is within five years of the planned closure date a detailed closure planning process will be initiated. The mine closure planning will consider the backfill compaction related subsidence risk for any potential final land use developments.

3.10 Australian Rail Track Corporation

ARTC advises that it has been in consultation with the proponent regarding the Environmental Impact Statement (EIS) and assessed project train movements and capacity impacts. ARTC confirms that the NSW rail network is available for the United Wambo open cut coal mine project and that no further investigation of rail network capacity and associated impacts would be required other than that contained in the EIS.

Noted.

3.11 Rural Fire Service

The NSW RFS has reviewed the EIS documents provided with the SSD/modification applications and provided the following comment:

- **The NSW RFS is the primary response agency for either bush or structural fires impacting on the development and associated infrastructure.**

Therefore the NSW RFS recommends the following conditions be attached to any consent granted:

5. Prior to extraction of coal under this consent, a fire management plan is to be prepared that addresses the following requirements:

a) Contact person (site supervisor) and 24 hour contact phone number; and

b) Schedule and description of proposed bush fire mitigation works including:

- **Location of managed and unmanaged vegetation within the site;**
- **Location of water supply;**
- **Internal access roads.**

c) A plan identifying the location and storage of bulk flammable liquids and materials;

d) A 'hot works' management plan including:

- **Restriction when 'hot works' are limited or prohibited;**
- **Safety measures to be implemented when 'hot works' are being conducted.**

e) An Emergency/Evacuation Plan is to be prepared consisted with the NSW Rural Fire Service document 'Guidelines for the Preparation of Emergency/Evacuation plans' and Australian Standard AS 3745 2010 'Planning for Emergencies in Facilities'.

The fire management plan shall be prepared in consultation with NSW RFS Singleton Fire Control Centre. A copy of the fire management plan shall be given to the Singleton Fire Control Centre prior to works commencing.

Bushfire risk is currently managed within the Project Area through the Wambo Bushfire Management Plan 2013 (Wambo BMP) and the United Bushfire Management Plan (United BMP). These existing management plans have been developed in consultation with the NSW Rural Fire Service (RFS) and Singleton Council. The RFS was consulted in relation to the Project.

As outlined in Section 6.17 of the EIS, United has committed to developing and implementing a site specific Bushfire Management Plan for the Project in consultation with the RFS to manage bushfire threat and to document emergency response procedures in relation to the Project. The RFS's recommended conditions are noted and could be addressed through United's proposed Bushfire Management Plan should they be included as the conditions on any development consent. It is proposed that the existing BMPs are suitable for use for the Project for 12 months prior to a new BMP being developed.

3.12 Hunter New England Health

Air Quality

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

Consistent with the comment from Hunter New England Heath above, Section 6.20.1 of the EIS noted that there is no known safe level of exposure to airborne particular matter where there is no potential for impact on human health (WHO 2005).

To minimise human exposure to particulate matter as a result of the Project, United proposes to implement all reasonable and feasible dust mitigation measures. The proposed measures, detailed in Section 9 of the AQIA, have been compared to the measures outlined in the *NSW Coal Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Donnelly et al, 2011). The comparison identified that the majority of proposed measures are consistent with best practice dust mitigation measures. As requested by DPE, a comparison of the proposed air quality management measures to be implemented as part of the Project to the NSW Coal Benchmarking Study is provided in **Section 3.1**.

On 15 December 2015, the National Environment Protection Council (NEPC) agreed to vary the National Environment Protection (Ambient Air Quality) Measure (NEPM). The amending instrument took effect on 4 February 2016. The new standards are as follows:

Pollutant	Averaging Period	Maximum concentration standard	Maximum allowable exceedances
Particles as PM_{10}	1 day	50 µg/m^3	None
	1 year	25 µg/m^3	None
Particles as $PM_{2.5}$	1 day	25 µg/m^3	None
	1 year	8 µg/m^3	None

Reference: https://www.legislation.gov.au/Details/F2016C00215

The EIS explains that, at the time of preparation of the report, the Environment Protection Authority (EPA) had not yet prescribed changes to the air quality criteria for NSW following the amendment to the NEPM. However, it would be expected that the EPA will introduce the amended criteria within the foreseeable future, and the EIS should have taken this into account.

As noted in Hunter New England Health's comment, in December 2015 the Australian Government announced a National Clean Air Agreement (Agreement). This Agreement aims to reduce air pollution and improve air quality via a number of actions, including strengthened ambient air quality reporting standards for particle pollution. Specifically:

Taking into account the latest scientific evidence of health impacts, Ministers agreed to strengthen national ambient air quality reporting standards for airborne fine particles. Ministers agreed to adopt reporting standards for annual average and 24-hour $PM_{2.5}$ particles of 8 µg/m^3 and 25 µg/m^3 respectively, aiming to move to 7 µg/m^3 and 20 µg/m^3 respectively by 2025. Ministers also agreed to establish an annual average standard for PM_{10} particles of 25 µg/m^{3}....The decision was also taken to review PM_{10} standards in 2018.

While all jurisdictions have agreed to this action, no States (including NSW) have prescribed a change to their air quality criteria to be used for the assessment of specific projects. As such the criteria outlined in Table 6.3 of the EIS remain current for the assessment of potential Project impacts. The Agreement indicates an initial work plan of two years to progress the actions.

As outlined in Section 6.4.2 of the EIS, the air quality assessment criteria adopted for the Project are those recommended by the EPA and specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC 2005a). These criteria are consistent with the national standards set by the National Environmental Protection Council under the National Environment Protection Measures (NEPM) for Ambient Air Quality (NEPC 1998). At this stage the NEPM Advisory Reporting Goals for $PM_{2.5}$ have not been adopted by the EPA for assessment of impacts from specific projects.

Section 4 of the AQIA also makes reference to the National Clean Air Agreement and amendment to the NEPM. The AQIA considered the overall conclusions of the assessment in the context of the National Clean Air Agreement, finding that the overall findings of the assessment will not change as a result of the proposal to establish an annual average standard for PM_{10} of 25 µg/m^3.

Private residence R28, approximately 2km northwest of the Wambo pit in the Moses Crossing area, is predicted to experience PM_{10} above 50µg/m^3 on 6 days in Year 2 of the Project, and 3 days in years 6, 11 and 16. Currently the criteria allows up to 5 days of exceedance per year. However, the new NEPM has no allowance for exceedances.

Noted. Residence 28 has recently been purchased by the Joint Venture and is therefore no long a sensitive receiver for the Project.

The EIS states that analysis of wind patterns from the Wambo meteorological station for the period 2011 to 2015 indicate that wind patterns are relatively consistent from year to year, and the most common winds are from the south-southeast, southeast and west-northwest. It would be expected that the particulate matter contours may follow this pattern. However, the contour lines for predicted annual average $PM_{10}$and $PM_{2.5}$ concentrations as shown in Figures 26 and 32, respectively, of Appendix 7: Air Quality Impact Assessment indicate the plume moving more in a northerly direction. If the PM was distributed and settled in accordance with the common wind patterns, it might be expected that there would be more of an impact on the residences to the northwest of the Project in the Moses Crossing area than these Figures predict. HNE Health would recommend expert analysis of these modelling results.

The shape of contour plots derived from air dispersion models are influenced by several factors but primarily by the prevailing meteorological conditions and the location of modelled sources. Contours do not typically represent a plume at any one point in time, rather they reflect the annual or maximum 24-hour average concentration that was predicted at each location. This means that the contours will not necessarily show a pattern that follows the pattern of wind-roses from a single location.

In the case of the figures in the Air Quality Impact Assessment, the shape of the contours for cumulative predictions are influenced by all nearby mining operations. It can be seen from these figures that the highest concentrations are centred on these sources. Variations in meteorology at different locations across the modelled area will also influence the output from dispersion models.

Peer reviews undertaken by Pacific Environment Limited and, following EIS publication, Ramboll Environ did not identify any specific issues associated with the meteorological inputs or shape of the contour plots.

Noise and Blasting

Environmental noise can have negative impacts on human health and well-being and trigger ongoing community complaints about annoyance, sleep disturbance and stress. Evidence concerning the adverse health effects of environmental noise is detailed in a number of publications, for example, the World Health Organization Night Noise Guidelines for Europe (2009) and the WHO Guidelines for Community Noise (1999). To protect public health, it is prudent to take all reasonable and feasible measures to minimise public exposure to mine-related noise, irrespective of compliance with the relevant noise policies.

The potential health impacts of environmental noise are noted and were discussed in Section 6.20 of the EIS. As noted by Hunter New England Health it is prudent to take all reasonable and feasible measures to minimise noise. As discussed in the EIS, United has committed to implement all reasonable and feasible noise management and mitigation measures to minimise the noise impacts of the Project. Details of the proposed measures and the management process to be implemented to minimise noise impacts were also discussed in the EIS and in the Noise Impact Assessment.

The residence that will be most impacted by increases in noise is R19, which is predicted to experience day time exceedances of the PSNL of up to 13 db(A), and night time exceedances of up to 17 dB(A). This residence is also predicted to be the only private residence to experience exceedances of the sleep disturbance criteria. This is the same residence mentioned in the Air Quality section that has current acquisition rights from both Wambo and Mount Thorley Warkworth mining operations. It is advised that the proponent engage in clear and open consultation with the owner/occupier of this residence to ensure they are aware of the additional impacts and their options.

United has been consulting with the owner of R19. The owner is aware of the predicted impacts associated with the Project and their existing acquisition rights and expected voluntary acquisition rights for the Project. It is noted that the owner of R19 does not currently live in the property full time.

United will continue discussions with the owner of R19 in relation to the Project and mitigation options.

The other 6 residences in the Noise Affectation Zone are located 1-2km to the northwest of the Wambo pit on the Golden Highway in an area known as Moses Crossing. The majority of residences in the Active Noise Management Zone are located approximately 1-3km to the west of the Wambo pit in the Redmanvale Road area. These are communities that are already experiencing significant impacts from noise, as evidenced by the number of complaints in relation to noise mentioned previously. As part of any approval, we would emphasise the need for effective community consultation throughout the project to facilitate public involvement and to allow for the community to participate in the mitigation selection process.

To support United's aim of designing and developing a Project that will coexist with the local community, a comprehensive stakeholder engagement program has been implemented for the Project to date. If the Project is approved, the intent is to build upon the stakeholder engagement program that has been implemented throughout the environmental and social assessment process. Commitments relating to ongoing community engagement were included in Section 8 of the EIS.

Specifically in regard to consultation about noise impacts, United has consulted directly with all of the residents in the noise affectation and active noise management zones for the Project to discuss the predicted impacts and the options available to them (e.g. noise mitigation treatments, acquisition where relevant etc.). As outlined in Section 6.6.11.2 of the EIS, United will develop and implement a Noise Management Plan for the Project which will detail the implementation of monitoring and management measures to be utilised to manage noise impacts. In relation to community consultation, the Noise Management Plan will include:

- mechanisms for stakeholder consultation relating to noise
- consultation processes to monitor and manage the potential for cumulative noise with neighbouring mining / industrial operations
- complaint/enquiry handling process including maintenance of a 24 hour community contact line.

United is committed to continuing to work with the community as it transitions into operations, should the Project be approved.

Although mostly compliant with relevant criteria, the current blasting practices are still resulting in a large number of complaints from residents.

As highlighted in the NSW Health submission and outlined in Section 6.7 of the EIS, in the period 2011 to 2014, a number of complaints were received about blasting operations at Wambo. Over this period, blast vibration, overpressure and dust/fume associated with blasting was the second highest reason for community complaints. Further complaints were received in 2015 with blasting being the most common reason for complaints (11 blasting related complaints out of a total of 16 complaints).

United acknowledges that blasting impacts are a key issue for the local community and has committed to a range of blast management practices, as outlined in Section 6.7.6 of the EIS. In addition to implementing the blast management controls necessary to meet the relevant criteria for private residences (except where an agreement is in place with the land owner), infrastructure, heritage sites and other sensitive receivers, United is also committed to seeking to minimise impacts to reduce community concern. As committed to in the EIS, United will develop a Blast Management Plan to guide blasting practice at the site.

The EIS states there is potential for residence R19 to experience ground vibration exposure levels and airblast impacts in excess of relevant limits for human comfort. The EIS also states that any blasting impacts in excess of the criteria at R19 would be the subject of a negotiated agreement with the resident while it remains privately owned. As stated previously, it is advised that the proponent engage in clear and open consultation with the owner/occupier of this residence to ensure they are aware of the additional impacts and their options.

As noted above, United has been consulting with the owner of R19. The owner is aware of the predicted impacts associated with the Project and their existing acquisition rights and expected voluntary acquisition rights for the Project. It is noted that the owner of R19 does not live in the property full time.

United will continue discussions with the owner of R19 in relation to the Project and mitigation options.

United will continue to consult regularly with all residences that may be impacted as a result of the Project.

We emphasise the need to ensure strict control of blast conditions to protect the public from the impacts of vibration, overpressure and blast fume emissions.

As outlined in Section 6.7 of the EIS, United will implement the blast management controls necessary to meet the relevant criteria and to minimise blasting impacts. Blasting activities will be undertaken in accordance with a Blast Management Plan to be prepared and implemented for the Project. This Blast Management Plan will be prepared in consideration of the relevant aspects of the existing Wambo Open Cut Blast Management Plan (Peabody Energy 2014) and the Blast Fume Management Strategy, which is currently being implemented at Wambo.

As detailed in Section 6.7.6 of the EIS, the Blast Management Plan will include the following management and monitoring measures to minimise the potential impacts of blasting activities:

- a pre-blast assessment protocol that outlines the process for designing blasts to meet the relevant criteria, which may include limiting the charge mass of blasts close to potentially affected locations or other blast vibration management controls (e.g. optimisation of initiation design)
- blasting will be undertaken between 9.00 am and 5.00 pm Monday to Saturday
- a maximum of 15 blasts per week and three blasts per day, with an allowance for additional blasts where there are low vibration blasts or misfires
- blasting related closures of the Golden Highway associated with the Project will be limited to one per day
- continued operation of the existing multi-station blast monitoring system for the Wambo Open Cut and installation of one additional monitoring station located to the northeast in the Maison Dieu area
- access to weather monitoring data to allow for the assessment of pre-blast meteorological conditions as part of the pre-blast assessment protocol
- development of a road closure management plan in consultation with RMS and Singleton Council
- implementation of appropriate exclusion zones to manage the risk of flyrock
- coordination of blasting times between the two Project mining areas to avoid blasting occurring simultaneously
- liaison with the operators of nearby mines in relation to the coordination of blasts to avoid concurrent blasting and therefore cumulative airblast and vibration impacts
- liaison with HVO regarding blasting within 500 metres of the Riverview Pit Dam wall.

United has also committed to implementation of the Glencore blasting procedures relating to fume management as part of the Project and that key fume management actions will be outlined in the Blast Management Plan.

It is considered that the blast management protocols proposed for the Project will manage blast conditions to protect the public from the impacts of vibration, overpressure and blast fume emissions.

Rainwater Tanks

It is noted that in the EIS the proponents have committed to providing for the inspection and, as necessary, cleaning of drinking water tanks every 2 years for all private residences and Joint Venture owned residences within 4 kilometres of the mining area for the Project. HNE Health would recommend including more frequent inspections and cleaning where necessary in response to residents' complaints.

The Project presents a low risk of potential drinking water contamination. However, to address any residual concern about potential dust deposition impacts on drinking water tanks, United has committed to provide for the inspection and, as necessary, cleaning of drinking water tanks every 2 years for all private residences and Joint Venture owned residences within 4 kilometres of the mining area for the Project.

The two year timeframe for inspection of water tanks is consistent with the guidance provided by the Commonwealth Department of Health (www.health.gov.au) which recommends: '*tanks should be inspected every 2-3 years for the presence of accumulated sediments. If the bottom of the tank is covered with sediment the tank should be cleaned*'. The more conservative timeframe of 2 years has been adopted.

Given the low risk of drinking water contamination associated with the Project, the existing commitment is considered adequate, however, if any private residences within the 4 kilometre area have any concerns in relation to their drinking water tanks during the life of the mine, they would be encouraged to liaise with United and appropriate measures would be discussed with the residents.

3.13 Roads and Maritime Service

1. Consultation with Roads and Maritime

- **Roads and Maritime has had ongoing consultation with the proponent in relation to preliminary design drawings for the new road alignment and geotechnical (stability) assessment of the new road in relation to the open cut mine.**
- **Roads and Maritime notes that the documentation submitted as part of the project application does not include preliminary design plans and geotechnical/stability assessment reports which have been previously submitted for our review and which were requested as part of the SEARs process.**
- **Roads and Maritime considers that the proposed Golden Highway realignment is a key component of the project and all relevant documentation which has been reviewed as part of the ongoing consultation process should form part of the project application.**
- **Roads and Maritime requested that the proponent submit all relevant documentation relating to the proposed Golden Highway realignment for formal review and comment.**

The EIS was prepared in accordance with the SEARs for the Project as provided by DPE including the requirements relating to transport. The reference to the SEARs in the RMS submission relates to the RMS's letter provided to DPE to inform DPE's preparation of the SEARs. As noted in the above comment by RMS, the detailed technical documents requested by the RMS letter to DPE regarding the SEARs have been previously provided directly to RMS by United. United recognise the importance of the preliminary design and geotechnical information to RMS as the Golden Highway is a State road, however as the documents are highly technical and large in size and would have therefore resulted in a much larger EIS, they were not included in the EIS but provided separately to RMS.

A concept design for the Golden Highway realignment was presented in Figure 3.20 of the EIS. To satisfy the RMS submission, the further detailed preliminary design plans for the realignment which have been previously submitted to RMS are included in **Appendix 13** of this report.

A geotechnical study on the stability of the rock pillar beneath the Golden Highway has been prepared by Pells Sullivan Meynink (Engineering Consultants) (August 2016). As noted above, this study has been previously provided to RMS. To satisfy the RMS submission, the main text of the geotechnical study has been included in **Appendix 14** of this report, with the appendices not included due to their size and highly technical nature. Copies of the full report with appendices have been provided to RMS and DPE and can be made available on request.

2. Golden Highway realignment

- **A concept design including drainage details should be submitted to Roads and Maritime for review as part of the EIS submission.**
- **Pavement Design is to be based on 20 year design life based on current traffic volumes with a suitable growth rate.**
- **Appropriate clear zones are to be maintained to any structures, including any relocated utilities, and provided to Roads and Maritime for review. This includes overhead power lines as well as any physical structures on the ground, and must consider oversize and/or overmass vehicles.**
- **Roads and Maritime has previously advised that for planning purposes a worst case scenario to allow sufficient width of a duplication of the road corridor, is to be considered as part of the proposal. Roads and Maritime needs to ensure that there is sufficient corridor width for future upgrades to the Golden Highway on the section proposed for realignment.**
- **The EIS does not address the information on the closure and dedication of the highway alignment and whether the existing road alignment will be maintained as a road reserve.**

A concept design for the Golden Highway realignment was presented in Figure 3.20 of the EIS. To satisfy the RMS submission, further detailed preliminary design plans for the realignment which have been previously submitted to RMS are included in **Appendix 13** of this report.

Work to progress the detailed design of the Golden Highway realignment is ongoing. The detailed design report will include a Traffic Impact Assessment, detailed design of the Comleroi Road intersection and information on drainage, pavement design and clear zones for the proposed Golden Highway realignment and will meet relevant RMS design guides. The detailed design of the Golden Highway realignment will be subject to approval by RMS.

The requirement to allow sufficient width of a duplication of the road corridor will be incorporated during the design process. The concept design, and the detailed design, will make allowance for a potential duplication. It is noted that the Project proposes to relocate the existing single carriageway and does not propose to duplicate the Golden Highway, however, the road corridor width will be designed to allow for future upgrades.

In regard to the existing alignment of the highway, as outlined in the EIS, the land occupied by the section of the existing Golden Highway alignment that is proposed to be relocated is proposed to be mined as part of the Project. Accordingly, once the road is relocated, the road reserve will be closed. United will consult with the relevant authorities in relation to the closure and dedication of the road reserve.

3. Traffic & Transport Impact Assessment

- **The proponent is to submit the electronic input/output data files of the traffic analysis for Roads and Maritime review.**
- **The TIA should address in detail the impact of the proposed realignment of the Golden Highway with the intersection of Comleroi Road and any other property access points which are by-passed or affected by the proposed realignment.**

The electronic input/output data files of the traffic analysis have been provided to RMS as requested.

Work to progress the detailed design of the Golden Highway realignment is ongoing. An assessment of the proposed realignment of the Golden Highway with the intersection of Comlerio Road will be undertaken and included in the detailed design report. United has discussed this approach with RMS, subsequent to the receipt of the RMS submission, and RMS has confirmed that this approach is acceptable.

4. Stability of the Rock Pillar beneath the Golden Highway

- **Roads and Maritime has reviewed the geotechnical study for the stability of the rock pillar beneath the Golden Highway as part of the consultation process and provides comments in Attachment A to be addresses by the proponent.**

Attachment A contained several technical questions from the RMS regarding the geotechnical study provided by United to RMS. The responses to Attachment A of the RMS submission are presented in **Appendix 15**. United has discussed the questions and responses with RMS and has provided a copy of the responses to RMS for further review. As indicated in **Appendix 15**, RMS has reviewed the further responses and indicated that the questions raised from its initial review have been resolved.

4.0 Community and Other Stakeholder Submissions

As outlined in **Section 2.0**, 78 individual community submissions and 12 interest group submission were received relating to the Project. A response to the issues raised in these submissions is included in the following sections grouped by theme.

A number of the community and interest group submissions received were similar or had consistent themes. Where this is the case, the theme of the concern has been provided in **bold** in the text boxes below with some examples of specific quotes from the submissions provided in normal type to assist the reader. Specific issues, that is, where an issue was raised only once have also been addressed.

4.1 Agriculture and Land Use

Issues relating to impacts on agriculture and land use were raised in 6 community submissions and in one interest group submission.

4.1.1 Community

Impacts on agricultural resources:

'Agricultural resources will be lost to mining. Future generations deserve to benefit from the agricultural resources in the region'.

'I oppose this development due to the destruction of valuable farming land'.

A comprehensive Agricultural Impact Statement (AIS) was prepared to assess the potential agricultural impacts associated with the Project and was provided in Appendix 6 of the EIS. The AIS took into account the:

- existing land capability and current and historical agricultural uses of the Project Area
- the area and length of time over which agricultural resources will be impacted by the Project, beyond existing approved disturbance and impact
- proposed final landforms, land and soil capability and land uses
- likelihood that specific levels of land and soil capability will be achieved post mining.

The AIS also considers impacts of the Project on agricultural resources and uses/enterprises in the locality. The potential impacts of the Project on agricultural support services and the amenity, lifestyle and connectedness of rural communities were also considered.

Section 6.2.3 of the EIS provides the existing land and soil capability of the Project Area. The Project Area is dominated by Class 4 to 7 capability land (with Class 1 being the best quality agricultural land and Class 8 being the lowest) due to the combination of soil types and slopes and the disturbance associated with mining. Class 4 to 7 land has high limitations if used for agricultural land uses more intensive than grazing with limited or no cultivation.

The only agricultural enterprise within the additional disturbance area is a grazing lease over approximately 16 hectares of land in the northwest corner of the Project Area. This land, and adjoining land also used for grazing, is owned by Wambo. The current grazing activities within the Project Area will be discontinued during the operation of the Project. This cessation of grazing activity will occur due to the progression of the approved Wambo Open Cut and will occur regardless of the Project progressing. As noted above, this area is contiguous with other Wambo landholdings which will continue to be used for grazing. The impact of the Project on agricultural activities is therefore negligible given grazing will be excluded from the Project Area as a result of the approved Wambo operations irrespective of whether the Project is undertaken.

It is proposed that at the completion of mining, this area will be returned to agricultural use. Following the cessation of mining and the rehabilitation of mining related disturbance, the area would be available for grazing and other agricultural activities consistent with its land and soil capability. The location of this land adjacent to other moderate to good agricultural land means, that post mining, it can augment local agricultural enterprises.

Because of the scale and interim nature of the only current agricultural enterprise, the direct impact of the Project on existing agricultural enterprises is very low.

Top soil management:

'What are the plans for harvesting and redistribution of top soil?'

Section 6.13.4 of the EIS details topsoil management strategies that will be implemented for the Project. The overall aim regarding topsoil management is to remove topsoil prior to mining activity and reuse it in rehabilitation of the mine. Where topsoil cannot be directly reused in a rehabilitation area it will be stockpiled for later use, as outlined in Section 6.13.4 of the EIS.

As part of the Project United will undertake topsoil handling in accordance with the topsoil stockpile handling strategy detailed below to maintain the quality of topsoil for subsequent use in rehabilitation. Materials management and monitoring techniques to be adopted for this strategy include:

- Material characterisation of topsoil and subsoil will be undertaken at an appropriate scale across the site. Representative samples will be taken to characterise the nature of the soil material (e.g. sodicity, acid-generating potential, etc.) to determine the potential limitations to rehabilitation and sustainable plant growth. The results will be used to determine specific ameliorant techniques that may be applied to the soil material in order to overcome potential limitations and enhance vegetation establishment.

- Topsoil and subsoil stripping activities are to be restricted during adverse weather conditions to minimise the potential for dust generation.

- Topsoil and stripping depths will be identified for each stripping area and will be undertaken using appropriate equipment (e.g. dozer or scraper).

- Topsoil and subsoil layers will be assessed and managed so that they can be appropriately re-applied in areas to be rehabilitated.

- Wherever practicable, topsoil will be transferred directly from stripping location to areas that have been reshaped for rehabilitation, eliminating the need for storage and re-handling.

- Topsoil stockpiles will be located away from traffic areas and at an appropriate distance from watercourses.

- Appropriate sediment controls will be installed around topsoil stockpiles.
- Stockpiles will be generally less than 3 metres high to retain biological activity within the topsoil.
- Stockpiles to be kept longer than six months will be sown with a suitable cover crop to minimise soil erosion and invasion of weed species.
- Where required, machinery used to handle and transport topsoil will be washed down prior to and at the completion of works to minimise the transfer of weeds.
- Weed growth on topsoil stockpiles will be monitored and subsequently controlled if necessary.
- Prior to re-spreading, any weed growth will be scalped from the top of the stockpiles to minimise the transport of weeds into rehabilitated areas.
- Stockpiles will be appropriately identified to minimise the potential for inadvertent use or disturbance.

Topsoil management strategies will be detailed in the Rehabilitation Environment Management Plan for the Project, should the Project be approved.

Residence 320: Wambo mine provided filters for our drinking water for the house as the water coming from our tanks obviously polluted with mine dust was brown. We put the question to Wambo how are you going to purify the dams on our property polluted with mine dust that water our athletic horses. Still to this day no solution has been provided. The large dam on our property has underground pipes with a pump that pumps to the large tank specific to the watering of the horses in the smaller paddocks. The horses that live and graze in the larger paddocks drink directly from the dams. This particular dam is located only 232 meters from the acquisition zone, we now insist on a response and solution on how Glencore intend to purify the dam for our horses.

Residence 320 is located approximately 1.5 kilometres to the northwest of the Project Area. The closest mining activities associated with the Project are the approved Wambo Open Cut. The Wambo Open Cut is an approved mining operation which may continue regardless of the Project. The Project will not result in any mining operations coming closer to Residence 320 than currently approved, however it is acknowledged that the Project involves an extension of mine life beyond that currently approved of approximately 20 years

The Air Quality Impact Assessment has provided a comprehensive assessment of potential air impacts associated with the Project. The Air Quality Impact Assessment undertaken for the Project has concluded that with the Project, cumulative dust levels with the Project are predicted to comply with the relevant criteria at Residence 320. United has also committed to implement a range of best practice dust management and mitigation measures to minimise the air quality impacts of the Project.

Although the Project is predicted to comply with relevant air quality criteria at this location, United will commit to undertaking water quality testing at appropriate dams on the property associated with Residence 320, in consultation with the landholder. The water quality testing will be undertaken prior to commencement of the Project and at an appropriate interval after the commencement of mining operations associated with the Project. The results will be compared to relevant water quality guidelines and United will consult with the landholder in relation to the findings.

Water quality (blast fumes/dust) may be affected in the future in dams and waterholes for livestock consumption.

The Air Quality Impact Assessment has provided a comprehensive assessment of potential air impacts associated with the Project including assessment of both dust and blast fume. The assessment concluded that the Project is predicted to comply with all relevant air quality criteria at Residence 320. As discussed above, United has also committed to implement a range of air quality management and mitigation measures to minimise the air quality impacts of the Project.

Residence 320: The increased dust and thickness of the air has caused metabolic problems with some of our horses, others have suffered with coughs for extended periods, increased heart rates in some of the horses has also been a problem. The expansion of the Wambo mine with the increased mine environmental factors has impacted on our horse's health with some horses having ongoing coughs, metabolic issues, increased heart rates, skin and eye irritations. We are seriously concerned about the polluted environment in which our horses live and train.

The residents' concerns related to the health of their horses are noted.

The air quality criteria in place in NSW have been established to protect human health and natural resources and DPE (2016) has advised that it considers that these criteria are sufficient to assess and manage air quality impacts on the thoroughbred industry. As discussed above, Residence 320 is located approximately 1.5 kilometres to the northwest of the Project Area and the detailed air quality impact assessment for the Project has predicted that all relevant air quality criteria will be met at this location.

4.1.2 Interest Groups

4.1.2.1 Rivers SOS

The Hunter and its agricultural industries and expanding tourism must be protected from further destruction and degradation.

The impact of the Project on agricultural activities has been assessed as negligible given grazing will be excluded from the Project Area as a result of the approved Wambo operations irrespective of whether the Project is undertaken. In regard to impacts on agricultural resources, the majority of the additional disturbance area consists of Class 5 land and soil capability which is characterised as having severe limitations for agricultural production. There are small areas of Class 4 (moderate to severe limitations) and Class 3 (moderate limitations) also affected. Within the class 3 area there is approximately 3.6 hectares of biophysical strategic agricultural land (BSAL) which will be affected. This area will not be mined but will experience some disturbance associated with the construction of a proposed dam and other water management system infrastructure (e.g. drains). Physical disturbance of the soils in areas of verified BSAL will be minimised as much as practicable. The water management system elements proposed for this area will not adversely impact on the agricultural value of the land or the adjoining agricultural land. There is potential for these water management facilities to be retained in the post mining landform and used to support agricultural land uses.

The pre and post mining land and soil capability is presented in **Table 3.7**. The proposed rehabilitation plan proposes to return two areas within the Project Area to LSC Class 4 agricultural land in the northwest

corner of the Project Area and along the southern boundary of the current approved Wambo mine area. Following the cessation of mining and the rehabilitation of mining related disturbance, these areas would be available for grazing and other agricultural activities consistent with its land and soil capability.

In regard to the impact of the Project on tourism, the Project is proposed within an existing mining area at the site of two existing mines and immediately adjacent to other mines. As this area is currently used for mining, the potential for land use changes that adversely impact on the Hunter Valley's tourism industry are low. A key consideration is the ongoing impact on visiting tourists travelling along the Golden Highway due to views of mining operations. Road users on the Golden Highway will have intermittent views of mining activities within both the United Open Cut and Wambo Open Cut. Views from the north will be dominated by the approved Wambo Open Cut, particularly as it mines through the main ridgeline. The Project will not substantially alter these views and will therefore not substantially change the experience of any tourists using the road. Overburden emplacement will also be visible in some locations along the road. With additional roadside tree planting and progressive rehabilitation of emplacement areas, the visual impact of these activities will reduce over time. It is noted that views of mining operations are currently available to road users on the Golden Highway.

4.2 Air Quality

Issues relating to air quality were raised in 25 community submissions and in four interest group submissions.

4.2.1 Community

Dust impacts generally and increased dust levels:

'The current levels of dust from the mine has been marginally bearable however with this merger they will increase'.

'I oppose the development due to air pollution'.

'The proposed development is forecast to increase dust'.

'Poor air quality in the region will continue to worsen'.

'When driving past mining areas on the way to Singleton the dust cannot be controlled from Draglines and Dump Trucks moving the overburden and coal'.

The Project will result in emissions to air from a variety of activities including activities such as material handling, material transport, processing, wind erosion and blasting. These emissions will mainly comprise particulate matter (dust) from general mining activities, and to a lesser extent, diesel exhaust emissions and fume from blasting.

As discussed in Section 6.4 of the EIS, United understands that air quality is an important issue for the community and has designed the Project to minimise air quality impacts with a range of mitigation and management measures incorporated into the Project design. These measures include:

- minimising the area of disturbed land at any one time as much as practicable
- development of a mine plan that provides for timely progressive rehabilitation
- minimising the length of Project haul roads (where practicable) and adopting controls for haul road dust emissions

- utilising water sprays on ROM coal stockpiles
- maintaining the existing covered conveyors
- using temporary rehabilitation and stabilisation measures on disturbed land
- progressively rehabilitating all overburden emplacement areas and disturbed land associated with the Project
- implementation of the proactive and reactive dust controls.

The Air Quality Impact Assessment undertaken for the Project has concluded that with the Project, cumulative dust levels and other air quality parameters are predicted to comply with the relevant criteria at all surrounding private residences, with the exception of a single private residence in Warkworth village. This residence has current acquisition rights for Wambo and is expected to be afforded acquisition rights for the Project. As discussed in **Section 3.1**, outside of impacts on Warkworth (currently only one private residence) all other areas would experience no change in air quality as a result of the Project when compared to the existing situation.

Increased dust levels and health:

Residence 25: 'Increased dust emissions will exacerbate health problems in the region.'

'There will be a deterioration of air quality in the upper hunter resulting in more illness for the local community.'

'The mine should be opposed because Singleton already has serious life threatening air quality and an extension to mining will only make this worse.'

As discussed in the EIS, PM_{10} and $PM_{2.5}$ are the components of air borne particulate matter which are relevant to human health impacts and the NSW government has set criteria for PM_{10} and $PM_{2.5}$ that are intended to protect human health. The key assessment findings against these criteria are outlined below.

Cumulative annual average PM_{10} concentrations with the Project are predicted to comply with the EPA cumulative air quality criteria of 30 $\mu g/m^3$ at all surrounding private residences, with the exception of one private residence in Warkworth. This residence (R19) has current acquisition rights and is expected to be afforded voluntary acquisition rights for the Project.

Cumulative maximum 24-hour PM_{10} concentrations are expected to continue to exceed the EPA's 50 $\mu g/m^3$ criterion on at least one occasion each year for most of the modelled locations, as is currently occurring. The number of days above 50 $\mu g/m^3$ is expected to increase at Warkworth and remain well above the recommended goal of 5 days per year during the life of the Project.

The EIS identified that one additional private residence located to the northwest of the Project Area may experience a short term increase in the number of days above 50 $\mu g/m^3$, however, this property has recently been purchased by the Joint Venture and is therefore no longer a sensitive receiver for the Project.

Cumulative maximum 24-hour $PM_{2.5}$ concentrations are predicted to comply with the NEPM advisory reporting goal at all surrounding private residences, with the exception of the one private residence (R19) in Warkworth. All other private sensitive receiver locations are predicted to comply with both the 24-hour and annual average advisory reporting goals for $PM_{2.5}$.

The potential health risks associated with the existing air quality environment in Warkworth have been acknowledged in the development consents for the surrounding mining operations, with all of the residences within Warkworth being either mine owned or subject to acquisition rights. United will work with the mines that own these residences to provide for appropriate management of risk to the tenants of these properties, including ongoing monitoring of air quality in Warkworth. This will include providing tenants and owners with information regarding the dust levels in proximity to the residence and for properties owned by United and Wambo, including within the rental lease appropriate clauses relating to the tenants ability to terminate the lease without penalty should the dust criteria be exceeded.

In regard to minimising air quality impacts, as discussed in the EIS and **Section 3.1** of this report, United has committed to the implementation of a comprehensive air quality management program as part of Project that is consistent with best practice dust management for coal mining operations.

Applicable air quality criteria:

'The Environmental Impact Statement for this project uses the old 30mcg/m level for annual PM_{10} rather than the National Environment Protection Measures (NEPM) agreed levels for mining submissions but the WHO recommends annual average PM_{10} of less than 20 micrograms/m^3.'

The NEPM are discussed in **Section 3.11** of this report. In December 2015 the Australian Government announced a National Clean Air Agreement (Agreement). This Agreement aims to reduce air pollution and improve air quality via a number of actions, including strengthened ambient air quality reporting standards for particle pollution.

While all jurisdictions have agreed to this action, no States (including NSW) have prescribed a change to their air quality criteria to be used for the assessment of specific projects. As such the criteria outlined in Table 6.3 of the EIS remain current for the assessment of potential Project impacts. The Agreement indicates an initial work plan of two years to progress the actions.

As outlined in Section 6.4.2 of the EIS, the air quality assessment criteria adopted for the Project are those recommended by the EPA and specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC 2005a). These criteria are consistent with the national standards set by the National Environmental Protection Council under the National Environment Protection Measures (NEPM) for Ambient Air Quality (NEPC 1998).

Section 4 of the AQIA also makes reference to the National Clean Air Agreement and amendment to the NEPM.

The potential impacts of the Project were assessed with consideration of the NEPM amendments. It was found that there would be no change to the conclusions of the assessment as a result of applying the amended air quality criteria of 25 µg/m^3.

PM_{10} dust levels:

In Singleton over the last year there have been 134 days over 8 µg/m^3. Using the average readings (as they have used on pages 170-174) hides the fact there have been so many exceedances.

Exceedances of the 24-hour average PM_{10} criterion are not uncommon for most locations in NSW. This is demonstrated by **Table 4.1** which shows the number of days, each year, above 50 µg/m^3 for PM_{10}, and for

various locations in NSW including both urban and rural environments. These data, collected by the OEH, suggest that the Hunter Valley is not unique in terms of air quality conditions.

Table 4.1 Summary of PM_{10} exceedances at various locations in NSW

Year	Jerrys Plains (OEH)	Warkworth (OEH)	Muswellbrook (OEH)	Singleton (OEH)	Newcastle (OEH)	Tamworth (OEH)	Albury (OEH)	Bathurst (OEH)	Randwick (OEH)	Criterion
Number of days above 50 µg/m^3 PM_{10}										
2011	0[1]	0[1]	0	2	0	1	0	0	0	0
2012	0	0	1	7	0	1	1	2	0	
2013	6	8	3	12	4	0	2	3	3	
2014	6	3	1	1	2	1	5	0	0	
2015	1	3	2	3	3	1	2	2	1	

[1] Statistic based on an incomplete year of data

Residence 343: Dust is deposited on and inside our home and in our rainwater supply. This will increase with this project as will the noise impact, despite assurances offered.

Cumulative air quality criteria are predicted to be met at Residence 343 with the Project. It is noted that mining operations will not be undertaken any closer to Residence 343 than currently proposed at Wambo.

United has committed to provide for the inspection and, as necessary, cleaning of drinking water tanks every 2 years for all private residences and Joint Venture owned residences within 4 kilometres of the mining area for the Project. This commitment would be available to Residence 343.

Residence 47: The current impact of dust is unacceptable. Our water tank needs to be cleaned annually, exterior of the house regularly, and our pool needs constant cleaning to be free of dust. The proposed development is forecast to increase the dust impact. Regardless of the modelling the impacts are unacceptable now and will get worse.

As noted above United has committed to provide for the inspection and, as necessary, cleaning of drinking water tanks every 2 years for all private residences and Joint Venture owned residences within 4 kilometres of the mining area for the Project. Residence 47 is located approximately 4.5 kilometres from the Wambo Open Cut, however, United will continue to work with the owners of Residence 47 to address these concerns.

Residence 343 noted:

- **[*Name removed*]'s asthma has increased especially when air conditioning is in use as well as hay fever and congestion experienced by all members of the family including our young son.**
- **Indoors, the air conditioning system blows dust, causing and exacerbating hay fever and asthma incidents.**
- **Outdoor furniture, cars, clothes on the washing line, verandah area, vegetable garden, fruit trees, shed, and furniture stored in the shed, indoor surfaces and bedding are constantly covered in layers of dust.**
- **We wash bedding more often to reduce dust and are constantly cleaning and vacuuming to try and keep on top of the dust.**
- **Visible dust particles floating in the air in head lamps at night time and in the house during the day.**
- **One of the house water tanks has not been filling up due to a thick layer of coal dust blocking the pipe that fills the water tank. Not only are we unable to receive water from this tanks when this happens, the water runs off and is wasted.**

We are extremely unhappy with current levels of dust and the proposed Project will only make the situation worse. The mitigation measures offered by Wambo mine are currently not adequate and will be less so if the proposed Project is approved.

The potential health effects of airborne particulate matter are not disputed however it is important to consider the likely change in air quality as a result of the Project. A detailed Air Quality Impact Assessment was carried out, and included with the EIS which found that with the exception of in Warkworth (Residence 343 is not located in Warkworth) the cumulative air quality criteria are predicted to be met with the Project in place. As discussed in **Section 3.1**, outside of impacts on Warkworth all other areas would experience no change in air quality as a result of the Project when compared to the existing situation.

Dust deposition and dust concentration (TSP and PM_{10}) are monitored in the vicinity of the Project Area by a network of monitors operated by United, Wambo, HVO and the OEH. The trends and spatial variation were analysed in the Air Quality Impact Assessment for the Project. The analysis indicated that all monitoring locations in the vicinity of Residence 343 were generally within criteria. The exception being at least one day above the EPA's 50 $\mu g/m^3$ maximum PM_{10} criteria between 2011 and 2015, with 2013 data particularly impacted by bushfires.

United has put a broad range of measures in place to minimise the air quality impacts of the Project and will continue to consult with all private residences in relation to potential impacts associated with the Project.

Residence 44: We are already suffering with dust and noise and loss of amenity from the existing HVO and Wambo activities. We operate a horse breeding business which we believe has suffered over the years as a direct result of the proximity of the mines. The proposed project will come nearer and will increase the difficulties we are already experiencing.

Residence 44 is located approximately 3.5 kilometres northwest of the Project Area. The approved Wambo Open Cut is the closest mining associated with the Project to Residence 44 at approximately 3.8 kilometres.

Mining will not occur any closer to Residence 44 as a result of the Project, however it is acknowledged that the Project involves an extension of mine life beyond that currently approved of approximately 20 years.

The Project is predicted to meet relevant air quality criteria at Residence 44 and as discussed above, in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

Residence 49: At present we are currently being negatively impacted by Wambo Operations due to the effects of dust. This provides us with the constant reminder that dust will increase with the large scale of this development. I have great concerns for the associated health implications of fine particulate pollution; coal production has on the residents of Jerrys Plains living alongside such an expansive operation. I believe that as a regional community we are not being protected and being provided with effective air quality monitoring of PM2.5 fine particles therefore we may be exposed to harmful levels of pollution.

The Project is predicted to meet relevant air quality criteria at Residence 44 and in Jerrys Plains. As also discussed above, in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

As outlined in Section 6.4.6 of the EIS, United and Wambo currently operate an air quality monitoring program for the existing mining operations. This existing monitoring program will be reviewed and revised as part of the implementation of the Project, with United to develop an air quality monitoring program that supports the proposed proactive and reactive air quality management system for the open cut operations. The monitoring program will be designed to allow evaluation of the effectiveness of the air quality management system, compliance with air quality operating conditions and source tracking monitoring for key emission sources. The locations and types of monitoring will consider the location of sensitive receptors, prevailing meteorological conditions, and location of mining activities. Real-time monitoring will be included in order to assist with reactive management and for the development of ambient air quality triggers. The air quality monitoring program will form part of the Air Quality Management Plan to be developed for the Project.

Residence 320: We are concerned of the potential harm being caused to our health whilst breathing in the very dusty polluted air now generated from Wambo mine as it becomes closer to our property and training area. We are seriously concerned about our own health spending so much time outdoors. The dust from Wambo currently has definitely increased and changed

The air quality guidelines adopted in NSW are those recommended by the EPA and are specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC 2005). These criteria were set to protect the amenity, health and safety of people in NSW. The Project is predicted to meet relevant air quality criteria at Residence 320. As also discussed above, in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

Residence 163: The mine is significantly impacting on our property by virtue of dust and air quality.

Residence 163 is located approximately 2.5 kilometres to the northwest of the Project Area. The Project is predicted to meet relevant air quality criteria at Residence 163 and in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

4.2.2 Interest Groups

4.2.2.1 Bulga Culture Centre

The location of Wambo – United Open Cut Mines and the close proximity to Jerrys Plains suggests that more stringent Mine Air and Noise Pollution Mitigation Controls are needed for even existing Standards to be achieved. During the next 20 years the increasing Knowledge of the Human Disease impact of Mine Pollutions are envisaged to require more stringent compliance and even lower Operational Pollution Emission Levels. For example, the NEPM Ambient Air Quality Australian Standards has recently been revised down in December 2015, and further progressive reductions of Pollution Standards are already set to continue.

As discussed in **Section 3.11**, in December 2015 the Australian Government announced a National Clean Air Agreement (Agreement). This Agreement aims to reduce air pollution and improve air quality via a number of actions, including strengthened ambient air quality reporting standards for particle pollution.

While all jurisdictions have agreed to this action, no States (including NSW) have prescribed a change to their air quality criteria to be used for the assessment of specific projects. As such the criteria outlined in Table 6.3 of the EIS remain current for the assessment of potential Project impacts.

As outlined in Section 6.4.2 of the EIS, the air quality assessment criteria adopted for the Project are those recommended by the EPA and specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC 2005a). These criteria are consistent with the national standards set by the National Environmental Protection Council under the National Environment Protection Measures (NEPM) for Ambient Air Quality (NEPC 1998). At this stage the NEPM Advisory Reporting Goals for $PM_{2.5}$ have not been adopted by the EPA for assessment of impacts from specific projects.

Section 4 of the AQIA also makes reference to the National Clean Air Agreement and amendment to the NEPM.

The potential impacts of the Project were assessed with consideration of the NEPM amendments. It was found that there would be no change to the conclusions of the assessment as a result of applying the amended air quality criteria.

4.2.2.2 Hunter Valley Glider Club

[Air quality will have] negative impacts on the health of club members and visitors.

Predicted dust concentrations at the HVGC site are not specifically stated…

The specific concerns of the Hunter Valley Gliding Club have been considered by extracting the predictions of changes to air quality at this location. **Table 4.2** shows the predictions at the Hunter Valley Gliding Club, for key particulate matter classifications and averaging times. **Figure 4.1** shows the predicted 24-hour average PM_{10} concentrations at the Hunter Valley Gliding Club, and contributions from various sources.

These results indicate that the concerns of the Hunter Valley Gliding Club, with respect to air quality, are valid. Specifically, there is the potential for some of the EPA's air quality criteria, set for the protection of both health and amenity, to be exceeded in the mining years assessed. In summary the results show:

- The number of days above 50 µg/m^3 PM_{10} at the Hunter Valley Gliding Club may increase in future years as a result of the combined contributions of operations in the vicinity of the HVCG. This assumes that all neighbouring operations will be at maximum production. The Project is predicted to contribute to exceedances. Other operations are also predicted to contribute to exceedances.

- Annual average PM_{10} concentrations are predicted to exceed the EPA's 30 µg/m^3 criterion (soon to be 25 µg/m^3), however the contribution from the Project is expected to be, at maximum, 9 µg/m^3.

- Annual average TSP concentrations are expected to comply with the EPA's 90 µg/m^3 criterion.

- Annual average dust deposition levels are predicted to exceed the EPA's 4 g/m^2/month criterion. However, the contribution from the Project is expected to be very low, at up to 0.3 g/m^2/month (which is below the EPA's 2 g/m^2/month project increment criterion).

- Maximum 24-hour average $PM_{2.5}$ concentrations are predicted to comply with the EPA's 25 µg/m^3 criterion.

- Annual average $PM_{2.5}$ concentrations are predicted to exceed the EPA's 8 µg/m^3 criterion, with a maximum Project contribution of up to 3 µg/m^3.

The results highlight a need to develop a suitable air quality strategy to manage the potential impacts at the Hunter Valley Gliding Club, acknowledging that the Hunter Valley Gliding Club is not continuously occupied. An agreement, prepared in consultation with RTCA and Hunter Valley Gliding Club and consistent with the approach adopted in Project Approval 06_0261, is proposed as appropriate.

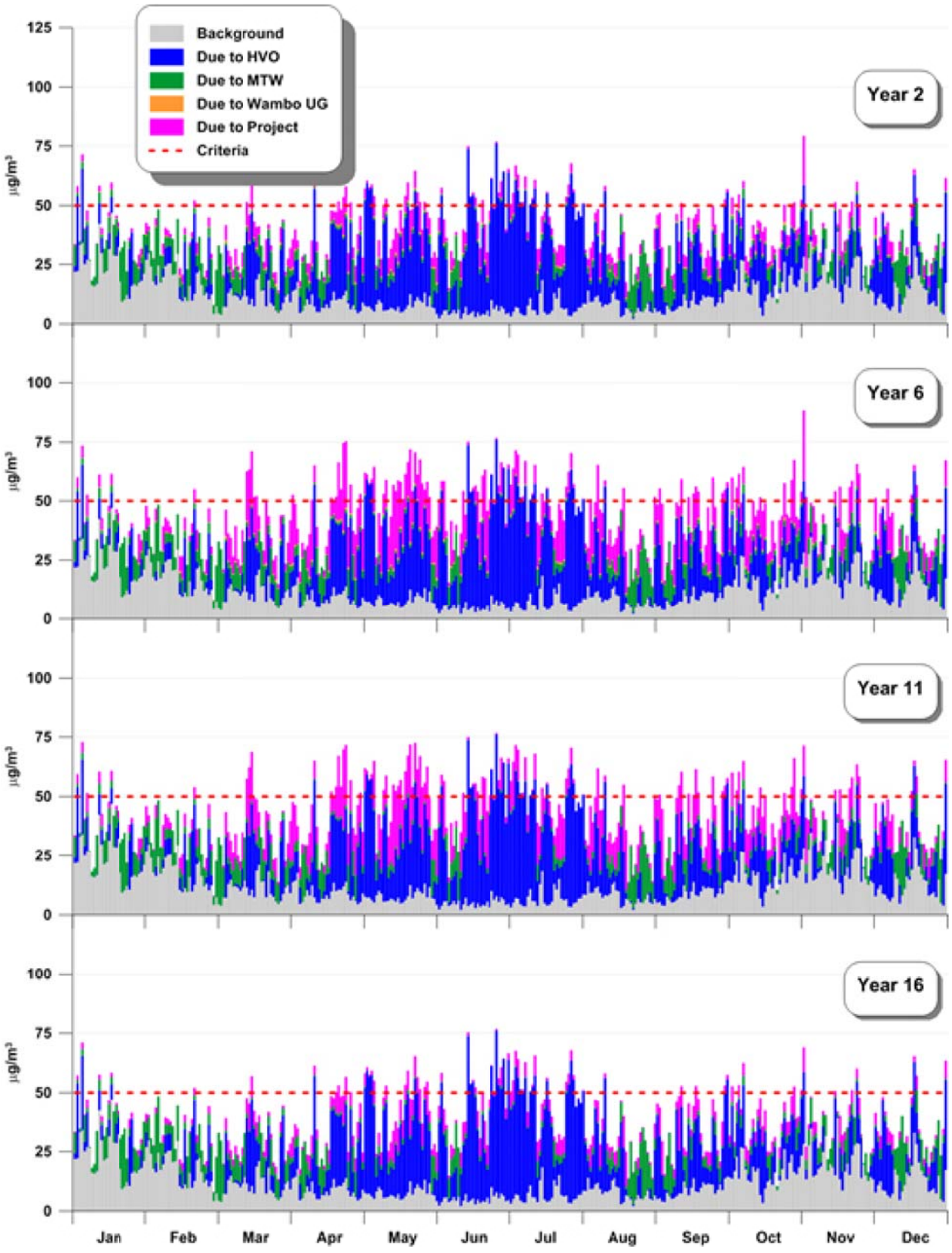


FIGURE 4.1

Time series of predicted 24-hour average PM10 concentrations at HVGC

Image Source: Jacobs (2017)

Table 4.2 Model predictions at the Hunter Valley Gliding Club

Statistic	Project in isolation				Cumulative					Criteria
	Year 2	Year 6	Year 11	Year 16	2014	Year 2	Year 6	Year 11	Year 16	
Maximum 24-hour average PM_{10} ($\mu g/m^3$)	22	39	40	23	62	79	88	77	77	50
Number of days >50	0	0	0	0	10	70	118	109	68	No extra days
Annual average PM_{10} ($\mu g/m^3$)	4	9	8	4	31	38	43	42	37	30
Annual average TSP	4	9	8	4	63	70	71	70	69	90
Annual average dust deposition	0.2	0.3	0.2	0.1	3.7	4.4	4.5	4.4	4.4	4
Maximum 24-hour average $PM_{2.5}$ ($\mu g/m^3$)	4	10	14	6	14	19	21	23	20	25
Annual average $PM_{2.5}$ ($\mu g/m^3$)	1	2	3	1	7	9	10	11	9	8

Increased workload in removing dust from surfaces of gliders, roofs, and buildings.

The Hunter Valley Gliding Club currently operates within an area dominated by mining operations, including the adjacent HVO South operations. Due to the proximity of the Hunter Valley Gliding Club facility, the Project will result in additional dust at the facility during periods of operations.

United has commenced discussions with the Hunter Valley Gliding Club regarding assistance with maintenance requirements. It is proposed that the agreed measures will be outlined in an agreement to be implemented by United.

4.2.2.3 Lock the Gate Alliance

An additional large open cut in this area will add to an air and noise pollution loads that are already unacceptable. There can be no doubt that an additional large open cut in this area will add to an air pollution load that is already unacceptable. The air quality impact of this project cannot be assessed in isolation from the cumulative effects the four nearby mines are already creating. No further open cut mines should be approved in this part of the Valley until air quality in the surrounding areas is brought within safe thresholds.

Exceedances of the 24-hour average PM_{10} criterion are not uncommon for most locations in NSW. This is demonstrated by **Table 4.3** which shows the number of days, each year, above 50 µg/m^3 for PM_{10}, and for various locations in NSW including both urban and rural environments. These data, collected by the OEH, suggest that the Hunter Valley is not unique in terms of air quality conditions.

Table 4.3 Summary of PM_{10} exceedances at various locations in NSW

Year	Jerrys Plains (OEH)	Warkworth (OEH)	Muswellbrook (OEH)	Singleton (OEH)	Newcastle (OEH)	Tamworth (OEH)	Albury (OEH)	Bathurst (OEH)	Randwick (OEH)	Criterion
Number of days above 50 µg/m^3 PM_{10}										
2011	0[1]	0[1]	0	2	0	1	0	0	0	
2012	0	0	1	7	0	1	1	2	0	
2013	6	8	1	1	2	1	5	0	0	0
2014	6	3	1	1	2	1	5	0	0	
2015	1	3	2	3	3	1	2	2	1	

[1] Statistic based on an incomplete year of data

The AQIA aimed to quantify the likely change in air quality as a result of the Project. This involved estimating emissions to air and predicting the existing and future concentrations of various particulate matter classifications and other relevant substances. Predictions were made using an air dispersion model, taking into account the local meteorological and ambient air quality conditions. The assessment was carried out in accordance with the EPA guidelines, namely, the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

In summary, Warkworth village was identified as the location of highest risk of potential air quality impacts. This location is expected to experience a measureable change in air quality, in terms of the number of days above 50 µg/m^3 for PM_{10}. No other sensitive locations are expected to experience an adverse change in air quality as a result of the Project. The performance of the model was reviewed by comparing predictions to measured results for a representative year. It was found that, with the adopted approach for modelling and assessment, the model predictions were typically within 20 per cent of measured results.

Glencore takes the approach that all reasonable and feasible measures should be taken to minimise human exposure to particulate matter. This is demonstrated by the emission management measures which are proposed for the Project. The proposed measures, detailed in Section 9 of the AQIA, have been compared to the measures outlined in the "NSW Coal Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining" (Donnelly et al, 2011). The comparison identified that the majority of proposed measures are consistent with best practice dust mitigation measures.

4.2.2.4 River SOS

Dust and noise are health hazards not only to residents and mine workers but also to tourists. It is said that black lung has re-emerged but we have evidence that it has never gone away, but only been covered up. Lung diseases caused by fine particles of coal dust are another appalling heritage being passed on from our generation to the next.

A comprehensive assessment of the potential air quality impacts of the Project has been prepared by Jacobs in accordance with relevant guidelines. Air quality impacts were identified by the community as one of the issues of most concern. The Project design and planning process included identifying air quality mitigation and management measures and incorporating them into the Project design to minimise air quality impacts.

In a statement released on 1 July 2016, Coal Services reaffirmed that in NSW there have been no new cases of black lung disease for decades amongst current coal mine workers. Despite this, United and Wambo are committed to effectively managing the air quality impacts associated with the Project and will implement a range of dust management measures for the key dust generating activities.

4.3 Greenhouse Gas and Energy

Issues relating to greenhouse gas and energy were raised in 24 community submissions and in three interest group submissions.

4.3.1 Community

Greenhouse gases causing climate change:

'The project's greenhouse gas emissions will drive climate change, which will affect all species on the planet.'

'Greenhouse gases are causing climate change. Time to move away from coal was a decade ago.'

'Hundreds of millions of tonnes of additional greenhouse gases will be generated. It is long past time to recognise that Australia is to play its part in avoiding the most dangerous effects of human induced climate change, no expansion of coal mining can be permitted.'

'The mine will generate 259.3 tonnes of additional greenhouse gases which, given our knowledge and, indeed, experience, of the deleterious effects of climate change, would show wilful blindness and /or stupidity if it was to be approved.'

'The long term problem of the greenhouse gases and consequent contribution to climate change from mining and burning this coal far outweigh the short term benefits.'

The continued accumulation of greenhouse gas emissions in the atmosphere, both natural and anthropogenic, will contribute to climate change. The source of anthropogenic greenhouse gas emissions will continue to change as new emission sources are generated and old emission sources are decommissioned. The Project will generate a new source of greenhouse gas emissions; however, the impact of the Project on climate change is limited to its Scope 1 emissions (approximately 5.8 million tCO_2-e). The impact of Scope 2 and 3 emissions included in the assessment (approximately 260 million tCO_2-e) are attributable to coal consumers and the many organisations that facilitate the Project and participate in the coal supply chain.

Assessing whether the Project's Scope 1 emissions are "additional" requires some insight into the future supply / demand dynamics of the coal market. Emissions from a new coal Project are likely to be additional where demand for coal is growing faster than supply. Under a demand surplus scenario, new coal supply can enter the market without displacing existing sources of supply. Emissions from a new Project are unlikely to be additional where supply is growing faster than demand. Under a supply surplus, new coal sources displace supply sources of inferior quality or extraction efficiency.

Recent projections published by in the World Energy Outlook (WEO) 2016, indicate that the future trade in thermal coal will largely be determined by future climate change policy. **Table 4.4** provides global thermal coal trade projections out to 2040, under three possible climate change policy scenarios.

Table 4.4 Global Thermal Coal Trade Projections to 2040

Policy Scenario	2014 (Mtpa)	2025 (Mtpa)	2040 (Mtpa)
Current Policies	801	917	1190
New Policies	801	767	824
450 Policies	801	580	320

The WEO projections indicate that under current policy settings, trade in thermal coal will continue to grow over the life of the Project. Under this scenario, global trade in thermal coal is forecast to increase by 116 Mtpa by 2025. Depending on other market entrants, the Current Policies scenario would allow the Project's annual production to be absorbed by global trade, without displacing existing coal sources. The Current Policies scenario creates the potential for a demand surplus and additional greenhouse gas emissions.

The WEO projections also include two alternative future trade scenarios. The New Policy scenario models the impacts of all current policies, plus policy intentions which have been announced, but not yet implemented (broadly equivalent to the Paris Agreement commitments). The 450 Policies scenario models the impacts of a policy environment which would keep atmospheric greenhouse gas emissions below 450ppm. Under both the New Policy scenario and the 450 Policies scenario, the trade in thermal coal is forecast to decline over the life of the Project. If a new policy environment does curtail future growth in thermal coal trade, then any future supply surplus is likely to generate a situation where the Project's output will displace less efficient coal sources, without generating additional emissions.

The Australian Government has made commitments to play its part in mitigating the impacts of climate change. The Australian Government plans to meet its international greenhouse gas reduction targets through the following policy streams:

- adjustments to Safeguard Mechanism baselines (2020)
- introduction of new technology
- energy use efficiency
- vehicle efficiency
- hydrofluorocarbons policy
- sequestration and waste management.

The EIS identified that while the Project is likely to increase the mitigation effort required to reach national targets, the Project itself is unlikely to prevent the Federal Government achieving its national greenhouse gas targets.

Global warming:

'Coal burnt will only add to Global warming.'

'If global warming is to be held under 1.5ºC above pre-industrial levels NSW must stop approving new coal mining developments.'

'We must accept that coal mining is a threat to the planet. Global Warming has reached critical levels and the time for a moratorium has been reached.'

'I object on the grounds of global warming.'

'If we are to come anywhere close to meeting our international commitments to keep global warming to significantly less than 2 degrees there can be no more new mines.'

As discussed above, the Project will generate a new source of greenhouse gas emissions, however, the impact of the Project on global warming is limited to its Scope 1 emissions (approximately 5.8 million tCO_2-e). The impact of Scope 2 and 3 emissions included in the assessment (approximately 260 million tCO_2-e) are attributable to coal consumers and the many organisations that facilitate the Project and participate in the coal supply chain.

The need for the Project is driven by global demand for coal as an energy source; the Project itself does not result in the combustion of the product coal, nor does it drive demand for coal. Put another way, the global demand for coal will be unaffected by whether or not the Project proceeds.

As discussed above, the Australian Government has made commitments to play its part in mitigating the impacts of climate change. The EIS identified that while the Project is likely to increase the mitigation effort required to reach national targets, the Project itself is unlikely to prevent the Federal Government achieving its national greenhouse gas targets.

To hold global warming below 2 degrees (IPCC's recent target) all economic sectors will require transformation. Future scenarios which limit global warming to approximately 2 degrees require large-scale changes to land use and global energy systems by 2100. Many of the modelled scenarios that limit global warming require accelerated electrification of energy end use, decarbonisation of the majority of electricity generation by 2050 and a phase-out of freely emitting coal generation. Studies indicate a large potential for energy use reductions, but also demonstrate that these reductions will not be sufficient by themselves to constrain GHG emissions (IPCC 2016).

In an increasingly 'carbon constrained' world, it is expected that the demand for coal will reduce with time however most energy source projections do not anticipate any significant reduction in overall global demand for coal as an energy source over the timeframe that the Project is proposed. It is however expected that there will be a transition from less efficient coal combustion towards cleaner, more efficient combustion. In this regard, the thermal coal from the Project is considered to have a relatively higher calorific value than from some other areas in the world and the use of coal from the Project will have a lower impact on climate change than lower caloric value coal from other parts of the World.

Quantity of greenhouse gases produced by the Project:

'259.3 million tonnes of additional greenhouse gases will be generated.'

'There is no accountability for the 259.3 million tonnes of greenhouse gases that the burning of this coal will cause**.'**

The Greenhouse Gas assessment found that approximately 259.3 million tonnes of Scope 3 emissions can be associated with the Project. That is, the Greenhouse Gas assessment found that approximately 259.3 million tonnes of greenhouse gas emissions will be generated by organisations not directly involved with the Project. The majority of Scope 3 emissions are generated by electricity generators combusting coal. The combustion of coal does not form part of the Project and the proponent is not seeking approval to combust coal. The Project will generate approximately 5.8 million tCO_2-e.

As discussed above, assessing whether emissions are "additional" requires some insight into the future supply / demand dynamics of the coal market and a new mine may not result in additional emissions as it may be replacing other sources.

As discussed above, the Australian Government has made commitments to play its part in mitigating the impacts of climate change. The EIS identified that while the Project is likely to increase the mitigation effort required to reach national targets, the Project itself is unlikely to prevent the Federal Government achieving its national greenhouse gas targets.

Accountability for the Scope 3 emissions associated with the Project occurs where the emissions are generated and reported. The majority of Scope 3 emissions will be generated when the coal is combusted in countries like China, India, Japan and South Korea. China, India and Japan are all signatories to the Paris Agreement and have submitted plans to reduce their greenhouse gas emissions by 2030.

Scope 3 emissions fail to take into account the Paris Agreement.

The majority of the Project's Scope 3 emissions (over 99 per cent) will be generated through the process of shipping coal to international markets and burning coal to generate electricity. The Project's Scope 3 emissions are directly attributable to shipping companies, and electricity generators in countries such as China, India, Japan and South Korea. The Scope 3 emissions associated with the Project will form part of various national greenhouse gas inventories and should be captured by the global inventory managed by the Climate Change Convention.

The EIS considers how greenhouse gas emissions generated by the Project may interact with the Paris Agreement (refer to Section 4.3 of Appendix 8). The Paris Agreement requires participating Parties (nations) to prepare and communicate greenhouse gas mitigation targets for 2020, and then develop new targets every five years. Each successive target is expected to represent a larger mitigation effort than the previous target.

The mitigation targets set by each nation will apply to national baseline emissions, which in most cases; will include significant emissions generated from coal combustion. Australia's primary markets for coal, such as China, India and Japan are all signatories to the Paris agreement, and each nation will implement mitigation programs to meet their respective mitigation contributions, while operating economies that utilise coal as a feedstock and energy source.

The majority of Scope 3 emissions associated with the Project will not impact Australia's greenhouse gas reduction commitments made under the Paris Agreement. Almost all Scope 3 emissions associated with the Project will occur outside Australia's reporting boundaries and will not impact Australian mitigation commitments.

Scope 3 emissions are very large in comparison to other open cut coal mines. More than twice Mt Owen.

Product coal is the primary driver of Scope 3 emissions, as the majority of Scope 3 emissions are generated by product use (i.e. burning coal) and product transport (rail and shipping). The Project is forecast to produce approximately 101,000,000 tonne of product coal, whereas the Mount Owen greenhouse gas assessment was prepared for approximately 48,000,000 tonne of product coal. The Project is forecast to produce more Scope 3 emissions than Mount Owen because United is forecast to produce at least twice the product coal as Mount Owen. **Table 4.5** compares the Scope 3 intensity (i.e. Scope 3 emissions per product tonne) of both United and Mount Owen.

Table 4.5 Scope 3 emissions comparison

Project	Product tonnes	Scope 3 emissions (t CO_2-e)	t CO_2-e/Tonne
United	101,064,783	259,295,440	2.57
Mount Owen	48,195,500	122,365,224	2.54

The Scope 3 emission intensity of the two mines is very similar, and differences can be attributed to product type (thermal / coking splits), fuel use ratios and outsourced activities. It's important to note that United outsources the CHPP activities for much of the Project, which generates additional Scope 3 emissions.

The EIS states, "The greenhouse gas and energy assessment found that the Project is unlikely to impact national greenhouse gas policy objectives due to the relatively small contribution (0.053%) the Project will make to national emissions on an annual basis" (EIS Appendix 8 page 3) but acknowledges that this is only 3 per cent of the greenhouse gases associated with the project (Scope 1 and 2 emissions) "The majority of Scope 3 emissions will be generated by third parties who transport and consume coal products. United has no operational control over Scope 3 emissions, as these emissions are generated by the activities of other organisations" (EIS Appendix 8 page 2). The potential environmental impact is recognised as significant but dismissed because it is generated by others, at another remote location. This is could be regarded as immoral even if it is not covered in the terms of reference. The proponent has not satisfactorily resolved the issue of greenhouse gas emissions and is unlikely to do so.

The Greenhouse Gas Assessment was undertaken following relevant guidelines and in accordance with the SEARs.

The Proponent will address greenhouse gas emissions to the satisfaction of Australian regulators via compliance with National Greenhouse and Energy Reporting Scheme and the Safeguard Mechanism. The Safeguard Mechanism legislation will have a direct impact on the Project, and it has the potential to impose emission restrictions over the life of the Project.

The proponent is not in a position to address the greenhouse gas emissions of coal consumers. By definition the proponent does not have operational control over the organisations that will generate Scope 3 emissions. The majority of greenhouse gas emissions generated by coal consumers will occur in countries such as China, India and Japan, who are all signatories to the Paris Agreement.

The effect of this Project on the future adverse climatic conditions has not been taken into account. The burning of the coal by the end user must be considered as well as the impact of the extraction process.

The consumption of coal by the end user was considered in the Greenhouse Gas Assessment. The Greenhouse Gas Assessment estimated that 246,215,035 tCO_2-e (from the use of coal, no other scope 3 emissions) of Scope 3 emissions would be generated through product use.

The EIS considers how greenhouse gas emissions generated by the Project may impact climate change (refer to Section 4.1.1 of Appendix 8). The following excerpt from the EIS describes how the Project may impact climate change.

Climate change models forecast many different climate change impacts, which are influenced by future greenhouse gas emission scenarios. Climate change forecasts also vary significantly from region to region.

The Project, in isolation, is unlikely to influence global emission trajectories. Future emission trajectories will largely be influenced by global scale issues such as; technology, population growth and greenhouse gas mitigation policy. NSW climate change projections have been modelled by the NARCliM project. NARCliM has modelled climate change projections for 2030 and 2070, using the IPCC high emissions A2 emission trajectory scenario. The A2 scenario assumes (IPCC 2000):

- relatively slow demographic transition and relatively slow convergence in regional fertility patterns
- relatively slow convergence in inter-regional GDP per capita differences
- relatively slow end-use and supply-side energy efficiency improvements (compared to other storylines)
- delayed development of renewable energy
- no barriers to the use of nuclear energy.

The Project is consistent with the A2 emissions trajectory scenario; therefore the climate change projections developed by NARCliM seem a reasonable basis for a qualitative climate change impact assessment. NARCliM makes the following climate change projections for NSW (Adapt NSW 2016):

- maximum temperatures are projected to increase
- minimum temperatures are projected to increase

- the number of hot days will increase
- the number of cold nights will decrease
- rainfall is projected to decrease in spring and winter
- rainfall is projected to increase in summer and autumn
- average fire weather is projected to increase in summer and spring
- number of days with severe fire danger is projected to increase in summer and spring

The extent to which global emissions and atmospheric concentrations of greenhouse gases have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions that includes all major emission sources and sinks.

4.3.2 Interest Groups

4.3.2.1 Climate Action Newcastle

Due to the unacceptably high downstream emissions from the United Wambo Open Cut Coal Mine Project, we strongly object to this new mine proposal. To keep warming within predicted safe limits (if such a thing is still possible), we know all countries, Governments, individuals and companies must make every effort to stop the burning of fossil fuels. Opening new coal mines and exporting more coal is completely inconsistent with attempts to stay under 2 degrees warming per the Paris Agreement.

To hold global warming below 2 degrees (IPCC's recent target) all economic sectors will require transformation. Future scenarios which limit global warming to approximately 2 degrees require large-scale changes to land use and global energy systems by 2100. Many of the modelled scenarios that limit global warming require accelerated electrification of energy end use, decarbonisation of the majority of electricity generation by 2050 and a phase-out of freely emitting coal generation. Studies indicate a large potential for energy use reductions, but also demonstrate that these reductions will not be sufficient by themselves to constrain GHG emissions (IPCC 2016).

In an increasingly 'carbon constrained' world, it is expected that the demand for coal will reduce with time however most energy source projections do not anticipate any significant reduction in overall global demand for coal as an energy source over the timeframe that the Project is proposed. It is however expected that there will be a transition from less efficient coal combustion towards cleaner, more efficient combustion. In this regard, the thermal coal from the Project is considered to have a relatively higher calorific value than from some other areas in the world and the use of coal from the Project will have a lower impact on climate change than lower caloric value coal from other parts of the World.

As discussed above, the Australian Government has made commitments to play its part in mitigating the impacts of climate change. The EIS identified that while the Project is likely to increase the mitigation effort required to reach national targets, the Project itself is unlikely to prevent the Federal Government achieving its national greenhouse gas targets.

Accountability for the Scope 3 emissions associated with the Project occurs where the emissions are generated and reported. The majority of Scope 3 emissions will be generated when the coal is combusted in countries like China, India, Japan and South Korea. China, India and Japan are all signatories to the Paris Agreement and have submitted plans to reduce their greenhouse gas emissions by 2030.

As also discussed above, adjustments to Safeguard Mechanism baselines by the Commonwealth Government are expected to deliver the largest proportion (approximately 34 per cent) of the 2030 mitigation task. Safeguard Mechanism legislation will have a direct impact on the Project and has the potential to impose emission restrictions over the life of the Project.

4.3.2.2 Environmental Justice Australia

The Project is proposed after Australia has signed the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement. The agreement is explicit that 'deep reductions in global emissions will be required in order to achieve the ultimate objective of the Convention' which is to avoid dangerous man-made climate change, or keep temperature rise to well under 2°C. This application is contrary to the Paris Agreement as it will contribute to increased carbon emissions.

Under the Paris Agreement, the Australian Government has committed to reduce National greenhouse gas emissions by 26-28 per cent on 2005 levels by 2030.

As discussed above, the Australian Government has made commitments to play its part in mitigating the impacts of climate change. The EIS identified that while the Project is likely to increase the mitigation effort required to reach national targets, the Project itself is unlikely to prevent the Federal Government achieving its national greenhouse gas targets. It is also expected that adjustments to Safeguard Mechanism baselines are expected to deliver further reductions in emissions over time.

4.3.2.3 Hunter Communities Network

All responsible Governments across the globe are seeking to reduce carbon emissions in the hope of curbing the economic, social and environmental costs of runaway climate change. The proposal to produce an additional 259.3 million tonnes of greenhouse gas emissions is counter to Australia's commitment in the Paris Agreement to strive to limit the anthropogenic increase in global temperature to 1.5 degrees.

The Greenhouse Gas assessment found that approximately 259.3 million tonnes of Scope 3 emissions can be associated with the Project. That is, the Greenhouse Gas assessment found that approximately 259.3 million tonnes of greenhouse gas emissions will be generated by organisations not directly involved with the Project. The majority of Scope 3 emissions will be generated by electricity generators located in countries such as China, India and Japan. The majority of Scope 3 emissions associated with the project will not impact Australia's national emissions or Australia's ability to meet its commitments under the Paris Agreement.

4.3.2.4 Lock the Gate Alliance

The greenhouse assessment of this project fails to contextualise the project and its Scope 3 emissions within a carbon budget consistent with limiting global warming to 2 degrees and 1.5 degrees above pre-industrial levels. This is crucial information for understanding the impact of the project, and assessing it against the matters for consideration in the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 which requires Scope 3 assessment.

The IPCC has developed Representative Concentration Pathways (RCPs) to describe future greenhouse gas emission and land use scenarios. Each scenario is then used to model potential climate change. Current modelling suggests that global warming may be kept below 2 degrees if the global community can transform its emissions and land use patterns to emulate either RCP4.5 or RCP2.6. Regardless of future pathways, the IPCC's modelling has found that from 2011, cumulative anthropogenic emissions cannot exceed 1,000 GtCO2-e, if the global mean surface temperature is to be kept below 2 degrees.

The Project's emissions will contribute towards the accumulation of greenhouse gases. The Project itself is forecast to generate 5.8 million tCO_2-e, or 0.00058 percent of the "not to exceed" cumulative emissions.

Scope 3 emissions associated with the Project are forecast to generate approximately 260 million tCO_2-e, or 0.026 percent of the "not to exceed" cumulative emissions.

This information was included in the Greenhouse Gas and Energy Assessment for the Project and provided for consideration by the determining authority for the Project.

4.3.2.5 National Parks Association of NSW

There will be substantial emissions that contribute to the global process of climate change.

The Project's direct emissions are forecast to be approximately 253,000 t CO2 –e per annum. To put the Project's emissions into perspective, global greenhouse gas emissions are forecast to be 46,000,000,000 t CO2-e per annum by 2020. During operation, the Project will contribute approximately 0.00055 per cent to global emissions per annum (based on its projected Scope 1 emissions).

The Project, in isolation, is unlikely to influence global emission trajectories. Future emission trajectories will largely be influenced by global scale issues such as; technology, population growth and greenhouse gas mitigation policy.

4.3.2.6 National Conservation Council of NSW

The scope 3 emissions associated with the Project are the most concerning. The total scope 3 emissions for the project are listed on p 187 of EIS Volume 1 as 259.30 million tonnes of CO_2 equivalent emissions – dwarfing the figure from Scope 1 and Scope 2 sources. A comparison against the Scope 3 GHG emissions of other proposals in the area (Bylong and Mt Owen) shows that the scope 3 GHG emissions of the Project are substantially greater than other proposals in the area.

Product coal is the primary driver of Scope 3 emissions, as the majority of Scope 3 emissions are generated by product use (i.e. burning coal) and product transport (rail and shipping). The Project is forecast to produce more product tonnes than Bylong or Mount Owen. **Table 4.6** compares the Scope 3 intensity (i.e. Scope 3 emissions per product tonne) of the three mines.

Table 4.6 Scope 3 Intensity Comparison

Project	Product tonnes	Scope 3 emissions (t CO_2-e)	t CO_2-e/Tonne
United	101,064,783	259,295,440	2.57
Mount Owen	48,195,500	122,365,224	2.54
Bylong	89,792,647	202,978,885	2.26

The Scope 3 emission intensity of United and Mount Owen is very similar, and differences can be attributed to product type (thermal / coking splits), fuel use ratios and outsourced activities. The Scope 3 intensity of Bylong is lower than United, as the Bylong assessment does not include Scope 3 emissions associated with shipping coal products to international markets.

NCC maintains that it is fundamentally irresponsible for the NSW Government to continue to approve new or expanded coal mine projects at a time when thermal coal prices are at record lows (implying poor royalty returns to the NSW government) and Australia's GHG emission trajectory is moving in the opposite direction to that required for Australia to meet its international GHG emission reduction commitments. In light of the unequivocal evidence that the burning of coal contributes to anthropogenic climate change and an international agreement to keep global average temperatures to below 2 degrees Celsius with an aim of 1.5 degrees, we do not consider that the approval of the United Wambo Open Cut Project is in the public interest.

The NCC position is noted. As outlined in the EIS, the detailed economic assessment for the Project undertaken following NSW Government guidelines found that the Project would result in a net benefit for the NSW community.

4.4 Noise

Issues relating to noise were raised in 37 community submissions and in five interest group submissions.

4.4.1 Community

Increased noise impacts:

'38 nearby residences are predicted to be impacted by increased noise pollution from this project. The proposed development is forecast to increase noise.'

'The current levels of noise from the mine have been marginally bearable however with this merger they will increase.'

Residence 47: 'The current impact of noise is unacceptable. We currently hear mine noise through the closed windows during the night. The windows cannot be opened in summer. The proposed development is forecast to increase the noise impact. Regardless of the modelling the impacts are unacceptable now and will get worse'.

'38 nearby residences are predicted to be impacted by increased noise pollution from this project. When will NSW DoPE accept that Hunter Valley Citizens deserve to live in a peaceful rural environment as was their original choice?'

'I object to the negative impact this development will bring to the nearby residents in terms of increased noise'.

'The height of the spoil heaps will increase again, beyond the approval of the Wambo's current consent, and exacerbate noise impacts.'

'I live near three open cut mines and find the noise to be unacceptable for a rural area without adding another open cut operation into the area'.

The NIA has provided a comprehensive assessment of potential noise impacts associated with the Project. The NIA has identified six residences in the Noise Affectation Zone where significant noise impacts in excess of the project specific noise levels (PSNLs) are predicted. These properties are expected to receive acquisition rights should the Project be approved. A further 18 residences are within the Active Noise Management Zone where moderate exceedances of the PSNLs are predicted, and a further 13 residences are within the Noise Management Zone where negligible exceedances of the PSNLs are predicted.

As outlined in Section 6.6 of the EIS, a key focus of the Project design was the minimisation of noise impacts. Through a process of iterative noise modelling and incorporation of reasonable and feasible noise controls, the predicted noise impacts of the Project were significantly reduced from those initially predicted. This included reducing the number of residences in the Noise Affectation Zone by approximately two thirds, and approximately halving the number of residences within the Active Noise Management Zone.

A combination of proactive and reactive/adaptive noise controls will be implemented over the life of the Project as detailed in Section 6.6.11 and Section 8.0 of the EIS.

Noise Impacts on Apple Tree Flat

'The impact of the noise that we are experiencing now at Apple Tree Flat is hard to deal with. We are woken up in the middle of the night with the noise from the mines in the area. We have gone outside of a night time to see who has come up our driveway only to realize that the noise is from the mine over the mountain. On other occasions we have had discussions about whom or what is up the back of our property, only to realize that it is again, only the noise from the mines'.

'We noticed on the EIS that there is mention of the impact on residential properties in other rural areas, however we noticed that there is no mention of any impacts at Apple Tree Flat. Apparently no noise, dust or impacts on the Aquifers can pass through the National Park to the other side. We are closer to this mine project than Wambo United would like to admit'.

The NIA prepared for the Project assesses noise impacts at the nearest potentially affected receivers. This includes a group of private residences located to the northwest of the Project Area in Redmanvale. Apple Tree Flat is located a further approximately 4.6 kilometres north west of Redmanvale, away from the Project Area. Appendix F and Appendix H of the NIA indicate that Project-related and cumulative noise levels are predicted to be less than 35dB(A) in this area and will therefore comply with relevant noise criteria.

Compliance management:

'How is the Department going to maintain compliance with noise?'

While this is a matter essentially for the Department, noise compliance criteria are generally established as part of any development consent and Environment Protection Licence. As outlined in Section 6.6.11 of the EIS, United will implement a noise monitoring program to allow measurement and reporting against the relevant Project compliance criteria. **Section 3.4** provides further information about the proposed approach to noise compliance management as part of the Project.

Noise management measures:

'Concerned that land acquisition is the only way the project will attenuate its projected noise exceedance.'

As discussed in Section 6.6.1 of the EIS, a key focus of the Project design was the minimisation of noise impacts. Iterative noise modelling undertaken as part of the mine planning and design phase of the Project resulted in a range of proactive noise controls being incorporated into the Project design. In addition, as outlined in Section 8.0 of the EIS, United has made clear commitments to the implementation of a range of noise mitigation and management measures as part of the Project to meet the predicted noise levels.

Residence 25: At least 38 nearby residences are predicted to be impacted by increased noise pollution from this project. In our area with the surrounding mountains there is an echo effect. When complaints are made there is always an excuse, usually weather conditions or coming from another source. With so many open cut mines in the area, it is impossible to tell sometimes, and no consideration is given to cumulative effects. Over time the noise of the surrounding mines has been added to the background noise, and we are just expected to put up with the accepted increase in noise levels.

The NIA includes an assessment of cumulative noise impacts from the Project and surrounding approved and existing mining operations (refer to Section 7.0 of the NIA) which is based on the Project achieving its predicted noise levels to minimise potential cumulative noise impacts.

As outlined in Section 8.0 of the EIS, United will implement an appropriate continuous Noise Monitoring Program that will enable the proactive and real time management of operations during adverse noise propagating conditions. United has also committed to the preparation of a Noise Management Plan for the Project which will outline the approach to noise management and monitoring, including the proactive and real time management approaches.

Residence 343: Our Property is identified as "Receiver 343" and we are considered to be within "Active Noise Management Zone - moderate impact" where operational noise level is predicted to be between 3-5dB. We hear dozer tracks, trucks on route and trucks dumping overburden at all hours, which is particularly disruptive at night and can be heard from the furthest point of the house away from the Wambo mine even when all doors and windows are closed. The serenity of country living is constantly overtaken by the murmur of mine noise. The noise level is predicted to get worse as the proposed Project continues.

As discussed in Section 6.6.3.4 of the EIS, 18 residences including Receiver 343 are within the Project's Active Noise Management Zone. United has consulted directly with all of the residents in the noise affectation and noise management zones for the Project to discuss the predicted impacts and the options available to them (e.g. noise mitigation treatments, acquisition where relevant etc.). As outlined in Section 6.6.11.2 of the EIS, United will develop and implement a Noise Management Plan for the Project which will detail the implementation of monitoring and management measures to be utilised to manage noise impacts.

Residence 343: Double glazing of windows does not assist with noise mitigation when we are outside and does little to reduce mine noise at night. It will certainly be less effective if the proposed Project is approved.

Double glazing is one of a number of receiver based treatment options that may be considered for properties within the Active Noise Management Zone. As discussed in Section 6.6.3.3 of the EIS, other management procedures that can be implemented in the Active Noise Management Zone include:

- prompt response to any issues of concern raised by community
- noise monitoring on-site and within the community
- making changes to operational noise mitigation measures, where practicable, to further reduce noise impacts.

Residence 44: We are already suffering with dust and noise and loss of amenity from the existing HVO and Wambo activities. We operate a horse breeding business which we believe has suffered over the years as a direct result of the proximity of the mines. The proposed project will comer nearer and will increase the difficulties we are already experiencing.

Residence 44 was assessed in the NIA and is one of 13 residences predicted to experience negligible exceedances (up to 2dB(A)) of the PSNLs. Exceedances of this magnitude are considered negligible (as per NSW government guidelines) as they are not discernible by the average person.

An assessment of cumulative noise impacts from the Project and surrounding approved and existing mining operations (refer to Section 7.0 of the NIA) identifies the potential for cumulative noise impacts at properties in Moses Crossing (including R44), with predicted cumulative noise levels of 42 dB(A) compared to the recommended acceptable level of 40 dB(A).The Project is estimated to contribute approximately 40 per cent of the cumulative industrial noise at this location.

As outlined in Section 8.0 of the EIS, United has made clear commitments to the implementation of a range of noise mitigation and management measures as part of the Project to meet the predicted noise levels. United will also implement an appropriate continuous Noise Monitoring Program that will enable the proactive and real time management of operations during adverse noise propagating conditions, which will be detailed as part of the Noise Management Plan for the Project. These measures will be put in place to seek to minimise the noise impacts of the Project.

Residence 49: At present we are currently being negatively impacted by Wambo Operations due to the effects of noise. This provides us with the constant reminder that noise will increase with the large scale of this development.

Residence 320: The noise from Wambo currently has definitely increased and changed. Some days and nights the noise is so loud you would think the mine was operating outside our back door causing sleep disturbance for our family.

Residences 49 and 320 were assessed in the NIA as one of 18 residence predicted to experience moderate exceedances (up to 5dB(A)) of the PSNLs. These 18 residences represent the residences within the Project's Active Noise Management Zone.

United has consulted directly with all of the residents in the noise affectation and noise management zones for the Project to discuss the predicted impacts and the options available to them (e.g. noise mitigation treatments, acquisition where relevant etc.). As outlined in Section 6.6.11.2 of the EIS, United will develop and implement a Noise Management Plan for the Project which will detail the implementation of monitoring and management measures to be utilised to manage noise impacts.

4.4.2 Interest Groups

4.4.2.1 Hunter Communities Network

Low Frequency Noise - The Umwelt report considers low frequency noise using the INP LFN C-A method, the draft ING (Defra) method and the Broner Method. The inclusion of the Broner method avoids a low frequency penalty which is NOT in accordance with the INP.

There are a range of different methods that can be used to assess low frequency noise, with the default method currently being that outlined in the INP. For completeness, the Noise Impact Assessment provided the results for three methods being:

- INP (current NSW government policy)
- ING (draft NSW government policy that has been placed on community exhibition for comment but is not yet in force)
- Broner – a method previously used in the assessment of low frequency noise impacts for mining projects in NSW.

By providing the results for each of these methods the NIA is comprehensive and provides the determining authority with comprehensive information with which to understand and assess low frequency noise. This information will be assessed and considered by DPE and EPA in the determination of relevant noise criteria for the Project.

The report stretches the concept of "90% of the people for 90% of the time" – see end of Section 3.1. The INP asserts that meeting the PSNLs in the INP is designed to protect 90% of the people for 90% of the time. Last dot point on page 13 in Section 3.2 stretches this and discusses the PSNL being achieved for 90% of the time. This will allow a higher noise emission, and therefore a noise level higher than the PSNL, and therefore less than 90% of the people will be satisfied and therefore the objective of the INP will not be met. Our assertion is that the PSNL should be met 100% of the time, which is intended to satisfy 90% of the people 90% of the time. We do not agree with the methodology in the 4th paragraph of Section 3.4.3 and the following example. If then, 1-2 dB over the PSNL is accepted, this further increases the % number of people affected.

The methodology for the NIA is consistent with the INP and has been accepted on a range of major projects by the EPA. As outlined in the EPA's submission, the NIA has been identified as being technically sound.

Similarly Section 3.5.1 first dot point states the "10th percentile noise level is at or below the PSNL". This is not true. If the PSNL is met, this will satisfy 90% of the population.

The methodology presented in the INP is to set target criterion for intrusive noise that can be achieved at least 90 per cent of the time period. Where noise modelling results predict this may not achievable, and annoyance reactions may occur, appropriate mitigation measures will be implement by the Project. This is consistent with the INP and has been accepted on a range of major projects by the EPA and DPE.

Modifying factors (Section 3.4.4). The report tends to talk about "strict application" (para 6) of the INP, when in fact it should just be "application" of the INP. Paragraph 6 is confusing, however we think it is saying that if a 5 dB modifying factor is added to the predicted noise level due to the C-A difference, then the criteria will be increased and mask operational noise levels later. The assumption that the criteria will be increased is wrong. The criteria should remain the same and mitigation proposed to compensate for the modifying penalty.

The implementation and application of noise criteria for major mining projects is dependent on the specific aspects of the Project and surrounding noise environments. This evolution is essential as it aligns with regulatory authorities requiring mining and other industrial operations to meet the predicted noise levels assessed and modelled in accordance with relevant guidelines. This in effect means that where noise predictions are below the PSNL, noise criteria may be set at the predicted levels. Equally where the predicted levels are less than 5dB above the PSNL, the predicted noise levels may be set at these predicted levels. It is noted that this approach is articulated in the Draft Industrial Noise Guideline (publicly exhibited in 2015).

Accordingly, where the modifying penalty is applied to predicted noise affect by low frequency, and where this is within 5dB above the PSNL this could give rise to situations where the noise criteria are set at these predicted levels plus penalty. In these instances, such as with the Project, this may in effect give rise to higher noise criteria on account of the application of the modifying penalty. This is considered to be a perverse outcome of the assessment process and as such the modifying factor has not been applied to the predicted noise levels for the Project.

Para 7 of Section 3.4.4 asserts that where the C-A is greater than 15 and the dBC exceeds 65 dBC and mitigation is not possible, only then will a modifying factor be applied "in accordance with the INP". Of course, this is not what the INP says – it doesn't mention or authorise the Broner method at all!

The results of the low frequency analysis presented in Table G1 of the INP shows that where the difference between C-weighted and A weighted is greater than 15 dB, the C-weight is less than 52 dB(C) and in most cases is less than 48 to 49 dB(C). At these levels, application of a penalty may lead to adverse outcomes for residents and on this basis penalties were not applied. The consideration of potential adverse outcomes for residence where determining whether to apply a penalty is consistent with the INP.

In addition to the assessment under INP, the low frequency component of the predicted noise was also assessed using the Broner method and the method proposed in the draft ING. This assessment found that low frequency noise did not exceed the draft ING or the Broner method. The Broner method and method proposed in the draft ING were both used to help identify potential adverse impacts from low frequency noise and identify where application of a the modifying penalty would be appropriate.

Table 4.1 provides data of the RBL and other descriptors. It doesn't report the measured RBL where it is lower than 30 dBA, which limits the information provided. See Note 1 to table 4.1. It would be helpful to have this data.

In accordance with the INP, where the RBL is determined to be lower than 30 dB(A) the minimum RBL of 30 dB(A) is to be applied. This is outlined in Table 4.1 of the NIA. Notwithstanding, it is noted that the measured RBL were provided in Appendix B of the NIA.

Table 4.4 provides criteria for the Wambo Mine Development Consent. We note that the criteria is 35 dBA at all residences during the day. Why isn't the criteria for this application also 35 dBA at all residences during the day? The answer to that is probably that the existing acoustic environment is affected by mining noise and therefore raises the intrusive noise criteria as per background + 5 dB. This is not right as the RBL should be measured with the mine NOT in operation. We suspect this was not done. Therefore as a conservative approach, the criteria should be the same as the current criteria of 35 dBA during the day at all residential locations.

It should be noted that criteria in a development consent are the final outcome of a detailed, project specific process that is outlined in the INP. The Wambo Mine criteria referred to above was established as part of the Wambo development consent. As part of the NIA the application of target project specific noise levels (PSNL) have been determined for the Project in accordance with relevant guidelines. As detailed in Section 4.3 of the NIA this includes the consideration of both intrusive and amenity noise criteria applicable to the Project. In accordance with the INP the target PSNLs have been identified based on the characteristics of the noise environment for the areas surrounding the Project. As determined in accordance with the INP, the target PSNL adopted for the Project were the lower of the intrusive or amenity level to ensure the most stringent levels are applied to the assessment of noise impacts from the Project.

Section 5.0. A significant part of the mitigation is the use of the attenuated fleet including 3 x 550T excavators, 7 x 240T haul trucks, 8x 150T haul trucks and yet Section 5.1.6 states these sound power levels are considered to be indicative and not mandatory. Further, it states in Section 5.1.6 that the actual; performance of the mining operation as a whole will be determined by monitoring the environmental noise levels over the life of the project. Attenuated fleet cannot be bought off the shelf and take several months to be selected and attenuated. This should be modelled and decided before operation so that delays are not incurred while the noise criteria is exceeded due to use of un-attenuated fleet. Appendix E does not identify the attenuated fleet for comparison against the sound power level of a standard machine.

As outlined in Section 8 of the EIS, United have made clear commitments to the implementation of a range of noise mitigation and management measures as part of the Project to meet the predicted noise levels. This includes the incorporation of a range of noise mitigation measures, including the use of attenuated fleet. As outlined in the EIS, United will commit to meeting the predicted noise levels over the life of the Project. Several equipment manufacturers can supply noise attenuation on new equipment, especially for haul trucks and excavators, and the attenuation does not have to be retro-fitted post-delivery. Whilst this may have been the case in the past, the demand for lower noise level equipment has resulted in many manufacturers now providing such low noise level plant from new.

Section 6.1.2- no modifying factors were found to be necessary due to the inclusion of the non-authorised Broner method.

As outlined previously a range of methods were utilised to assess the potential impacts of low frequency noise. This was completed to provide the determining authority with comprehensive information in relation to the potential impacts associated with the Project. Multiple methods were used in order to ensure that there was not a perverse outcome relating to any applicable low frequency noise considerations.

Table 6.1 – 8 private residences are predicted to be above the PSNL by more than 5 dB and therefore afforded acquisition rights. In an area that is already affected by mining noise, this seems to be a very high number of residences significantly affected. The assessment should determine what is required to meet the PSNL and then argue the case that those controls are not reasonable.

It is noted that the NIA has identified six residences in the Affectation Zone (i.e. likely to receive acquisition rights should the Project be approved). As outlined in Section 8.0 of the EIS, United have made clear commitments to the implementation of a range of noise mitigation and management measures as part of the Project to meet the predicted noise levels.

Table 6.2 - 18 private residences are predicted to be above the PSNL by 3- 5 dB and therefore afforded noise mitigation rights. In an area that is already affected by mining noise, this seems to be a very high number of residences significantly affected. The assessment should determine what is required to meet the PSNL and then argue the case that those controls are not reasonable.

The NIA included a detailed discussion about the application of reasonable and feasible noise mitigation measures to the Project in the context of the predicted noise levels.

As outlined in Section 8.0 of the EIS, United have made clear commitments to the implementation of a range of noise mitigation and management measures including real time monitoring and both proactive and reactive measures, as part of the Project to meet the predicted noise levels.

Section 6.1.4 – No criteria provided in Area 3 – Warkworth, as they are afforded acquisition rights and therefore the proposal is 'allowed' to make whatever noise level they like! Section 6.2 also acknowledges that sleep disturbance will occur in Warkworth.

As noted in the EIS, acquisition rights have already been established for Area 3 Warkworth and the Project does not seek to alter these arrangements. United, on behalf of the Joint Venture, have consulted with all private residents within Area 3.

Section 7.1.3 acknowledges the difficulties in monitoring the noise from individual noise source and that the cumulative already exceeds the criteria. The noise criteria for the proposal should be set so that the cumulative level is not exceeded, rather than to the cumulative level itself. A BarnOwl or similar should be permanently setup and access allowed to the EPA so that data is always available to the regulator.

The NIA includes an assessment of cumulative noise impacts from the Project and surrounding approved and existing mining operations (refer to Section 7.0 of the NIA) which is based on the Project achieving its predicted noise levels to minimise potential cumulative noise impacts.

As outlined in Section 8 of the EIS, United will implement an appropriate continuous Noise Monitoring Program that will enable the proactive and real time management of operations during adverse noise propagating conditions, which will be detailed as part of the noise management plan for the Project.

Overall, the noise impact on the already affected residential areas seems to be very high with a high number of residences significantly affected by the noise emission from the proposal. An additional eight residences significantly affected and therefore entitled to acquisition rights is very high and unacceptable.

As noted above, the NIA has identified six residences (not eight, it was initially seven but one property has since been purchased by the Joint Venture) in the Affectation Zone (i.e. likely to receive acquisition rights should the Project be approved).

The NIA has provided a comprehensive assessment of potential noise impacts associated with the Project. As outlined in Section 6.6 of the EIS, the identification and assessment of reasonable and feasible noise controls have been considered throughout the Project design process and incorporated into detailed noise modelling. The incorporation of these reasonable and feasible controls has reduced the extent of the noise affectation and management zones and related noise impacts associated with the Project as far as practicable. A combination of proactive and reactive/adaptive controls will be implemented over the life of the Project as detailed in Section 6.6.11 and Section 8.0 of the EIS.

4.4.2.2 Hunter Valley Glider Club

The additional noise generated by the proposed project, as modelled, will result in sleep deprivation to those staying overnight at the airfield in caravans, tents and bunk rooms. We also note that the project's realignment of the Golden Highway will move the highway closer to the HVGC, further increasing the noise level at the HVGC site. We expect that some current members will not be able to tolerate the increased noise levels and will cease their membership of the HVGC.

The Hunter Valley Gliding Club currently operates within an area dominated by mining operations, including the adjacent HVO South operations and currently experiences noise impacts. It is also noted that the location of the Hunter Valley Gliding Club in an area surrounded by mines and mine owned buffer land reduces the potential for the clubs noise generating activities to impact on sensitive receivers. Consistent with the existing proximate mining operations, it is acknowledged that the Project will result in noise impacts on the Hunter Valley Gliding Club facility including potential sleep disturbance impacts. United has undertaken consultation with the Hunter Valley Gliding Club on three occasions and has commenced discussions with the Hunter Valley Gliding Club regarding the development of an agreement outlining agreed measures to reduce the amenity impacts of the Project on the club, with the measures in the agreement to be implemented by United.

4.4.2.3 Lock the Gate Alliance

An additional large open cut in this area will add to an air and noise pollution loads that are already unacceptable.

Discussion of the predicted air and noise impacts of the Project is provided in the EIS and above.

4.5 Blasting

Issues relating to blasting were raised in 6 community submissions and in two interest group submissions.

4.5.1 Community

Cumulative impacts: Blasting emissions do not take into consideration cumulative impacts.

Section 6.7.5.6 of the EIS discusses cumulative blasting impacts. Due to the Project's proximity to adjoining mining operations, without appropriate management, there is a possibility of concurrent blasting with nearby mining operations (e.g. HVO and MTW) which may result in cumulative airblast and vibration impacts on nearby residences and structures. All blasting undertaken as part of the Project will be managed to meet the relevant criteria except where an agreement is in place with the land owner.

United will liaise with the operators of these nearby mining operations regarding the coordination of blasting activities so as to minimise the possibility of concurrent blasting and therefore cumulative airblast and vibration impacts. Procedures for liaison with the operators of other mining operations will be set out in the Blast Management Plan to be prepared for the Project.

As also outlined in the EIS, United has committed to maintain the current limits on number of blasts at the Wambo open cut and the Project will therefore not result in an increase in the number of blasts per day or per week when compared to the existing situation.

Impacts on Warkworth: Blasting will impact the village and its historical buildings.

A detailed Blasting Impact Assessment has been undertaken by Enviro Strata Consulting Pty Ltd and is presented in Appendix 10 of the EIS. The Blasting Impact Assessment identified a number of blast sensitive locations which were assessed, including:

- private residences
- public roads and bridges, including the Golden Highway, proposed Golden Highway realignment and Comleroi Road
- power transmission lines
- Prescribed Dams within Wambo
- Hunter Valley Gliding Club and Warkworth Shooting Complex
- telecommunications infrastructure
- historical sites, including St Philips Church in Warkworth, the Wambo Homestead Complex, the former Warkworth Pubic School, Piggery and Butcher's Hut, former Queen Victoria Inn, Springwood Homestead, the Montrose property (including the shearing shed) and Dog-leg Fence.

It is noted that there is only one privately owned residence in Warkworth Village (Residence 19).

As outlined in Section 6.7 of the EIS, predicted ground vibration and airblast overpressure will exceed impact criteria at Residence 19 and the Warkworth Public School. Residence 19 is located in close proximity to the proposed United Open Cut and could potentially experience ground vibration exposure levels and airblast impacts in excess of the relevant limits for human comfort. This residence is currently subject to voluntary acquisition rights under the Wambo mine, Wambo train loading facility and MTW development consents. Any blasting impacts in excess of the criteria at residence 19 would be the subject of a negotiated agreement with the resident while it remains privately owned.

In regard to the former Warkworth Public School, which is no longer a school and is owned by a mining company, blasts will be managed to meet 5 mm/s to negate the risk of vibration impacts except where agreed otherwise with the owner and/or based on a structural assessment that identifies an alternate acceptable vibration level.

Blast fume: The proposed development is forecast to increase fume. Blast fumes are unpredictable and are potentially dangerous for those residents within a 2km radius. (Possible sequelae include respiratory irritation, pulmonary oedema and death). The mine has already had 2 prosecutions for blast fumes.

The issues and potential impacts of blasting emissions were documented in Section 8.5 of the Air Quality Impact Assessment. Post-blast fume and odour were identified as the key air quality issues associated with blasting. Both of these issues were investigated and it was found that, with Glencore's routine blast management procedures, there is unlikely to be any adverse impacts in terms of post-blast fume and odour.

As outlined in Section 6.7 of the EIS, since 2012, there have been two incidents relating to the emission of odorous fumes from blasting at Wambo which have resulted in prosecution by the EPA. As discussed in Section 6.4 of the EIS, in response to these incidents, Wambo has implemented a Blast Fume Management Strategy (Peabody Energy 2015), which includes a range of fume minimisation measures for all blasting activities.

Increased vibration: The proposed development is forecast to increase vibration.

Modelling indicates that ground vibration and airblast overpressure levels can be managed effectively within the relevant blast emission criteria at all private residences, with the exception of Residence 19.

In order to achieve the blast emission criteria at all other private residences, management of charge masses (or other techniques) may be required when blasting in proximity to some residences. In the Wambo Open Cut, lower charge masses may be required when blasting in proximity to three private residences located to the northwest along the Golden Highway and Redmanvale Road areas to manage blast overpressure levels. It is noted that two of these residences (Residences 39 and 40) are located within the predicted noise affectation zone for the Project and are likely to have voluntary acquisition rights should the Project be approved. Predicted vibration levels at these three private residences are well within the vibration criteria for human comfort for the full range of blast charge masses modelled. A detailed blast design process would be undertaken for each blast in order to establish the charge masses required to meet the relevant blast emission criteria at these locations.

Residence 343: Potential for blast fumes to reach our vicinity in future with our property only being 1.4 kilometres from the proposed Project.

It is acknowledged that the closest point of the property boundary of Residence 343 is located approximately 1.2 kilometres from the Project Area and 1.4 kilometres from the Wambo Open Cut. The dwelling associated with Residence 343 is located approximately 1.7 kilometres from the Project Area and approximately 2.1 kilometres from the Wambo Open Cut.

The Project will not result in mining operations being any closer to Residence 343 than is currently approved.

Blast fume emissions were assessed as part of the Air Quality Impact Assessment and presented in Section 6.4.5.2 of the EIS. Blasting activities have the potential to result in fugitive fume and particulate matter emissions.

Post-blast fumes comprise oxides of nitrogen (NO_x) including nitric oxide (NO) and nitrogen dioxide (NO_2). It is the NO_2 which has been linked to adverse health effects. In general, at the point of emission, NO will comprise the greatest proportion of the total emission. Ultimately, however, much of the NO emitted into the atmosphere is oxidised to NO_2. The rate at which this oxidisation takes place depends on prevailing atmospheric conditions and can vary from a few minutes to many hours. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low then the level of oxidation is unimportant. However, if the oxidation is rapid and the dispersion is slow then high concentrations of NO_2 can occur.

As part of the Air Quality Impact Assessment the CALPUFF dispersion model was used to quantify potential NO_2 concentrations due to blasting. The assessment showed that with the proposed blasting procedures in place, the Project is predicted to comply with the criteria at all sensitive receivers.

Blast fume management is outlined in Section 6.4.6 of the EIS. United will implement existing Glencore blasting procedures in place at other Glencore Hunter Valley mines relating to fume management, including pre-blast review of weather conditions so as to avoid blasting in adverse conditions. A site specific blast management plan will also be developed and implemented during operations, including key fume management actions such as defining the potential risk zone based upon weather patterns and the ability to fire a blast based on an assessment of real-time weather conditions. The blast fume management actions will be determined in consideration of the relevant aspects of the existing Wambo Blast Fume Management Strategy (Peabody Energy 2015a) currently implemented at Wambo mine.

Residence 343: The house shakes during blasts, to the point where it scares the animals causing them to be agitated for hours.

There has been noticeable cracking to the tile grout near all 4 cornices in the bathroom and a crack to the centre of one bathroom wall.

There is a large crack running through the external concrete slab near the back door.

A detailed blasting assessment was undertaken for the Project and presented in Appendix 10 of the EIS. Modelling indicates that ground vibration and airblast overpressure levels can be managed effectively within the relevant blast emission criteria at Residence 343.

Wambo has been monitoring airblast overpressure and ground vibration around the Wambo Open Cut since 2004. A review of monitoring data from 1093 blasts for the period to June 2015 identified no exceedances of ground vibration criteria at private residences. Wambo has also advised that no exceedances have occurred at this residence in 2016.

Four blasts were found to have exceeded the maximum airblast overpressure criteria of 120 dBL at private residences, with a further 12 blasts in excess of the 115 dB recommended airblast overpressure criteria. The number of blasts that exceeded the recommended airblast overpressure criteria of 115 dB constituted less than 5 per cent of the total number of blasts in a 12 month period and is therefore compliant with relevant criteria (Peabody Energy 2015).

It is understood that Wambo have received a number of complaints in relation to blast vibration, overpressure and dust/fume associated with blasting. Wambo will continue to consult with the community in relation to any current concerns relating to their operations.

It is also noted that as part of the Project pre-blasting inspection of properties within 2 kilometres distance of the mine will be undertaken to record the condition of buildings and structures for future reference should there be any future concerns about vibration related impacts from the Project.

The dust and gases from the blasting are not acceptable, especially when it is only benefitting multinational Mining Companies.

Blasting activities have the potential to result in fugitive fume and particulate matter emissions. A detailed AQIA was undertaken for the Project (refer to Appendix 7 of the EIS) which assessed the potential impacts of air quality and blast fumes.

As outlined in Section 6.4.5 of the EIS, cumulative dust levels and other air quality parameters are predicted to comply with the relevant criteria at all surrounding private residences, with the exception of a single private residence in Warkworth village which has existing acquisition rights. The assessment also found that with the proposed blasting procedures in place, the Project is predicted to comply with the relevant criteria for post-blast fumes at all sensitive receivers.

Residence 49: At present we are currently being negatively impacted by Wambo Operations due to the effects of nitrous oxide pollutants from blasting. This provides us with the constant reminder that nitrous oxide pollutants from blasting will increase with the large scale of this development.

Blast fume emissions were assessed as part of the Air Quality Impact Assessment and presented in Section 6.4.5.2 of the EIS. As discussed above, the assessment showed that with the proposed blasting procedures in place, the Project is predicted to comply with the criteria at all sensitive receivers.

Residence 49: At present we are currently being negatively impacted by Wambo Operations due to the effects of vibration. This provides us with the constant reminder that vibration will increase with the large scale of this development.

A detailed blasting assessment was undertaken for the Project and presented in Appendix 10 of the EIS. Modelling indicates that ground vibration and airblast overpressure levels can be managed effectively within the relevant blast emission criteria at Residence 49. The Project will not result in mining operations being any closer to Residence 49 than is currently approved.

4.5.2 Interest Groups

4.5.2.1 Bulga Culture Centre

Mine Blasting Plumes into the atmosphere need to be curtailed by enhanced Blast Hole Stemming, and the use of "Plastic Stemming Plugs".

As discussed in Section 6.7.1 of the EIS, United will undertake blasting for the Project in accordance with a detailed blast design process that considers operational, geological and environmental constraints, with the design and size of each blast determined to meet these constraints and satisfy blasting criteria. Blast design and sizes will vary over the life of the Project and will depend on a number of factors including the nature of the overburden / interburden strata material, the design of open cut benches and environmental considerations. The detailed blast design process will seek to maximise blast efficiency, and minimise potential vibration and overpressure impacts. Blasts will be designed to achieve compliance with the site specific blast conditions. This detailed blast design process will be set out in a Blast Management Plan to be prepared for the Project and implemented for all blasting activity. This Blast Management Plan will be prepared in consideration of the relevant aspects of the existing Wambo Open Cut Blast Management Plan (Peabody Energy 2014) and Wambo Blast Fume Management Strategy (Peabody Energy 2015a) which are currently being implemented at Wambo.

4.5.2.2 Hunter Valley Glider Club

There will be significant operational impacts due to blasting, in particular the process of clearing the blast area will be lengthy and difficult to accomplish for blasts in the immediate vicinity of the HVGC property boundary. As a result it will be difficult to guarantee the safety of HVGC members and visitors during these blasts.

The Blasting Impact Assessment identified a number of blast sensitive locations within a 5 kilometres radius of the Project, which included the Hunter Valley Gliding Club.

The blast impact criteria for prevention of structure damage for the Hunter Valley Gliding Club is identified in Section 6.7.4 of the EIS. The criteria are provided in **Table 4.7**.

Table 4.7 Blast Impact Criteria for the Prevention of Structural Damage

Receiver	Peak Particle Velocity (mm/s)	Overpressure (dBL)
Hunter Valley Gliding Club	25	133

The Blasting Impact Assessment predicted the maximum predicted vibration exposure from the United Open Cut at the Hunter Valley Gliding Club to be 13mm/s. This is well below the applicable vibration limit of 25 mm/s for the considered infrastructure on the site. Similarly, the airblast exposures would by below the applicable limit of 133 dBL.

HVO has previously blasted adjacent, and continue to blast in proximity, to the Hunter Valley Gliding Club facility. Existing procedures would be in place to manage interactions between mining operations, including blasting, and the Hunter Valley Gliding Club activities. It is considered that operational impacts as well as members and visitors safety can be successfully managed as HVO operations have been.

The Hunter Valley Gliding Club will be notified of all blasting activity in the United Open Cut, this process will form part of the agreement to be developed with the Hunter Valley Gliding Club prior to mining commencing should the Project be approved. It is noted that a clearance zone for any blast of 500 metres would be enforced as a safety precaution and that this would include parts of the Hunter Valley Gliding Club land for some blasts. United will also consult with the Hunter Valley Gliding Club on blasting procedures and schedules to determine an appropriate strategy to minimise impacts to the Hunter Valley Gliding Club as far as practicable.

A landing or departing aircraft may collide with undetected blast debris on the airstrip following a blast, resulting in potentially serious injury and aircraft damage. There is a real possibility that an aircraft overflying the mine/blast area during landing or take-off will be impacted by airborne blast debris or shock wave. Such an impact has potential to be catastrophic.

As part of the Project United will implement procedures to minimise the generation of flyrock and procedures to undertake inspections of all relevant potentially impacted infrastructure following blasting prior to their use. For example, as outlined in Section 6.7.5 of the EIS, it is proposed to manage flyrock for the Golden Highway which is located between the Project Area and the Hunter Valley Gliding Club. In managing flyrock for the Golden Highway, it is considered that this will also manage potential flyrock issues for the Hunter Valley Gliding Club; however, United will consult further with the Hunter Valley Gliding Club on this issue and implement appropriate procedures.

As stated above, HVO has previously blasted adjacent, and continue to blast in proximity, to the Hunter Valley Gliding Club facility. Existing procedures would be in place to manage interactions between mining operations, including blasting, and the Hunter Valley Gliding Club activities. It is considered that operational impacts can be successfully managed as HVO operations have been. Additionally, it is noted that a clearance zone for any blast of 500 metres would be enforced as a safety precaution. This would include coordinating flights during blasting to manage any potential interactions with aircraft.

As discussed above, the Hunter Valley Gliding Club will be notified of all blasting activity in the United Open Cut, this process will form part of the agreement to be developed with the Hunter Valley Gliding Club prior to mining commencing should the Project be approved.

4.6 Surface Water

Issues relating to surface water were raised in 19 community submissions and in two interest group submissions.

4.6.1 Community

Impacts on water resources:

'The wholesale destruction of surface water catchments for the Hunter River and Wollombi Brook tributaries is already too great.'

'The proposed Project has the potential to worsen the already negative impacts on the Hunter River, local watercourses and aquifers.'

'Open cut [mines] in the Hunter Valley are a threat to water resources.'

The Project will occur within an existing mining area and much of the mining will be undertaken within the area covered by the existing Wambo and United mine water management system (WMS). Changes to the existing WMS are proposed to effectively manage water as part of the Project, with the design developed in accordance with legislative requirements and relevant guidelines and standards. The WMS for the Project will maximise water recycling, reducing external water import and releases, whilst also providing for compliance with legislative requirements.

Impacts on water resources associated with the Project were assessed in detail as part of the EIS. The EIS found that the Project is not predicted to result in significant impacts on downstream water quality, flows, flooding or water users.

It is also noted that Redbank Creek flows through the centre of the United site and into a clean water catch dam, with United holding a licence to use water from this dam for mining operations.

Impacts on water quality:

'I oppose the development due to water pollution.'

'I object on the grounds of damage to water quality.'

As stated in the Surface Water Assessment, the WMS for the Project has been designed in accordance with relevant government standards to limit potential impacts on downstream water qualities by: containing mine water; managing runoff from disturbed areas; and undertaking all discharges in accordance with EPLs and, where relevant, under the provisions of the HRSTS.

The Project WMS includes mine dewatering systems, water storages, sedimentation and retention basins, settling and tailings ponds, drains, levee banks, laydown hardstand areas and fuelling areas. The Project WMS has been designed to convey clean water around mining operations and segregate, store and reuse mine-impacted water to minimise adverse effects on water quality from mining operations to downstream waterways.

It is proposed to integrate water management for the Project with the Wambo WMS to maximise water sharing and reuse, limiting the potential impacts of the Project on downstream water quality by managing water that has the potential to cause environmental harm. In conjunction with the proposed WMS, a series of erosion and sediment control measures will be utilised during construction, operation and rehabilitation phases of the Project to manage water quality.

The surface water monitoring programs have been in place at United and Wambo for a number of years and were developed based on the management of risk to downstream water quality posed by the existing operations. The Surface Water Assessment found that the Project will not change the specific risks to water quality compared to the existing operations.

Residence 25: Previous mining has already seriously impacted on the surface waters, particularly Wambo Creek and the aquifers that supplied water to the neighbouring properties. It is nonsense to indicate a buffer zone exists to halt impact. The Wambo mine has already had a significant subsidence impact on Wambo Creek to the point where the state of the creek has been downgraded from permanent in 1991 to ephemeral today. This condition is the result of previous mining in contradiction to consent conditions and the lack of monitoring hampers further progress towards repairs.

The impacts of the approved Wambo mining operation have been subject to previous detailed environmental assessment and approval processes and are not the focus of the EIS and this report which relates to the Project. The Project does not include underground mining and will not therefore result in mine subsidence impacts. Wambo Creek is located to the south of the Project Area for this Project and is outside the influence of the Project.

In regard to the Project, the commitment to maintain a buffer zone between the proposed open cut mining area and Wollombi Brook (a distance of 370 metres) contributes significantly to minimising the impacts of the Project on the Brook.

Impacts on water resources associated with the Project have been assessed as part of the EIS to satisfy the SEARs for the Project. The EIS demonstrates that the Project will have no impacts on Wambo Creek as Wambo Creek lies outside of the zone of impact.

Despite the significance of this information regarding the long-term impact and utility of the pit lakes, it is only present in Appendix C of Appendix 11 of the EIS and is not discussed in detail within the main text of the Statement. Such water quality is completely at odds with potential beneficial future uses of the pit lakes such as aquaculture (which are envisaged by the EIS). In addition, toxic contaminants such as mercury, selenium, cadmium and other heavy metals may accumulate in pit lakes. Such risks are site-specific and so must be assessed on this level. However, the EIS does not consider or assess the potential for these pollutants to accumulate in the pit lakes.

There was no intent to downplay the significance of the long-term water quality of the final void pit lakes in the EIS. The assessment formed part of the water balance assessment for the Project which was included as an appendix to the Surface Water Assessment as noted above. For clarity, this information has been re-presented in Section 3.1.6.1 of this report

Final void end land use is an area of developing research. Research suggests that there are a range of options available for potential final void land uses. One option recently used as an example within the mining industry is the utilisation of voids as a natural feature within the landscape in the creation of a pit lake.

The closure plan for the operation will be developed and refined over time with the detailed closure plan to be developed 5 years prior to the date of planned closure. The rehabilitation of voids and infrastructure areas will only commence following the cessation of mining.

Further detail on water quality and heavy metal constituents is included in Part B of the RTS.

4.6.2 Interest Groups

4.6.2.1 Hunter Environment Lobby

The Hunter Environment Lobby engaged Pells Consulting to undertake peer reviews of both the Surface Water and Groundwater Assessments. Responses to each of the questions posed in the review and the recommendations made by Pells Consulting in regards to the Surface Water Assessment are included below.

The methodology for representing "predicted changes in catchment contribution" is not stated. A hydrological model should be used to make such assessments.

The Surface Water Assessment provides an overview of the methodology used to determine impacts on flow volumes in both gauged and ungauged (in this case ephemeral) watercourses. The assessment was undertaken using flow duration curve analysis for flow gauges on both Wollombi Brook and the Hunter River. The analysis was undertaken by adjusting flows proportionally for catchment contribution and baseflows (as described in the text). The assessment for ephemeral watercourses was based on the predicted changes to catchment area.

It is noted that the methodologies used are similar to those used in previous assessments for mining projects in the Hunter Valley, with these approaches accepted by both DPE and the DoEE.

The most significant impacts to streamflow are expected to occur downstream of the Wollombi Brook station and hence are not represented in the flow duration analysis.

Flow gauging data was used from the Wollombi Brook DPI Water gauge to assess potential impacts on flow duration, and as such flows in the Wollombi Brook. The Wollombi Brook gauge is used to generate a flow sequence for the Brook downstream of the Project Area, therefore, it correctly assesses the maximum impacts. This approach is conservative (i.e. worst case) which overestimates the predicted impacts.

The analysis showed negligible impacts to frequency of high flows and an average increase of no flow days of 0.4 days per year for the final landform. This predicted change is not considered to result in a significant impact on streamflow.

Hunter River gauging station at Singleton is a significant distance downstream, and representative of a very large catchment. Relative impacts to this flow record from the Project is not an appropriate indicator of impacts to surface water resources.

Flow gauging data was used from the Hunter River DPI Water gauge at Singleton to assess potential impacts on flow duration, and as such flows in the Hunter River. In order to provide the basis for a suitable assessment, flow gauging data from a gauge with a long term record in the vicinity of the Project Area is required. The Hunter River flow gauging station at Singleton is located some 27 kilometres downstream of the confluence of Wollombi Brook and the Hunter River. This Singleton gauge was chosen for the analysis as the gauge has available flow data from 1914 to date and has the longest period of gauge records in the vicinity of the Project Area. It is considered that the Singleton gauge provides an appropriate analysis due to the longer period of record/data. It is noted that while the Hunter River gauge has been used to examine the impact on the Hunter River it hasn't been used to assess impacts on Wollombi Brook or other local watercourses which has been done using other local data.

The gauged records incorporate impacts from existing regional mines. The analysis does not consider cumulative impacts from mining.

The gauge analysis considers the current mining impacts as part of the current gauging records, that is, the current mining developments and associated impacts are included in the existing gauge records. This method has been accepted in previous assessments by both DPE and Commonwealth DoEE.

The objective of the *NSW Water Management Act 2000* (WM Act) is the sustainable and integrated management of water in NSW and is based on the concept of ecologically sustainable development. The WM Act defines water access and water sharing strategies within NSW. As part of the WM Act, Water Sharing Plans (WSPs) have been developed across NSW to protect the health of rivers, whilst at the same time securing sustainable access to water for all users. The WSP's specify maximum water extractions and allocations. By complying with the requirements of the WSP's, water take will be within the sustainable yield for the water system as determined by the NSW government. This in turn provides for sustainable environmental flows within the water systems.

The main surface water model used for water sharing and management is the Integrated Quantity and Quality Model (IQQM). IQQM has been developed to assess the impacts of different management strategies on all water users (DPI Water, http://www.water.nsw.gov.au/water-management/modelling). The models have been developed to simulate the major hydrological processes in river valleys along with relevant management rules, including establishing the water allocation/licensing system. Cumulative impacts from all current and future water users (including the environment) have been considered in the IQQM modelling used to establish water allocations. This is contained within WSPs. The Project is using existing allocations consistent with the IQQM modelling undertaken and which therefore takes into account cumulative impacts.

All water take for the Project beyond that which is in accordance with harvestable rights or exempt from licensing will be licenced. Water extracted from the Hunter River and Wollombi Brook will occur in accordance with Water Access Licences (WALs) held under the *Hunter Regulated River Water Sharing Plan 2004* and the *Hunter Unregulated and Alluvials Water Sharing Plan 2009* respectively.

Impacts to flow duration and frequency appear to have been made without the support of hydrological modelling. Assessment of reductions to baseflow rely on groundwater modelling, that may under-represent such impacts due to the choice of storage values. Impacts on flow duration and frequency should be supported by modelling of catchment runoff processes and revised groundwater modelling.

As stated above, the approach utilised in the assessment, i.e. flow duration and catchment analysis, combined with baseflow impact predictions, is similar to the method used in previous assessments and has been accepted for these assessments by both DPE and the DoEE. As long term gauge records are available for both the Wollombi Brook and the Hunter River, using actual historical data from the gauged catchments to undertake the analysis of potential impacts, as opposed to creating a model to simulate the catchment response, is considered to be a more robust and appropriate method.

4.6.2.2 Lock the Gate Alliance

The quality of the void water is a key environmental impact and has ramifications for long-term liability and the utility of the final landform legacy for the community. The EIS assume the voids will be sinks due to evaporation and surface water diversions and this will have a profoundly negative impact on the voids water quality over time in regards to salinity and possibly heavy metals. The EIS document does not contain sufficient information relating to final void water quality. The Proponent acknowledges that at this stage of the project the work has not been completed that will predict the final void water quality. It is imperative that this work be conducted and properly reviewed prior to determination of this project.

An assessment of the water and salinity balance has been completed for the Project and was included in the EIS. Further discussion of the final void water and salinity balance is provided in **Section 3.1.6.1** confirming that the voids are predicted to be long-term sinks and thus will not affect water quality in the surrounding environment.

The proponent undertook flooding modelling and discovered that the inundation extent of the 1 in 100 year flood event for Wollombi Brook includes an area of the proposed footprint of the United Open Cut and proposes a flood levee to protect the pit from flooding. And yet, the proposed mine water storages are only designed to have sufficient freeboard to contain runoff for events up to and including the 1 per cent 24 hour AEP storm event (see Table 6.7 Main Text). That a levee installed to protect the mine has higher flood protection than the water storages designed to protect surrounding creeks and rivers gives some insight into the proponent's priorities. With intensifying climate change, 1 in 1000 year scale storms may increase in frequency, and rainfall events in general are expected to become more intense. It is reasonable to expect the proponent to offer flood protection to the surrounding environment at least as good as it creates for its own operation.

The design of the water management system uses well established and accepted design criteria for water management systems for coal mines in the Hunter Valley of NSW. The design criteria proposed for the WMS are in accordance with relevant legislation and guidelines and have been accepted by EPA, OEH, DPE and DoEE.

The analysis of flood impacts and associated flood levels have been undertaken for the Project for the Probable Maximum Flood (PMF) event which is typically considered to be a 1 in 10,000 to 1 in 100,000 year event. In addition, as requested by OEH in the SEARs, the 0.5 per cent AEP (200 year) and 0.2 per cent AEP (500 year) flood events were modelled to act as proxies for assessing sensitivity to climate change and the findings considered in the flooding assessment.

As requested by OEH, the flood modelling has analysed larger flood events to ensure that should flooding increase as a result of climate change any risks are identified through the modelling. The modelling of these larger flood events show that there will be only minor changes to flood hazard categorisations within the Project Area under these scenarios. This indicates that there is a minor risk of climate change resulting in adverse flooding risks associated with the Project.

We seek clarification from the proponent about the flood modelling. The images depicted in Figures 6.20 and 6.21 in the Main Text of the EIS do not appear to model the effect of the flood levee the proponent proposes to establish to protect the United pit from flooding. Further information needs to be sought about the effect of the flood levee on surrounding properties and infrastructure. We note that the proponent proposes that both the 330KV transmission line and the re-aligned Golden Highway will be on the flooding side of the 1 in 1000 year flood levee proposed to protect the United pit from inundation (see Figure 3.23 of the main text).

As discussed in the Surface Water Assessment the flood levee was modelled as part of the developed condition scenario. The developed condition scenario was selected to provide a "worst case" for flooding impacts combining the maximum catchment areas and maximum development extents, including the flood levee, simultaneously. The results presented in the EIS therefore show the effect of the flood levee. As outlined in the EIS the modelling indicates that the potential impacts on flooding associated with the Project are generally limited to localised changes in the downstream reaches of North Wambo Creek and in the upstream reaches of Redbank Creek. The modelling indicates negligible impact on flooding in Wollombi Brook.

Section 6.8.1.6 of the EIS summarises the potential flooding impacts associated with the Project. The flooding assessment for Wollombi Brook indicates that the Project will have negligible impact on the flood depths, flow velocities or flood hazard categories within Wollombi Brook or on adjacent private land, including the township of Warkworth. The modelling indicates that the Project is unlikely to modify the flood planning controls or flood prone land within the Project Area, the surrounding area or in the township of Warkworth. Similarly the modelling has determined the Project is unlikely to impact on flood hazard categories and associated accessibility along either the Golden Highway or private access roads/driveways during flood events.

The land adjacent to Waterfall Creek is owned by mining companies and as such the primary risks associated with the Project are around changes to access along the Golden Highway during flood events and changes to the flow velocities and associated erosion/scour. The modelling indicates that the increase in catchment area of Waterfall Creek as a result of the Project results in minor increases in flood flows and related flood elevations and velocities during the 10 per cent, 5 per cent and 1 per cent AEP flood events (sometimes referred to as the 1 in 10, 20 and 100 year Average Recurrence Interval (ARI) flood events) and the probably maximum flood (PMF) event. The changes in peak elevations all occur on land owned by mining operations and are considered to be acceptable. An assessment of flooding impact at the Golden Highway crossing over Waterfall Creek indicates that the highway will remain flood free up to and including the 1 per cent AEP flood event. The modelling indicates that the road is impassable to vehicles and pedestrians during the PMF event and is also likely to be subject to structural damage during this event. The modelling indicates that the flood access on the Golden Highway over Waterfall Creek during the PMF event will remain in the current flood hazard category of 'structural damage likely' (as described by the NSW Floodplain Development Manual, 2005). The modelling indicates an increase in duration of flooding over the Golden Highway during a PMF event with water over the road increasing from approximately 2 hours and 5 minutes to approximately 2 hours and 30 minutes due to the proposed catchment change associated with the Project. This change in flood duration is considered negligible compared to the potential impacts of a PMF; that is, that the existing crossing will most likely be washed out based on the analysis of the flood hazard category. This change in flood duration is considered negligible compared to the potential impacts of a PMF (i.e. a flood event of between 0.01 per cent and 0.0001 per cent AEP, or 10,000 years and 100,000 years ARI).

4.7 Groundwater

Issues relating to groundwater were raised in 24 community submissions and in six interest group submissions.

The following responses have been prepared with input from AGE who completed the GIA for the Project.

4.7.1 Community

Groundwater impacts on the Hunter River and Wollombi Brook:

'Modelling shows there will be a reduction in flow to the Hunter River and Wollombi Brook'

'The Hunter Valley can't afford further draw down of its rivers and alluvial aquifers'

'The proposal compromises the integrity of the alluvial aquifers of the Hunter and Wollombi Brook'

Residence 25: 'This mine and the three surrounding it will cause more than two metres draw down in the productive alluvial aquifers of the Hunter River and Wollombi Brook. The cumulative loss of water and productivity in these water sources is already too great'

'Wollombi Brook and the Hunter River will lose more base flows'

'Both Wollombi Brook and the Hunter River will lose more base flows due to this mine and the social and environmental impacts on the water impact of this mine have not been adequately accounted'

A detailed assessment of the groundwater impacts of the Project was undertaken in accordance with the NSW Aquifer Interference Policy (AIP). The assessment findings are outlined in the EIS, including in the Groundwater Impact Assessment (GIA). As also discussed in the EIS, Wambo and United have sufficient groundwater licences to cater for the predicted groundwater take for the Project.

Changes to surface water flow are discussed in Section 7.1.4 of the GIA. Cumulative impacts from approved mining (i.e. HVO South, MTW and approved mining at Wambo) reduce the net baseflow to Wollombi Brook from 1,450ML/year to 1,000ML/year. The Project accounts for between 1ML/year and 37ML/year (Year 8) of the cumulative impacts on baseflow. This is a small proportion of the total baseflow, at around 3 per cent when compared to the modelled approved surface water flux.

Cumulative impacts on the Hunter River baseflow based on currently approved and foreseeable operations at Wambo and United are predicted to reduce the net baseflow to the Hunter River by up to 46ML/year. This is a small proportion of the total baseflow, at around 2 per cent contribution. This was calculated using the peak take in year 11 of 58ML/year, divided by the net baseflow of the Hunter River of 3226ML/year.

All water take for the Project, including those that are post-operations, beyond that which is in accordance with harvestable rights or exempt from licensing will be licenced. Water extracted from the Hunter River and Wollombi Brook will occur in accordance with Water Access Licences (WALs) held under the *Hunter Regulated River Water Sharing Plan 2004* and the *Hunter Unregulated and Alluvials Water Sharing Plan 2009 respectively.*

In regard to social impacts, a detailed Social Impact and Opportunities Assessment was completed as part of the EIS to consider the range of social impacts that may occur. In regard to groundwater impacts, United and Wambo have sufficient groundwater licences to cater for the groundwater take associated with the Project ensuring that it remains within the sustainable take determined for the affected aquifers by the NSW Government. The Project is therefore considered unlikely to significantly impact on other groundwater users.

We have no right to deny future generation's critical water resources. Water loss from mining is now considered to be well beyond acceptable levels.

All water take for the Project, including those that are post-operations, beyond that which is in accordance with basic landholder rights (e.g. harvestable rights) will be licenced. As also discussed in the EIS, Wambo and United have sufficient existing groundwater licences to cater for the predicted groundwater take for the Project and therefore there will be no change in the water available for other licenced users.

The privately owned wells in the Wambo mining lease are not monitored, even though it is a consent condition. It is of great concern that there is likely to be further losses from this project, but we will probably never know the real impact because of the lack of monitoring.

Groundwater monitoring at Wambo is undertaken in accordance with the Wambo Groundwater Monitoring Program. Currently manual groundwater level monitoring is conducted on a monthly to bi-monthly basis, in addition to daily readings recorded by the VWP data loggers. The findings of the groundwater monitoring program are reported to relevant government agencies.

For the Project, United has committed to the preparation of a Groundwater Management Plan which will identify the ongoing groundwater monitoring and reporting requirements for the Project. The plan will be prepared with consideration to Wambo's existing groundwater monitoring program in consultation with relevant government agencies and monitoring will be undertaken in accordance with the approved plan.

Yearly reporting of the results from the monitoring program will be included in the Annual Review. The Annual Review will also identify if any additional monitoring sites are required, or if optimisation of the existing monitoring program should be undertaken.

Residence 25: The cumulative impact on the aquifers by the local mines is not fully assessed. Our wells have been reduced from productive to almost totally useless - another 4 metres will have them unable to produce.

The United Wambo Groundwater Model is one of the most extensive groundwater models developed for the region and is considered the best tool for assessing cumulative impacts. The model extent incorporates three large coal mines surrounding the operation that target the same seams as are mined at Wambo/United. Using this model, the GIA predicts cumulative impacts on all bores in the vicinity of the Project. The assessment identified impacts on one private bore with a predicted drawdown of over 2 metres. This bore is not currently serviceable and is located on a property within the noise affectation zone for the Project and which is therefore expected to be subject to a voluntary acquisition clause in any consent granted for the Project.

The Project will not result in an additional 4 metres drawdown at a bore on Residence 25. It is unclear where this assumption comes from.

The impact on the underground water, cannot sustain the draining of the aquifers that occurs from mining. In time we will all pay the supreme penalties when the aquifers are all destroyed. Water is our greatest Resource NOT COAL.

All water take for the Project, including those that are post-operations, beyond that which is in accordance with harvestable rights will be licenced. United and Wambo have sufficient groundwater licences to cater for the groundwater take associated with the Project ensuring that it remains within the sustainable take determined for the affected aquifers by the NSW Government and therefore there will be no change in the water available for other licenced users. The Project is therefore considered unlikely to significantly impact on other groundwater users.

As outlined in Section 7.3 of the GIA, the alluvial groundwater systems are predicted to be largely unaffected by the proposed post closure landform.

Our rivers cannot afford to lose more base flows.

All water take for the Project, including those that are post-operations, beyond that which is in accordance with harvestable rights will be licenced using existing licences held by the Joint Venture. As discussed in Section 7.1.4 of the GIA, both Wollombi Brook and the Hunter River are only predicted to lose a small proportion of their baseflows as a result of the Project and this take will be licenced using existing water access licences.

Pit lake water chemistry is extremely poorly examined and presented. Both final voids are predicted to form terminal sinks: pit lakes where inflows of water from precipitation and groundwater are balanced by evaporative losses. Therefore, these voids will drawdown local groundwater in perpetuity.

Further discussion of final void water and salinity balance is provided in **Section 3.1**.

4.7.2 Interest Groups

4.7.2.1 Hunter Communities Network

HCN has major concerns about the predicted cumulative impact of the proposal on surface and groundwater systems associated with Wollombi Brook and the Hunter River. These cumulative impacts are significant and will result in the permanent removal of access to productive alluvial aquifers and flows in the Hunter River system. The proposed two final voids will create a permanent groundwater sink that will continue to drain alluvial aquifers and base flows in perpetuity. Mining companies currently have access licences that cover the volume of water removed from the system. A portion of these licences will have to be retired at the end of mining to mitigate permanent loss of water, thus removing any future opportunities for other economic uses. It is unclear how this has been identified in the EA.

Changes to surface water flows are discussed in Section 7.1.4 of the GIA. Cumulative impacts from approved mining (i.e. HVO South, MTW and approved mining at Wambo) reduce the net baseflow to Wollombi Brook from 1,450ML/year to 1,000ML/year. The Project accounts for between 1ML/year and 37ML/year (Year 8) of the cumulative impacts on baseflow. This is a small proportion of the total baseflow, at around 3 per cent when compared to the modelled approved surface water flux.

Cumulative impacts on the Hunter River baseflow based on currently approved and foreseeable operations at Wambo and United are predicted to reduce the net baseflow to the Hunter River by up to 46ML/year. This is a small proportion of the total baseflow, at around 2 per cent contribution. This was calculated using the peak take in year 11 of 58ML/year.

As noted in the comment above, the final voids will act as a long term sink and although there is potential for the Project to increase salt loads post mining within the final voids, the GIA found that the risk of impacting surrounding groundwater is low and the risk of changing the beneficial use of the water source was considered improbable as the final void will be a long term sink.

In regards to water licencing, it is acknowledged that a portion of the licences held by the Project may be retired at the end of the Project. This will be subject to consultation with DPI Water.

It is predicted that both voids will form permanent groundwater sinks and evaporation will concentrate salts in the water body over time. There is no analysis of other water pollutants such as heavy metals concentrating in the water body over time. It is of considerable concern that the Wambo void is predicted to reach hyper salinity levels. The proposal is that modelling undertaken to predict the final water level and quality within the voids will be refined over the life of the mine. The assessment of the hydrochemistry, additional to salinity predictions, should be carried out at this stage of the planning process.

Further discussion relating to final void water quality is provided in **Section 3.1**. Additionally, further information on mine water geochemistry is presented in Part B of the RTS.

4.7.2.2 Hunter Environmental Lobby – Pells Consulting

Groundwater modelling results hinge on the values of hydraulic conductivity and specific storage assumed. Values chosen should be based on measurements of hydraulic conductivity and storage (Young's modulus) that are available. The specific storage values used in the model indicate Young's Modulus values that are simply wrong, and will result in the model under-predicting the rate of propagation of effects. The modelling and predictions should be adjusted to values that represent the Youngs moduli of the formation, which is known with reasonable accuracy, and are likely to be available from regional investigations and studies. Predictions of mining impacts and conformance to the Aquifer Interference Policy should be made with reference to revised modelling adopting measured conductivity and storage values (Young's modulus).

As outlined within Section B3 of the GIA, the numerical model was calibrated manually and with automated parameterisation software (PEST, Doherty 2010[1]) to determine optimal hydraulic parameters and recharge rates. The automated parameterisation software was restricted in the changes it made to model parameters to realistic upper and lower bounds determined from available field data and experience. Appendix B, Figure B-11 of the GIA compared available field data to the modelled hydraulic conductivity values (assuming 20m depth where depth dependence calculations exist). Note, not all field data was representative of 20m depth, most was collected from greater depths, explaining the higher modelled values. The utilisation of field data appears reflected in the comment made within the submissions by Pells Consulting that *"Based on our experience with Sydney Basin geology, we accept that the values of hydraulic conductivity appear to generally be reasonable".*

[1] Doherty, J 2010, "*PEST – Model independent parameter estimation user manual: 5th edition"*, Watermark Numerical Computing, Corinda, Australia, 2010.

Storage properties in tight strata are typically estimated during the modelling processes, as the limited volume of water in these rocks precludes field testing. Pells Consulting note that specific storage can be inferred from a correlation with Young's modulus. Young's modulus is a standard geotechnical approach to estimating responses to linear stress based on the ratio between stress and strain. This ratio influences the compressibility of strata, which in conjunction with porosity influences specific storage. Young's modulus is correlated with storage properties that describe the volume of water released from strata with a change in head. Specific storage influences the speed at which changes in hydraulic head propagate through strata around mining.

Pells Consulting commented that some of the values utilised for specific storage correlate with an unrealistic value of Young's modulus. To investigate this comment, the adopted storage values were compared with appropriate values for Young's modulus and it was concluded that most values for the 3 layers representing confined strata in the model are appropriate. It is acknowledged that specific storage values for layers 3, 4, 5 and 7 correlate with a Young's modulus outside the typical range. Layers 3, 4 and 5 represent the Narrabeen Group, Watts Sandstone and Newcastle Coal Measures, respectively. These layers are only present to the south of the Project Area and are not directly intersected as part of the Project. Layer 7 represents the Whybrow Seam, which subcrops at and to the south of the Project Area, but has been largely removed with historical mining.

The propagation of groundwater drawdown as a result of the Project is most prominent within the target coal seams. As outlined in Table B-2 of the GIA, the target seams for the Project include the Blakefield, Glen Munro, Woodlands Hill, Arrowfield, Warkworth, Mt. Arthur, Piercefield and Vaux seams. These seams are represented in layers 13 to 29 of the groundwater model, and storage properties for these seams are within the typical range of Young's modulus values. The key potential impacts assessed for the Project included groundwater inflows, drawdown at water supply works and impacts on alluvium and streams. Groundwater inflows are derived from direct interception of the mined seams in layers 13 to 29. Within Section 7.1.2 of the GIA, the extent of drawdown has been represented for the various seams, including Wambo, Glen Munro, Arrowfield and Vaux seams. The predicted impacts on alluvium and streams is largely influenced by depressurisation of the shallow Permian coal measures to the north and east of the Project Area, where layers 3, 4, 5 and 7 are absent. Consequently, the predicted impacts are not considered to be sensitive to specific storage values adopted for layers 3, 4, 5 and 7.

Presentation of numerical groundwater results should include cross sections showing total and pressure heads at various stages of development.

Presentation of pressure heads at various stages of mine development can be useful for assessing pressure head changes within strata overlying underground mines. However, the United Wambo Project is an open-cut operation only, so all overlying strata will be removed within the Project Area as part of the modification. Consequently, inclusion of cross-sections of pressure heads is not considered a requirement of the GIA.

Impacts to flow duration and frequency appear to have been made without the support of hydrological modelling. Assessment of reductions to baseflow rely on groundwater modelling, that may under-represent such impacts due to the choice of storage values.

Impacts on flow duration and frequency should be supported by modelling of catchment runoff processes and revised groundwater modelling.

This issue is addressed in the surface water section of this report, refer to **Section 4.6**.

The risk from accumulation of salts and contaminants in mine pits should be addressed with reference to extreme flood events and in terms of a mine closure plan.

Flood modelling completed for the Project confirms that the final voids are outside of flood prone land. The flood modelling work included prediction of the probable maximum flood as a worst case assessment.

The proposed final landform has been designed to minimise the catchment contributing to the proposed final voids. The water balance for the final voids indicates that the equilibrium water levels will be approximately 55 mAHD in the Wambo Open Cut final void and approximately 20 mAHD in the United Open Cut final void, well below the surrounding land surface level, therefore these voids could not spill to the surrounding environment (refer to **Section 3.1.6.1**). The final voids are therefore predicted to remain self-contained systems with no surface flows predicted to downstream watercourses. As such, it is considered that the final voids will have no impact on surface water quality in downstream watercourses.

As outlined in the EIS, United has committed to prepare a detailed mine closure plan and to consider closure planning at each stage of the Project planning and implementation process.

4.7.2.3 Hunter Environment Lobby – Dr Matthew Currell

The scale of Figure 5-5 makes it hard to see precise groundwater levels in the alluvial aquifer(s) and the location of monitoring points P12 and P33 are not identified.

An updated figure has been provided to address the above comment in regard to Figure 5-5, refer to **Figure 4.2**.

The locations of monitoring points P12 and P33 are provided on Figure 10-1 of the GIA.

Figure 5-6 shows significant drawdown to the north of the project site associated with Hunter Valley Operations South mine (HVO South), but little impact from the existing Wambo and United mine areas.

Figure 5-6 of the GIA represents groundwater levels within the Vaux Seam of the Jerrys Plains Subgroup. The Vaux Seam is proposed to be mined as part of the Project, but is not currently mined at United or Wambo. HVO South operations actively mine down to the Bayswater Seam, removing the Vaux Seam. Further details about approved mine operations and the coal seams mined at each site is included within Section B2.2.4 of the GIA.

Water level contour maps in the report do not show particular monitoring points and the associated values used to construct the water level surface.

Refer to **Figure 4.2** and **Figure 4.3** which present available water levels from site bores, as documented in Table A-1 of the GIA. When reviewing these figures it is important to note, as detailed in Appendix A of the GIA, the water level measurements represent the latest available for 2015, so the temporal variation needs to be considered.

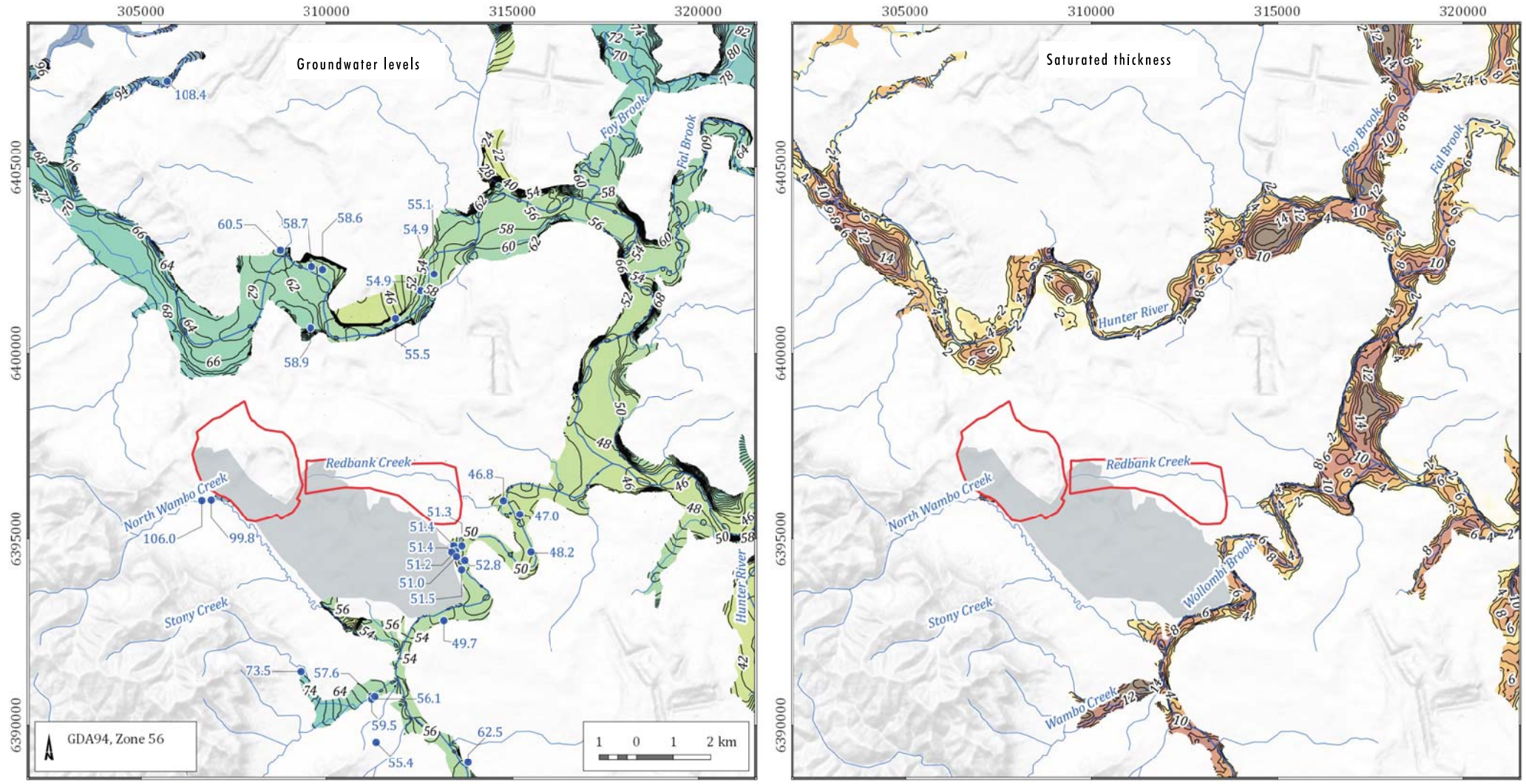


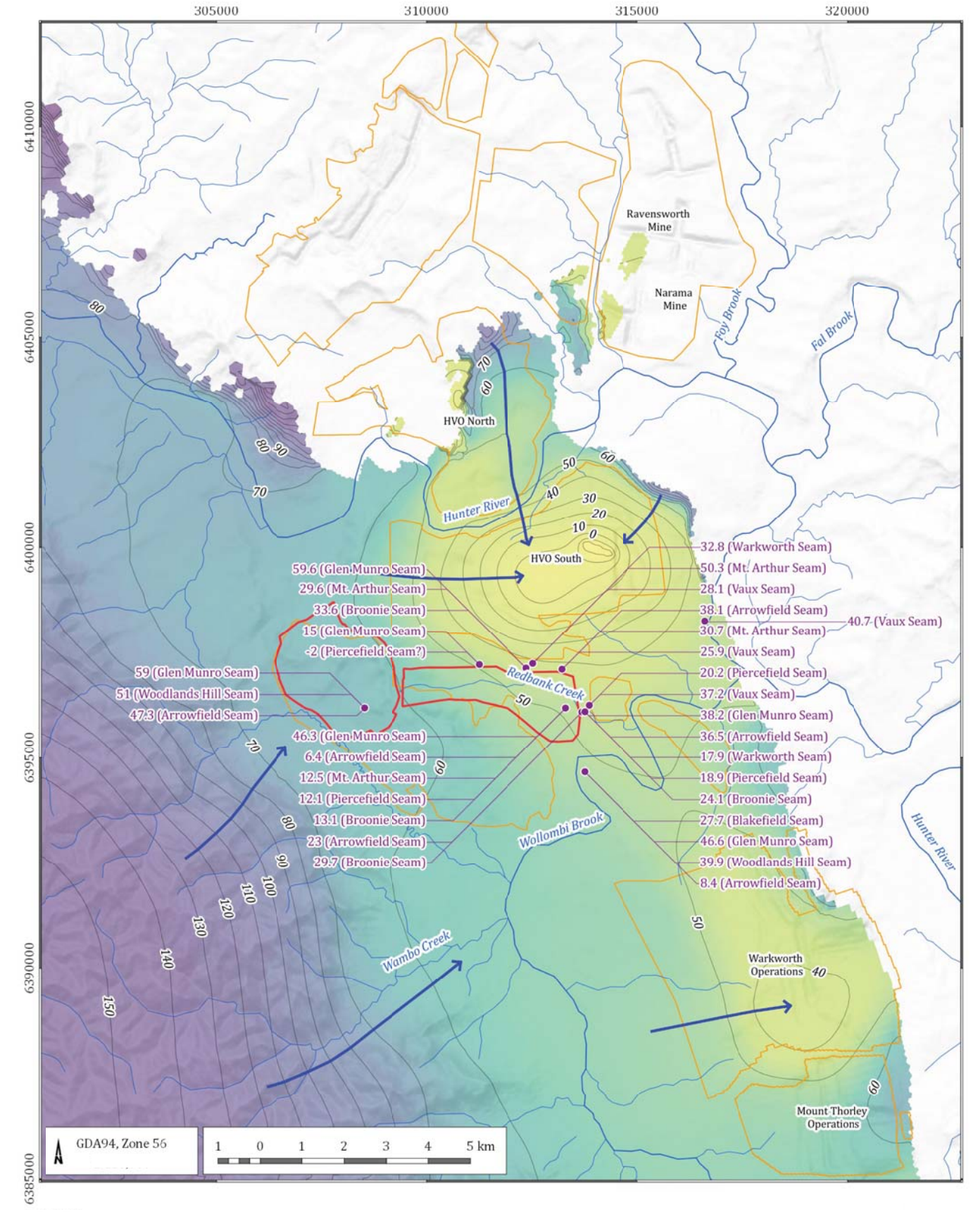
Image Source: AGE Groundwater & Environmental (2017)

Legend

- Proposed extraction area
- Existing mine disturbance area
- Major drainage
- Minor drainage
- Conotour
  - Groundwater level (mAHD, 2m interval)
  - Saturated thickness (2m interval)
- Monitoring bore (SWL, mAHD)

FIGURE 4.2

Groundwater levels and saturated thickness
Quaternary alluvium



Legend

- Proposed extraction area
- Major drainage
- Minor drainage
- Contour (mAHD, 10m interval)
- Historic and approved open cut mining
- Flow direction
- Monitoring bore (SWL, mHD)

FIGURE 4.3

Groundwater levels and flow direction Wittingham Coal Measures (Vaux Seam)

Image Source: AGE Groundwater & Environmental (2017)

There are only four groundwater hydrographs presented even though there are apparently 50 or more actively monitored sites (including bores and piezometers). The only other water level monitoring data is included as an appendix to the model report (Appendix B of Part 2), and this data is not analysed systematically with respect to water level trends in different areas, flow patterns and hydraulic gradients in particular aquifers, different water levels at different depths (and thus vertical hydraulic gradients) or different possible influences on water levels (e.g. mining, climate, groundwater pumping, recharge events, groundwater-surface water interaction).

Selected hydrographs were presented to assist the reader of the GIA. It was not considered necessary to present hydrographs for all monitoring sites. The existing monitoring data was used in the calibration of the groundwater model for the Project and has therefore been considered in the assessment process.

A Project specific WMP and groundwater monitoring program will also be developed for the Project with consideration to Wambo's existing WMP and groundwater monitoring program in consultation with the regulator.

Given the potential for impacts to the Wollombi Brook and Hunter River alluvium, a dedicated section on groundwater-surface water interaction, discussing evidence of baseflow, calculation of potential fluxes of water to and from the surface water bodies along different stream reaches using various methods (e.g. analysis of hydrographs, EC trends through time, Darcy fluxes), is warranted.

Groundwater-surface water aspects and interaction is discussed within Section 3, Section 4, Section 5 and Section 7 of the GIA. It is considered that these interactions have been addressed in a manner that satisfied the NSW Aquifer Interference Policy (AIP).

The bores logs for the new monitoring bores will be made available in the relevant groundwater monitoring report, however, it is not considered necessary to develop a separate local scale conceptual model at this stage. If the monitoring demonstrates that the impacts exceed or are inconsistent with those predicted the current groundwater model, the local conceptual model will be reviewed and the model updated as required.

Develop a local scale analytical model and/or field techniques (sampling for radon-222, analysis of temperature and/or EC time-series) as they can provide a lot more detailed information about ground-surface water interaction than a regional flow model.

The purpose of the groundwater model is not to examine short term events, but long term changes in the groundwater regime and the nature of the groundwater interaction with surface water. As noted above, it is considered that these interactions have been addressed in a manner that satisfies the AIP.

The current analysis and modelling is sufficient for predicting impacts and determining appropriate mitigation measures. Additional analysis, such as suggested by Hunter Environment Group, will be used if there are significant variations between the model predictions and observed data.

There is no analysis of the various groundwater 'types', indicating which major ions make up the highest proportion of the TDS (e.g. with the aid of Schoeller or Piper plots).

Schoeller and Piper plots are used routinely where there is uncertainty regarding the source of groundwater. They are not required for this assessment, but will be used where needed in the interpretation of annual monitoring data.

Figure 5-7 in the GIA should not have the label on the second y-axis obscured and the Hunter River data point should be added.

Acknowledged. Both of these issues have now been addressed, refer to **Figure 4.4** below.

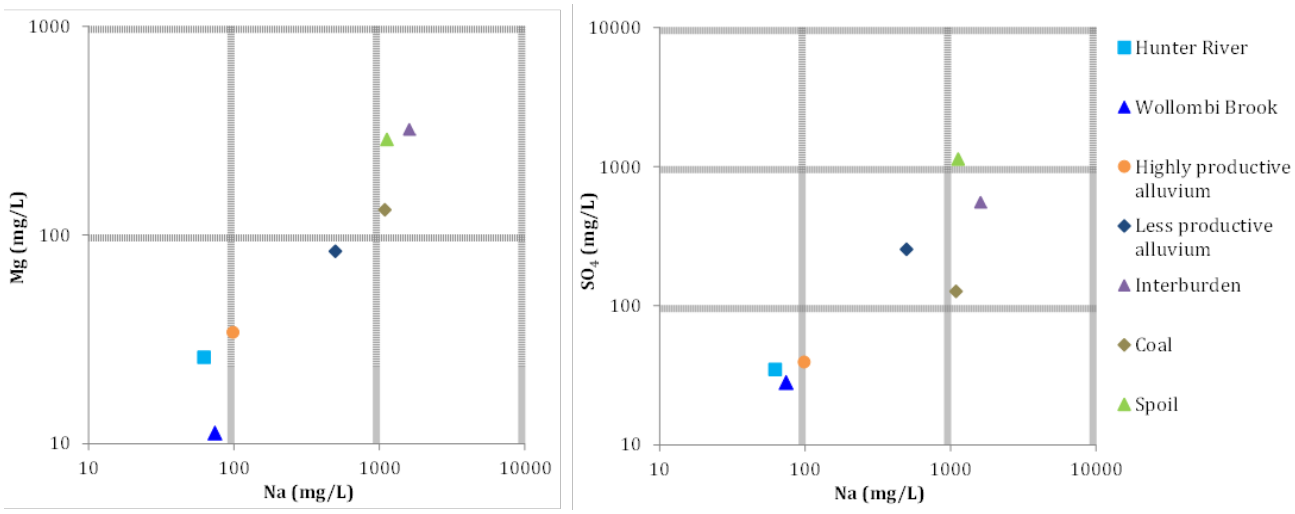


Figure 4.4 Mg/Na scatterplot and Na/SO4 scatterplot of groundwater quality

There is no discussion of the pH or redox conditions in the groundwater, which is a major omission, given that these parameters are critical indicators of issues such as acidification and mobilization of metals due to mining.

Redox is not measured as part of routine monitoring at site or at surrounding operations. As presented in Table A-2 of the GIA, groundwater bearing strata largely contains water with a neutral pH within the region, which is not expected to result in mobilisation of significant concentrations of dissolved trace elements.

Measuring redox has historically not been a standard measurement required by regulators at mine sites across the Hunter Valley. Measurement of redox conditions in groundwater is not considered to affect the overall conclusions of the assessment.

There is no analysis of the cause of elevated metals readings.

The spike in hydrochemical results did not relate to water quality data collected from the Project Area. The spike in hydrochemical results relate to historic water quality data, collected as part of routine monitoring at neighbouring mining operations. This externally sourced data (i.e. publicly available annual reviews) was used at face value, as laboratory reports were not available for comparison to exclude data entry errors. Elevated metals readings appear to be infrequent, as shown by the distribution of data (minimum, maximum, median and average) presented in the updated water quality table in **Appendix 5**.

In addition, all mines operate under mine approval conditions, which includes requirements for routine monitoring and reporting of groundwater level and quality trends. Review of publicly available routine reporting did not identify trends of elevated metals readings within the region.

There is a lack of raw water quality data from the various monitoring sites around the mine including details about the bores, number of samples and timing.

Re-presentation of all raw field data from external sources is not considered necessary.

Water quality data was obtained through a range of sources, including site data, publicly available sources (i.e. annual environmental reviews) and limited access data sharing agreements with adjacent mines.

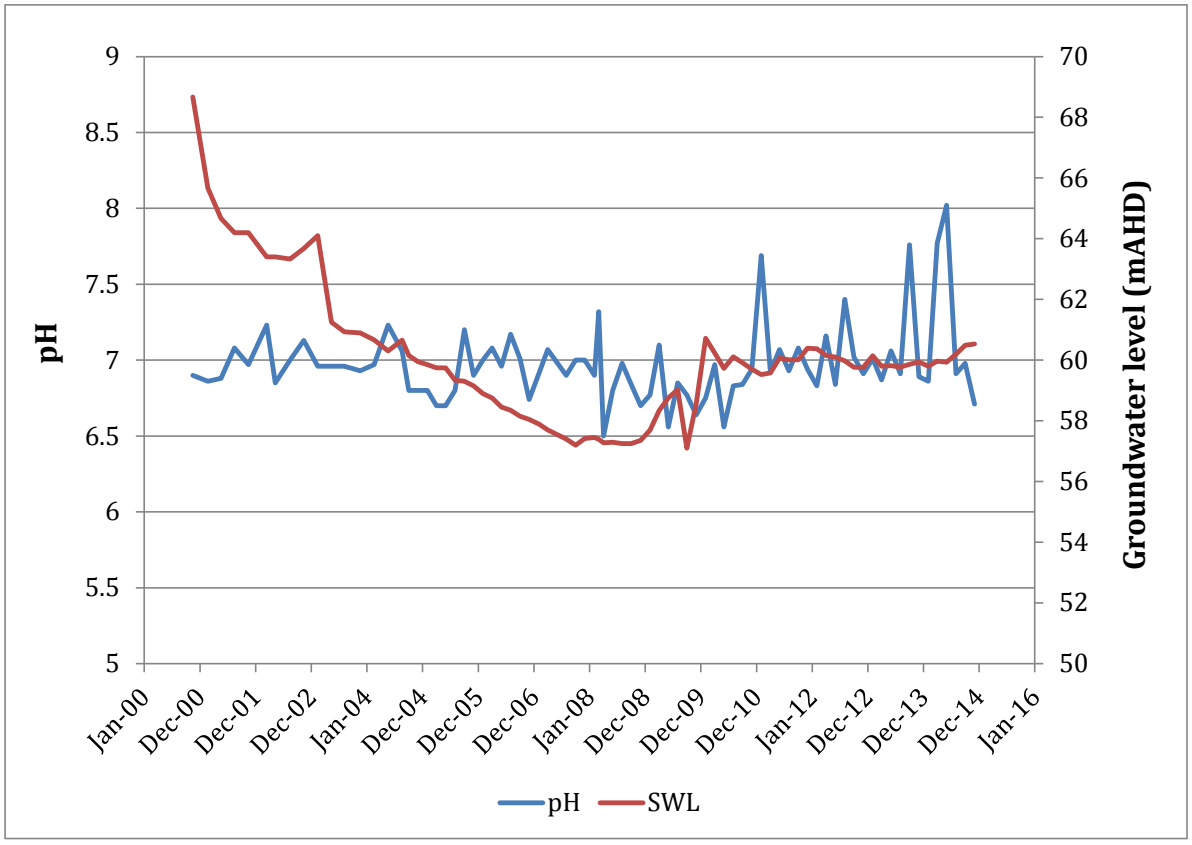
Figure 3.3 and **Figure 3.4** present the location of bores where water quality data was obtained and **Appendix 4** presents additional statistics on the water quality data, including median and sample population. **Appendix 4** indicates there are at least 30 readings for most analytes, with significant data (up to 2686 readings) for some analytes, such as EC and pH. The population of available data is considered adequate for the purposes of the GIA.

The information about TDS in Wollombi Brook (Figure 5-9 in the GIA) should discuss how TDS correlates with flow volumes.

Baseflow in Wollombi Brook and Hunter River is presented in Section 3.4 of the GIA. This section outlines the potential contribution of baseflow from the underlying strata to the streams. The change in TDS within Wollombi Brook over time is also presented within Figure 5-9 of the GIA, and correlation between TDS trends and flow/climatic characteristics are discussed in Section 5-4 of the GIA.

The relationship between water quantity changes and possible water quality changes requires further attention.

An example of this comparison is presented in **Graph 4.1**. **Graph 4.1** shows that despite a decline and rise in groundwater levels within the Permian strata at site bore P1, pH has remained neutral, with a pH range of 6.5 - 8.



Graph 4.1 Bore P1 – pH vs Water Level Trend (Permian interburden)

A Project specific WMP and groundwater monitoring program will be developed in consultation with the regulator. During development of the groundwater monitoring program, the proponent will consider the benefits of presenting and analysing changes in water level against set water quality parameters.

Why was a 4km radius used for the bore census.

A bore census is generally conducted at the early stages of a groundwater assessment, in order to help inform the process. Therefore the extent is chosen based on previous experience and is intended to cover the full extent of potential groundwater impacts. For the purpose of this study, it was anticipated that impacts would be conservatively contained within 4km of the mine area, and this has been validated by the results of the modelling completed for the Project. The extent of the bore census also enabled collection of regional groundwater data to better inform the GIA.

The extensive set of hydraulic conductivity data is better than a typical hydrogeological impact assessment, but more is required and additional details (i.e. bore logs) presented.

Field hydraulic data was available for most units represented within the groundwater model, and on the rare occasions where data was not available, a conservative estimate, based on parameters used for similar strata, was used. Additional data is not considered essential as an uncertainty analysis was used to determine the influence of parameter variability on the model predictions.

It is not clear why only a sub-set of the bores and piezometers are monitored.

Mines conduct routine groundwater monitoring and reporting in accordance with approved groundwater monitoring programs. Groundwater monitoring programs are developed in consultation with the regulator, and can change with time to reflect changes in mine operations, removal of damaged/erroneous monitoring points and installation of new monitoring points.

Proposed monitoring network looks quite good, but could benefit from additional bores northwest of the site.

The proposed monitoring network has been updated, with additional proposed monitoring points to the northwest of the site, as discussed in **Section 3.1**. DPE and DPI Water will be consulted during development of the WMP to determine the optimal sites for additional monitoring bores.

Additional discussion on baseline field data (i.e. vegetation health) is required near GDE1 near the confluence of Redbank Creek and Wollombi Brook.

GDE1 is located on land owned by a neighbouring mining company and is part of the HVO South mine complex. Data for the site was obtained through publicly available annual environmental reviews, previous approvals and a limited access data sharing agreement. As outlined the EIS and GIA, the predicted impacts on GDE1 occur due to existing approved mining operations regardless of the Project. Further discussion of the existing predicted impacts on GDE1 are discussed in **Section 3.1**.

There was no analysis of the relationship between stygofauna and dissolved oxygen concentrations in groundwater.

Measurement of dissolved oxygen (DO) is not included within monitoring requirements outlined with the EMP and WMP for United and Wambo, respectively. Consequently, historic DO data and trends were not available for analysis as part of the EIS, and given the limited impact of the Project on the alluvium, is not considered necessary.

As outlined in **Section 3.1**, results of additional stygofauna survey indicates that stygofauna exist in very low diversity within the alluvial aquifer of the Hunter River and are absent at the sites surveyed within the Wollombi Brook Alluvium. A risk assessment ranked ecological risk to sites where stygofauna were present as low value/low risk. The remaining bores which did not record stygofauna were ranked as low value/low risk (refer to **Appendix 6**).

Additional monitoring of stygofauna within the Hunter River alluvium required.

Additional stygofauna surveys have been completed in the Hunter River alluvium. The report is provided in **Appendix 6** and found that stygofauna exist in very low diversity within the alluvial aquifer of the Hunter River in the area of interest for the Project. **Appendix 6** includes an assessment of potential impacts from the Project on identified stygofauna sampling locations. As detailed in **Appendix 6**, a risk assessment ranked ecological risk to sites where stygofauna were present as low value/low risk. The remaining bores which did not record stygofauna were ranked as low value/low risk.

While covered within the GIA, quantification of impacts to surface water (e.g. baseflow to Wollombi Brook and the Hunter River) is not explicitly stated within the modelling objectives.

Predictive numerical modelling was undertaken to assess the impact of the Project on the groundwater regime, including impacts on baseflows. The objectives of the predictive modelling were to:

- assess the groundwater inflow to the mine workings as a function of mine position and timing
- simulate and predict the extent and area of influence of dewatering and the level and rate of drawdown at specific locations
- identify areas of potential risk where groundwater impact mitigation/control measures may be necessary
- quantify the potential indirect take from alluvial and surface water features (i.e. baseflow reduction).

Use of new model code (MODFLOW-USG) means there are fewer modellers capable of resolving modelling issues.

MODFLOW-USG was developed by USGS and first released in May 2013. AGE is a specialist groundwater consultancy that has invested heavily into advancements in numerical groundwater modelling. AGE have worked closely with the developers of MODFLOW-USG to ensure seamless integration of the software into the company. The transition between MODFLOW-SURFACT was further supported by AGE's unique model code, established to enable improved application and visualisation of model inputs.

The GIA was peer reviewed by Dr Noel Merrick, who is also highly skilled in the application of MODFLOW-USG.MODFLOW-USG is an up to date groundwater modelling package. The use of current technology to assess potential impacts of the Project as accurately as possible is considered an appropriate approach. MODFLOW – USG gives a better representation of the mining operations than MODLFOW –SURFACT. Given the local features and adjacent mining operations, the refinements offered by a variable grid were considered necessary for this Project.

The numerical model contains numerous layers, alternative conceptualisations should be explored with fewer layers.

It is agreed that there is an optimal complexity in groundwater models. Appropriate natural processes need to be represented whilst avoiding over-elaborate complexity where possible. In this case, representing the cumulative impacts appropriately required representation of numerous coal seams that are mined in bulk by the open cut mines, and individually by underground mines. As presented in Figure B-11 of Appendix B, field data is available for nearly all model layers. It is for these reasons the number of layers is considered appropriate for the region.

Changes in K and S with mine progression is a good approach but may be hard to validate with field data.

It is agreed that measuring hydraulic properties of spoils and overlying underground mines is technically difficult at operating mines. This however should not preclude the approximation of these processes within the numerical models. The properties in the model were changed to represent mined out areas (open air void), the void areas filled with spoil (field data available) and where underground fractures overlying strata (goaf effects). Properties can be approximated for these processes, which can have significant influence on impacts and are therefore considered important to be included.

The overall predictions in terms of pit inflows and groundwater levels will be validated during operation. If there is significant variation in the predictions the model will be recalibrated.

Alternative approaches to recharge estimation should be considered (e.g. chloride mass balance, water table fluctuation analysis).

As stated in the Numerical Modelling Report (Section B2.3.1) of Appendix B in the GIA "A spreadsheet based soil moisture deficit calculation (SMDC) was used to estimate the timing and magnitude of recharge events used in the model. The simple soil moisture balance calculates when the soil profile reaches field capacity and deep drainage occurs."

Soil moisture deficit calculation is an acceptable industry approach to recharge estimation, particularly where supported by calibration to water level fluctuations.

The practice of ongoing calibration and validation of the groundwater model will be included within the Project WMP. During development and revisions to the WMP, consideration will be made for advancements in numerical modelling and parameter estimation approaches to ensure the model maintains industry standard.

Why is the evapotranspiration rate capped at a maximum of 365mm/year.

This equates to an evapotranspiration rate of 1mm/day, the same value used for the Wambo groundwater model. Typically evapotranspiration rates have a very low impact on the uncertainty of predictive impacts, therefore consistency with existing assessments was relied upon. It should be noted that evaporation was already included in the SMDC calculation. Measured actual evapotranspiration from the Gridded Average Evapotranspiration Metadata (BOM, 2003) dataset over the modelled area is approximately 620mm/year. It is a reasonable assumption that vegetation removes approximately half of the total measured rate.

The spread of calibration targets for the model is not even, with more to the east and south of the Project, and fewer to the west and immediate north of the Project.

An even spread of calibration points is ideal, but rarely achievable due to factors such as land access restrictions due to land ownership and physical impediments (i.e. cliffs, geological variability and depth to strata). The calibration points were selected based on where monitoring points with available data were present. The model was calibrated to 301 monitoring points, which is considered an extensive dataset for model calibration.

Predicted impacts north and around the Wambo Open Cut has relatively high uncertainty due to a lack of observation data.

Models are tools to estimate large regional processes. There is extensive data available for the region that informed the model development, and where data was lacking, conservative estimates were used. This includes the properties of the alluvium. As a result, the predictions are considered a conservative estimate of potential impacts.

The exclusion of 18% of the water level observation data in calibration should be discussed in greater detail.

It is a common practise to exclude groundwater measurement points that do not replicate the resolution of groundwater model layers, or points with anomalous localised groundwater processes. The model had 32 model layers, and this allowed 82 per cent of all available data to be included within the model. Measurements that were excluded were either influenced by distal unstimulated tailings storage facility / surface water recharge, or pressure anomalies recorded by vibrating wire piezometers.

What are the 'micro groundwater processes' that are not easily replicated by the model (as discussed in the text)?

This text was referring to localised anomalies in water level records that do not fit well with regional trends. For example, a low measured water level within the interburden may be due to a fractured zone measuring 5m in thickness, which could not be represented by a numerical model layer up to 100 metres in thickness. Calibrating a 100 metres thick layer to an anomalously low water level outlier would skew the average transmissivity of the model layer.

The Zone Budget package in MODFLOW could be used to study water balance changes in particular areas.

An equivalent of the Zone Budget package in MODFLOW was used to analyse the MODFLOW USG water budgets. This included division of the Quaternary alluvium into zones that correlate with regulatory water sharing plan zones (i.e. Lower Wollombi Brook).

The modelled baseflow is a much more 'dampened' time series (less variation between minimum and maximum) compared to observed flows. It is questioned if the groundwater model is the best tool for predicting groundwater-surface water interaction.

The purpose of the groundwater model is not to examine short term events, but long term changes in the groundwater regime and the nature of the groundwater interaction with surface water. Short term baseflow may not be true baseflow, but drainage of 'bankflow' or 'interflow' that is not considered necessary to be represented within the groundwater model.

Sensitivity analysis was thorough, but could include a change in hydraulic conductivity by more than 1 order of magnitude.

The purpose of sensitivity analysis is to assess potential changes in predictions as a result of changes to parameters based on realistic bounds. Changes in hydraulic conductivity beyond one order of magnitude were considered unrealistic. For example a two order of magnitude increase in the hydraulic conductivity of the basal sands and gravels would result in a hydraulic conductivity of 1000m/day.

Assessment does not present changes in water levels within ephemeral streams (i.e. Redbank Creek and Waterfall Creek) and within underlying regolith.

Ephemeral streams have no direct connectivity with the underlying groundwater system, and are therefore unchanged by depressurisation.

Issues such as potential acidification of groundwater, contamination with metals and other trace elements are not explained.

These issues where discussed in the GIA, however, further information has been gathered and is discussed in Part B of the response to submissions in response to the IESC submission.

The impact of any short or long-term mounding of groundwater around the final landform and/or runoff events where water interacting with mine waste is able to reach surrounding receptors is given limited attention.

Groundwater mounding is unlikely within the spoil material as it has a relatively high permeability when deposited, and it is in close proximity to voids, which will drain the spoils by the evaporative pumping effect from the lakes that form within the voids.

If the fixed ET rate of 365mm/year has been used in these simulations, then salinization of water bodies following mine closure has probably been under-estimated.

A fixed ET rate of 365mm/year has not been used in the water balance modelling. As outlined in Section 5.0 of the EIS Water Balance, the model simulates inflow from catchment rainfall runoff (including direct rainfall) and groundwater recovery and outflow due to evaporation. This included a 126 year climatic data set obtained from the SILO Data Drill for the Project Area. The data set was repeated several times over to generate an extended period of data for final void simulation, including final void recovery, to ensure equilibrium water levels were reached during the simulation period.

Further detail should be provided about proposed water quality monitoring, such as which particular bores, and how 'baseline' conditions will be determined (how many samples over what time period).

Appendix 4 outlines the proposed monitoring network, along with monitoring program details, which include monitoring frequency and water quality analytes to be tested for. Further details about the groundwater monitoring program will be detailed within a groundwater monitoring program, in accordance with relevant development consent conditions.

Mitigation measures if water level or water quality impacts are detected are listed in section 10.7; however the discussion is too brief and lacks further analysis.

The discussion is considered appropriate to provide the necessary information on approach. As discussed in the GIA, a WMP and groundwater monitoring program will be developed for the Project in consultation with relevant government agencies and will provide further detail on the mitigation measures for the Project.

Discussion of how mine water is going to be managed is relatively limited within the GIA (although this is discussed under the mine water management section of the main EIS, and the surface water assessment, where the approach to 'clean', 'dirty' and 'mine' water management is outlined).

As noted in the comment, significant detail on the approach to mine water management is included throughout the EIS including in the surface water assessment regarding management of stored and surface water.

The assessment focuses on the final voids acting as groundwater sinks; however, other unexpected contingencies – such as enhanced recharge and groundwater mounding in rehabilitated areas, or major runoff events should also be considered.

Groundwater mounding is unlikely within the spoil material as it has a relatively high permeability when deposited, and it is in close proximity to voids which will drain the spoils by the evaporative pumping effect from the lakes that form within the voids. Runoff events are considered within the mine void water balance outlined within the Surface Water Assessment.

As part of the final landform design there is predicted to be long-term take of groundwater due to the final void acting as a sink. Further information is required to provide context about 'critical thresholds' (e.g. point where drawdown causes losing conditions in streams and alluvium becomes unsaturated).

Long-term groundwater take is discussed in the GIA. The WMP will consider appropriate thresholds and triggers associated with the final landform.

Give further explanation for the rapid drop in groundwater levels for GDE1

This issue is discussed in the response to DPE in relation to impacts on groundwater in **Section 3.1** of this document.

The loss of baseflow (groundwater contribution to streamflow) to Wollombi Brook and the Hunter River as a result of the project during operation are predicted to be very similar to the overall predictions of take from the alluvial aquifers (e.g. peaking at ~40ML/year and ~60ML/ year, respectively). This is due to the high level of connectivity between the alluvial aquifers and the streams. Long-term, baseflow to Wollombi Brook and the Hunter River will be reduced by ~100ML/year and 20ML/year respectively, hundreds of years after mining according to the post-mining simulation model (section 7.3.4). The ecological effects of this may be significant in low flow periods.

The ecological impacts associated with reductions in baseflow were discussed and assessed in Section 6.9.4 of the EIS.

4.7.2.4 Lock the Gate Alliance

AIP minimum impact - "A maximum of a 2m decline cumulatively at any water supply work." Coal companies are now misapplying this criteria and misrepresenting it in environmental assessments as applying only to water supply works not owned by coal companies, just as they do with residences affected by air pollution.

Section 7.1.6 of the GIA presents the maximum predicted drawdown in groundwater levels at private bores, bores on land owned by other mines and bores on Wambo and United owned land. As outlined in the GIA, there is a predicted drawdown of more than 2 metres at one privately owned bore; this bore is not currently operable. As also outlined in the GIA, during mining the Project will also result in a maximum drawdown of more than 2 metres at three mine owned bores.

There is no information on how many other water supply works on coal-company-owned land are expected to experience more than 2m drawdown.

This statement is incorrect. Section 7.1.6 of the GIA presents maximum predicted drawdown in groundwater levels at private bores, bores on land owned by other mines and bores on Wambo and United owned land.

The assessment clearly shows that cumulative draw down well in excess of 2m is predicted or already being experienced in the alluvium of the Hunter River and Wollombi Brook.

The AIP outlines the Minimal Impact Considerations for Aquifer Interference Activities (Alluvial Water Sources). As stated in Table 1 of the AIP (p.14) "A maximum of a 2m decline cumulative at a water supply work". The AIP specifies the definition of a water supply work is derived from the *Water Management Act 2000*. The *Water Management Act 2000* outlines that a water supply work can be defined as "*a work (such as a water pump or water bore) that is constructed or used for the purpose of taking water from a water source"* . In accordance with the AIP, the GIA presented water supply works that recorded a cumulative drawdown of over 2m and with drawdown due to the Project in Section 7.1.6.

An attempt has been made by the proponent to model the cumulative effect of the three adjacent mines in this area, but the broader cumulative context still needs to be provided. DPI Water commissioned a Mid Hunter Groundwater Study which gives a broad indication of the extent of draw down in the Hunter as a result of mining operations, but that information is not included in this assessment.

The United Wambo Groundwater Model is one of the most extensive groundwater models developed for the region. The model extent incorporates three large coal mines surrounding the operation that target the same seams as are mined at Wambo/United. Discussion on the extent of the model (model domain) is included within Section B2.2 of the GIA. The GIA was peer reviewed by Dr Noel Merrick in accordance with national modelling guidelines, with a focus on compliance with the AIP and requirements of the Independent Expert Scientific Committee (IESC). The external peer review by Dr Noel Merrick is included within Appendix D of the GIA, which states that the spatial extent of the model is considered appropriate. The model extents contain all the individual Project impacts and the cumulative impacts associated with the Project, and an extension of the model would not change the predicted impacts.

It should also be noted that the Mid Hunter Groundwater Study was not a groundwater assessment of cumulative groundwater impacts, but instead a review of the groundwater regime. No figures are presented in the report on cumulative drawdown effects. As stated in page 43 of the Mid Hunter Groundwater Study report "*The potential extension of impacted areas due to cumulative impacts from multiple mines in one area has not been assessed".*

The model developed as part of the GIA to assess the impacts of the Project is the best tool for assessing cumulative impacts.

The EIS document does not contain sufficient information relating to final void water quality.

We did manage to find a graph on the final page of Appendix C to Part 1 of Appendix 11 – Surface Water. This Appendix to an Appendix reveals that "Modelled salinity [in the Wambo final void] is predicted to reach hyper-saline conditions within approximately 50 years and would continue to rise in the longer term." This long term is depicted in a final graph, showing the salinity increasing for hundreds of years till it reaches levels comparable with the Dead Sea. This is information that needed to be transparently included in the body of the EIS, not tucked away in the back end of an Appendix. There is no apparent information about other contaminants in the void water.

The quality of water contained within the final void was discussed as part of the EIS Surface Water Assessment, which modelled the change in final void salinity with time. Further discussion of the final void water and salinity balance is included in **Section 3.1**.

The proponent promises that, "As a means to confirm the ongoing management and land use strategy associated with the voids, a Final Void Management Plan incorporating the outcomes of specific final void groundwater assessments will be developed and included in the Final Closure Plan. The final closure planning process will be commenced five years prior to cessation of mining" (p367). We note that in an audit of Wambo mine last year, the auditors found that Wambo had not submitted its Final Void Strategy by Year 7 of the development as required in the development consent, making that plan up to two years late. The current Wambo Mining Operations Plan (MOP) indicates that this Plan is still not finalised.

Wambo submitted a draft Final Void Management Plan to the Compliance Branch of DPE in June 2016.

On submission of the document, it was noted this management plan would require revision to reflect the Project.

4.7.2.5 National Parks Association of NSW

More than 2 metres of draw down is expected, which will seriously undermine the integrity of affected surface water catchments. As damage to aquifers is largely intractable and persistent, the project diminishes society's natural capital on an intergenerational scale.

A detailed assessment of the groundwater impacts of the Project was undertaken in accordance with the NSW AIP. The assessment findings are outlined in the EIS. As also discussed in the EIS, Wambo and United have sufficient groundwater licences to cater for the predicted water take for the Project.

The Project does not involve any direct interception of alluvium, therefore there is no direct alluvial groundwater take predicted. The predicted reduction in baseflow relates to the reduction in upward seepage from the Permian coal measures to the alluvium. As outlined within the GIA, recharge to the Quaternary alluvium occurs via 'diffuse' recharge from rainfall, 'focussed' recharge through the stream bed and upward leakage from the underlying Permian coal measures. The water quality results for the Permian coal measures indicates that groundwater within the coal is generally moderately saline and is not suitable for stock water supply according to ANZECC (2000) guidelines. Therefore, while there is a reduction in the

quantity of groundwater, this will likely improve the quality of alluvial groundwater, which in turn improves baseflow (Wollombi Brook and Hunter River) water quality.

The Project has been designed to minimise potential impacts. The purpose of assessing cumulative groundwater impacts is to understand if the predicted impacts of the Project are exacerbated when accounting for existing groundwater impacts. The cumulative groundwater assessment predicts that the Project has only a minor contribution towards cumulative impacts.

4.7.2.6 Nature Conservation of NSW

The Project will have impacts on surface water and groundwater, including cumulative impacts taking into account the impacts on water of other coal mines in the region. This Project, and the three mines surrounding it, will cause more than two metres draw down in the productive alluvial aquifers of the Hunter River and Wollombi Brook. The cumulative loss of water and productivity in these water sources, and the wholesale destruction of surface water catchments for their tributaries, are already too great.

As detailed in **Section 4.7.2.5** above, the Project does not involve any direct interception of alluvium, therefore there is no direct alluvial groundwater take predicted. The predicted reduction in baseflow relates to the reduction in upward seepage from the Permian coal measures to the alluvium.

A detailed assessment of the groundwater impacts of the Project was undertaken in accordance with the NSW AIP. The assessment findings are outlined in the EIS. As also discussed in the EIS, Wambo and United have sufficient groundwater licences to cater for the predicted water take for the Project.

Changes to surface water flow are discussed in Section 7.1.4 of the GIA. Cumulative impacts from approved mining (i.e. HVO South, MTW and approved mining at Wambo) reduce the net baseflow to Wollombi Brook from 1,450ML/year to 1,000ML/year. The Project accounts for between 1ML/year and 37ML/year (Year 8) of the cumulative impacts on baseflow. This is a small proportion of the total baseflow, at approximately 3 per cent when compared to the modelled approved surface water flux.

Currently approved and foreseeable operations at Wambo and United are predicted to reduce the net baseflow to the Hunter River by up to 46ML/year. The Project accounts for up to 58ML/year (Year 11) of the cumulative impacts on the Hunter River baseflow. This is a small proportion of the total baseflow, at approximately 2 per cent contribution. This was calculated using the peak take in Year 11 of 58ML/year, divided by the net flux in Year 11 for the approved operations of 3226ML/year.

No significant impact on hydrology or water quality has been identified due to the Project with the exception of one private bore with a predicted drawdown of over 2 metres. This bore is not currently serviceable and is on a property within the noise affectation zone for the Project and is therefore expected to be subject to a voluntary acquisition condition in any consent granted for the Project.

4.8 Aboriginal archaeology and Cultural Heritage

Issues relating to Aboriginal archaeology and cultural heritage were raised in 4 community submissions and in one interest group submissions.

4.8.1 Community

Impacts on Aboriginal sites:

'The project will impact 128 Aboriginal heritage sites.'

'I object to any extension of coal mining activity at Wambo, due to the impact on over 120 irreplaceable aboriginal heritage sites.'

An Aboriginal Cultural Heritage Assessment (ACHA) has been prepared for the Project by Australian Cultural Heritage Management (ACHM) in collaboration with the Registered Aboriginal Parties (RAPs) and Knowledge Holder groups to assess the Aboriginal cultural heritage values of the Project Area and surrounds. An Aboriginal Archaeological Values Assessment was also prepared by OzArk Environmental and Heritage Management (OzArk) to assess the scientific (archaeological) value of sites and artefacts identified within the Project Area and this report is included as Appendix 15 of the EIS.

Throughout all stages of the assessment process, the RAPs including knowledge holder groups with traditional links to the area were invited to identify how they would like to participate in the Project's Aboriginal cultural heritage assessment process, including what cultural information they wanted to share to inform the assessment process, and what information (if any) should remain non-disclosed in the assessment and reporting process.

The three Knowledge Holder groups, the PCWP, Wonnarua Nation Aboriginal Corporation (WNAC) and the WTC were invited to undertake their own Aboriginal cultural heritage values assessment reports for the Project which incorporate the cultural, historic, social, spiritual and aesthetic values of their members and Elders. The RAPs not being consulted through the PCWP, WNAC and the WTC are referred to as the Community RAPs, and were consulted by ACHM and United to develop management recommendations and measures relevant to their cultural significance values statements and assessment concerns.

The ACHA process has involved consultation with all 83 RAPs from the four groups. The consultation process has also facilitated the three knowledge holder groups being able to consult with a large number of Aboriginal people who were not RAPs for the Project but are traditional knowledge holders of the Hunter Valley area, and therefore constitute important stakeholders. These people were Wonnarua Elders with knowledge and important contributions to the process.

The ACHA found that numerous Aboriginal stakeholders who participated in the cultural values assessment process hold values which relate to the wider Hunter Valley region generally and less directly to the Project Area specifically as well as Knowledge Holders such as the current registered Native Title Claimants who have traditional cultural links to the area.

In total, the archaeological assessment considered 128 sites. All of these sites are stone artefact sites as no other site type was recorded during the survey or remains extant from previous recordings. All newly recorded Aboriginal archaeological sites were assessed for their archaeological (scientific) significance. As a result of the survey and test excavation results, the majority of sites (122 sites) have been assessed as having low scientific significance. The remaining six sites have been assessed to have a low-moderate scientific significance.

The Project would directly impact 127 archaeological sites if approved, consisting of 80 artefact scatters and 45 isolated finds and two Potential Archaeological Deposits (PADs). One site (Wambo 202; #37-5-0343) will be partially harmed by the Project.

The Project would also result in indirect impacts on Aboriginal cultural heritage values and add to the cumulative loss of cultural heritage in the Hunter Valley.

The predicted direct and indirect impact on the Aboriginal cultural heritage values of the additional disturbance area add to the cumulative impact of mining development on the cultural heritage resource of the Upper Hunter Valley, and this has been considered in the development of detailed management measures, in collaboration with the RAPs.

The OEH submission states:

> Based on this review OEH is satisfied that the management measures proposed are adequate and appropriate given the nature of the archaeological record and the range of activities to be undertaken within the operations footprint of the mine. OEH has no additional concerns with respect to Aboriginal cultural heritage management.

4.8.2 Interest Groups

4.8.2.1 Bulga Culture Centre

The Bulga Culture Centre Ancestral Heritage is declaring the Bulga Community "Claims and Ramifications" on Wambo – United Mines Lands and Heritage Artefacts being a portion of "Cockfighters Valley Precinct".

We understand that Cockfighter's Creek comprises the lower part of Wollombi Brook, where it meets the Hunter River, to the east of the Project Area (Dunne 2012 *From Brook to Broke: A history of Broke Fordwich*). To the best of our knowledge there is no statutory or non-statutory heritage listing for the Cockfighters Valley Precinct.

4.9 Visual Amenity

Issues relating to visual amenity were raised in 7 community submissions and in two interest group submissions.

4.9.1 Community

Visual amenity:

'The open cut mine will spoil the visual amenity of the areas.'

'Coal mining generally causes visual amenity issues.'

Visual amenity was raised as key issue of concern to local community stakeholders, with key aspects raised including decreased amenity and impact on rural outlook.

Views of existing Wambo operations and associated infrastructure are currently available from surrounding areas, including residential areas, and from public viewing locations including the Golden Highway. The majority of views of Wambo are of the overburden emplacement areas. Views of active mining extraction areas have largely been shielded from public view by topography and vegetation surrounding the mine until recent mining by Wambo adjacent to the Golden Highway. As discussed in the EIS, as mining in the

approved Wambo Open Cut progresses north, there would be increased visibility of the Wambo operations to the north, including views of active mining extraction areas and overburden emplacement areas from both residences to the north (e.g. Moses Crossing area) and users of the Golden Highway. Mining in the Wambo Open Cut has recently commenced in the north of the approved mining area and increased views of the Wambo mining operations are currently available from these areas.

Some distant views of Wambo emplacement areas and mine infrastructure are possible from locations within Maison Dieu and a small number of residences to the north west of Bulga. The existing approved 24 hour mining operations at Wambo currently contribute to a night time glow, which, along with other mining operations, affects the local night time visual amenity (refer to further discussions below).

Restricted views of United are currently available from the Golden Highway, including views of mining infrastructure and some established rehabilitation areas.

The HVO South operations, located north and east of the Project Area are highly visible from the Golden Highway, from some residences including residences in Maison Dieu and some residences along the Golden Highway northwest of the Project Area. Active mining areas associated with the HVO South operations are located adjacent to the Golden Highway and are currently visible from sections of the Highway. There is bunding in place and vegetation screening located along parts of the Golden Highway; however, views of active mining areas remain available. Prominent views of overburden emplacement areas are also available from the Golden Highway.

The rural residential area of Maison Dieu also has views of overburden emplacement areas associated with the MTW Mine.

Many of the residences surrounding the Project Area and other surrounding public viewing locations currently have extensive views of open cut mining and associated activities.

As discussed in the EIS, the key aspects of the Project that have the potential to result in visual impacts include:

- clearing and overburden removal, which may be associated with views of mobile plant and equipment, exposed surfaces, dust, blasting operations and night lighting
- active mining operations, which may be associated with views of mobile plant and equipment, exposed surfaces, dust, blasting operations and night lighting
- emplacement of overburden, which may be associated with views of mobile plant and equipment, exposed surfaces, dust and night lighting
- rehabilitation, which may be associated with views of mobile plant and equipment and regenerating vegetation.

Photomontages were included in the EIS to provide an indication of the range of visual impacts that will occur as a result of the Project. To provide further information, more stylised photomontages for each of the modelled mining stages have been prepared that show the visible Project features in contrasting colours so that they stand out and are more readily distinguishable. While these stylised photomontages greatly overembellish the visual impacts of the Project, they assist in providing an understanding of the components of the Project that are likely to be visible. These stylised photomontages are provided in **Appendix 11**.

As outlined in the EIS, United held a workshop with community members to discuss the conceptual final landform and revegetation strategy for the Project, and has committed to creating a more natural looking

and functioning final landform which will reduce long term visual impacts. The revegetation strategy will also be a combination of woodland, grassland with pockets of woodland and pastoral grassland to provide visual contrast and to blend into the surrounding landscape. Rehabilitation will also be undertaken progressively throughout the life of the mine to minimise visual impacts as much as practicable.

To seek to further mitigate the visual impacts of the Project United has committed to a range of visual impact mitigation measures. These measures are outlined in Section 8.0 of the EIS.

Lighting:

'Light pollution causes a disruption of circadian rhythms resulting in sleep/wake disturbance, body temperature disturbance, hormone dysregulation and effects patterns of gene expression possibly increasing the risk of cancers such as breast cancer.'

'I live near three open cut mines and find the lights to be unacceptable for a rural area without adding another open cut operation into the area.'

As discussed in Section 6.12.5 of the EIS, the existing approved 24 hour mining operations at Wambo currently contribute to a night time glow, which along with other mining operations affects the local night time visual amenity. As part of the Project, mobile lighting will be required in active mining and emplacement areas during night time operations, which will be provided by mobile lighting plants and equipment headlights. Where possible, mobile lighting plant will be screened from residences and public viewing locations by overburden emplacement areas, vegetation or natural topography. Ongoing management will, however, be required on all emplacement areas that are visible from public roads or private residences so that mobile lighting does not impact on road users or local amenity. This is typically managed by pointing lights away from public roads and residences and through directing lights down at operational areas. This will be particularly important for the Golden Highway which will have views of each of the emplacement areas at various stages of the Project.

Lighting is required on site to meet operational and safety requirements however United has committed to keep lighting to a minimum where practicable and to install and maintain lighting in accordance with the relevant Australian Standard (*Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting*).

The height of the spoil heaps will increase again, beyond the approval of the Wambo's current consent, and generate visual impacts.

As discussed in Section 3.5.3 of the EIS, the approved conceptual final landform at Wambo consisted of a single, broad ridgeline with a southeast to northwest alignment reaching approximately 160 mAHD flanked on the western side by two final voids. Under the Project, the Wambo final landform will be modified to provide an integrated landform which will result in changes to the previously approved final landform heights with the area to be developed progressively to a typical height of approximately 190 mAHD, with some more elevated emplacement being included at the southern end of the emplacement area so that stockpiled material can be later used to cap the Homestead and Main Homestead tailings storage facilities. This elevated height of overburden emplacement at the existing Wambo Open Cut will increase its visibility from some areas.

The United Open Cut emplacement area will progressively backfill the void behind the active mining area and be developed to a typical height of approximately 160 mAHD. Emplacement activities will be managed to create a variable vertical profile and shape that provides a more natural looking and functioning final landform.

As discussed in Section 3.4.4 of the EIS, a key determining factor in the selection of the final Project mine plan was providing an improved integrated final landform outcome across the United and Wambo mining areas.

Some of the final landform options considered resulted in a higher emplacement area at United with little assimilation of this landform with the approved final landform at Wambo. This resulted in a lack of landform integration across the United and Wambo mining areas and a subsequent landform that was unnatural looking and did not blend in well with the surrounding landscape. The provision of an integrated, more natural looking final landform across the United and Wambo mining areas is one of the key benefits of the Project.

Residence 25: Visual impacts have increased since Wambo recommenced open cut operations under DA 108/91. The spoil heaps are an eyesore from all aspects. This will increase with the new mine.

The existing mining operations at Wambo are approved and will not change as a result of the Project. As noted in the above response, the height of emplacement activities at Wambo will increase with the Project.

A detailed visual assessment was undertaken for the Project, as presented in Section 6.12 of the EIS. Residence 25 was an assessment point (visual assessment point 8), representing views from private residences located to the northwest of Bulga. The visual assessment used Year 2 of the Project as the worst case when active emplacement is occurring closest to the residence and progressive rehabilitation is in its earliest stages. The emplacement area will increase in height in later years; however this increase in height will be aligned with progressive rehabilitation of the lower slopes. As discussed above, further stylised photomontages have been completed for the Project and are provided in **Appendix 11**. These show visible Project features at each key stage of the Project.

Views of the active mining extraction areas, including the United Open Cut will not be visible at any time from Residence 25.

The EIS identified that views from this residence would be impacted and therefore United has committed to consult with this landholder regarding the potential for additional tree screening/landscaping/mitigation works to minimise visibility of the Project.

Residence 25: Intrusive light impacts have increased since Wambo recommenced open cut operations under DA 108/91. Light impacts on our home regularly and is also evident when driving home at night along Wambo Road and our ROW. This will increase with the new mine.

Impact associated with lighting and their management are discussed above.

Residence 47: The currently approved Wambo consent saw the open cut mining in close proximity to our residence for a relatively short time and invisible from our residence. By contrast, the proposed development will be in direct line of sight for 23 years.

Residence 47 is located approximately 4.5 kilometres northwest of the Project Area along the Golden Highway. Based on site visits, views of the Project are not expected to be available from the residence. Views of the Project may be possible from agricultural land on the property.

The visual impacts associated with the Project from this location will be generally consistent with those currently approved by the Wambo Open Cut, noting as mentioned above that these views will occur for a longer duration. No views of the United Open Cut are predicted from this location due to the intervening ridgeline.

Residence 163: The mine is significantly impacting on our property by virtue of visual impact.

Residence 163 is located approximately 2.5 kilometres west of the Project Area along Redmanvale Road. As outlined in the visual assessment for the Project, an initial desktop screening exercise identified that residences along Redmanvale Road will not have views of the Project Area due to topographical shielding. This was confirmed during site inspections and by a series of radial analyses completed for residence locations in this area.

Residence 44: We would very much appreciate if you could consider our further submission objecting to the proposed United Wambo Open Cut Coal Mine (Application No SSD 7142) south of Jerrys Plains. We are taking this step due to the new mining activity Wambo has commenced in the past few weeks which is clearly visible from our living room at Lot 11 DP 658775

As outlined in our original submission we have been suffering adverse impacts from mining operations at HVO and Wambo for a number of years. Attached please see one photo of the HVO operation visible from our property. However it is the impact of the new Wambo activity over the past 10 days that has caused us great distress. We have complained to Wambo but have yet to hear back from them. They have also yet to address lighting issues at night which we have raised.

The operations shown in the photos are adjacent to the application which you are currently considering. From our view point this operation and others, should form a critical part of the assessment process for the new development. Wambo have already advised us that we have no recourse under their existing approvals - we implore you to ensure that this will not be the case with their new application. We believe you have the capacity to offer us some protection by ensuring that prior to approval the proponents are required to address our genuine grievances. We have participated in the "Community Consultation" process but as you can see by the photos once approval is in place, promises and reassurances mean nothing.

Since the submission of the EIS, Wambo has commenced operations in the north of the approved Wambo Open Cut. This area is the closest approved mining operations to Residence 44 associated with Wambo. The Wambo Open Cut is an approved operation and may continue regardless of the Project. These activities would form part of the Project, if it were to be approved.

Additional visual montages have been completed (refer to **Appendix 11**). The visual montages demonstrate that the Project will be visible from Residence 44 (View Point 4) throughout the life of the mine. The visual montages presented in **Appendix 11** are based on the mine staging in the EIS.

As described in **Section 3.1**, mining operations are dynamic and mining schedules change in response to a broad range of factors. The sequence of extraction within the approved Wambo Open Cut limits has changed compared to the sequencing presented in the EIS based on an approved variation to the Wambo Mining Operations Plan.

Wambo will continue to consult with this landholder about measures to mitigate the impacts of the approved operations on this property.

The EIS identified that views from this residence would be impacted and therefore United has committed to consult with this landholder regarding the potential for additional tree screening/landscaping/mitigation works to minimise visibility of the Project.

4.9.2 Interest Groups

4.9.2.1 Hunter Valley Glider Club

The visual amenity at the HVGC property is impacted by current and past mining activity to the north and north-west, and it is expected that the mining activity and the final landform of the United Wambo Project will further degrade the visual amenity from the HVGC property. The reduced visual amenity caused by the development will be considered offensive to some HVGC.

The Hunter Valley Gliding Club property is located in an area that is dominated by mining activity and is adjacent to an existing open cut operation (HVO). While the United Open Cut will intensify the mining in the area, it will not change the overall visual character of the area and will not be inconsistent with the current views of active open cut mining operations. It is also acknowledged that the Project will be highly visible from the Hunter Valley Gliding Club property and therefore United has commenced discussions with the Hunter Valley Gliding Club regarding the measures that could be put in place to minimise visual impacts from the facility. It is proposed that the agreed measures will be outlined in an agreement to be implemented by United to seek to mitigate amenity impacts on the club.

It is also noted that a key benefit of the Project is that it will provide for an improved final landform across the Wambo and United complex, with the proposed mining operation placing overburden to result in an integrated and more natural final landform. The final landform achieved for the Project will be a substantial improvement on the final landform that would have resulted from two adjoining, but not integrated mines, such as would likely have occurred without the Joint Venture. The approach to developing the final landform for the Project was subject to community consultation including a workshop, and the local community's views have been incorporated into the design.

It is considered that the final landform will not degrade the visual amenity from the Hunter Valley Gliding Club property and therefore the focus will be the management of visual impacts during the mining process. The Project proposes to undertake progressive rehabilitation of disturbed areas with a particular focus on overburden emplacement areas, to reduce the duration of visible soil exposure, including the use of temporary rehabilitation as appropriate. These measures will also assist to minimise visual impacts.

4.9.2.2 Lock the Gate Alliance

The conceptual final landform is difficult to ascertain and needs to be represented as a 3D model with dump heights and angles and void depths and angles articulated to give the reader a true indication of the final land form. The maps provided lack the detail and accessibility that would provide the reader with a clear picture of what the constructed legacy will look like and how such features as pre-existing creeks and water courses will be restored or impacted.

As discussed in **Sections 1.2** and **3.1**, the conceptual design of the final voids has been subject to further work by United and has been revised since the submission of the EIS. This further work including the areas and cross-sections of the voids is provided in **Section 3.1**.

The proposed process for the implementation of the conceptual final landform will utilise a natural landform design incorporating micro-relief principles. The process will be undertaken as part of the detailed mine planning process completed through MOPs for the operation. The key objectives of such an approach will include:

- the drainage density of the final landform is to reflect the nature of the drainage patterns in surrounding landforms
- steeper slopes are to be located higher in the catchment (that is, where water flows are smallest), with slope gradients flattening out downstream
- drainage lines will have both channel and floodplain components to provide stability during frequent flood events
- gentle flow transitions which emulate natural transitions and maintain a balance between scour risk and sediment load.

The micro-relief design process also results in a more natural looking landform, which reduces the visual impact of the final landform. Similar management commitments were made and are now successfully being implemented at Glencore's Mangoola Mine. The detailed design of the natural landform implemented at Mangoola has been developed progressively as part of the detailed mine planning process and is included in the staged rehabilitation plans in the MOP. The progressive development of micro-relief in the landform as part of the progressive detailed mine planning process is necessary to ensure that overburden material is efficiently handled and the drainage system of the rehabilitated final landform works effectively as part of the mine water management system.

United's approach to the development of detailed final landform design will be similar to that currently applied at Mangoola and will have the benefit of assimilating learnings from Mangoola and Glencore's other operations where similar approaches are also being applied such as Mount Owen.

4.10 Mine Closure and Rehabilitation

Issues relating to mine closure and rehabilitation were raised in 12 community submissions and in five interest group submissions. A further 25 community submissions and five interest group submissions were raised in relation to voids.

A detailed discussion of the issues raised relating to final voids is provided in **Section 3.1.6.1.** This section should be read in conjunction with **Section 3.1.6.1**.

4.10.1 Community

Concerns in relation to two final voids:

'It's going to leave behind two final voids, which are an unacceptable impact of mining that damage waterways for hundreds of years into the future.'

'It's going to leave behind two final voids, which are an unacceptable impact of mining, and are not wanted by the NSW community.'

'The two remaining voids will generate environmental issues for future generations.'

'Two large final voids will be left in the landscape.'

'Leaving mining voids are an irresponsible high risk legacy for future generations. These scars on the landscape continue to be a threat to surface and groundwater quality for 100s of years.'

'The current application will finish with two large voids and this is unacceptable. The Hunter Valley must not accept even more voids which are blight on the landscape. Any void created by mining must be backfilled and rehabilitated.'

'The Hunter cannot manage the extra two final voids it will create.'

The issues raised in relation to the numbers of voids and the constraints and opportunities they provide to future land uses are discussed in detail in the responses to issues raised by DPE (refer to **Section 3.1.6.1**) and DRE (refer to **Section 3.3**).

The indicative final voids, final landform and land use were presented to DRE and Singleton Council and were the subject of a community workshop as part of the EIS process. The feedback from these stakeholder engagement processes influenced the final landform considerations and the closure commitments discussed in Section 6.13 of the EIS. This included feedback on aspects such as:

- the balance between biodiversity offset requirements, woodland areas and land for agricultural purposes as part of the final land use and revegetation plan
- the desire to minimise the number and size of the final voids, where practicable
- the desire for the incorporation of natural landform design principles into the design of the final landform for the Project.

As discussed in **Section 3.1.6.1** based on the submissions received United has undertaken further work on the conceptual design of the final voids, resulting in a revised design. The details of the revised void designs are provided in **Section 3.1.6.1**.

Justification of final voids:

'There is no cost analysis for the management of final voids.'

'There is no risk analysis of final voids.'

A final void options analysis was undertaken as part of the EIS process and options were assessed as part of an agency and community workshop. The chosen final void strategy does not increase the total number of voids from that which was previously approved under the Wambo mine consent, however, it is

acknowledged that the size of the voids have increased due to the addition of the United Open Cut. Further discussion relating to final voids is provided in **Section 3.1.6.1**.

Size of final voids:

'The EIS notes as positive that the project will not result in an overall increase in the number of voids on the mine site. As the impact of voids is determined by their size, shape and hydrological impacts rather than simple abundance, there is nothing in the EIS to indicate that this is indeed a positive outcome. Given the scale of the planned United void relative to the existing void on the Wambo site to be back filled, it is likely that, in fact, the Project will result in voids with a more significant impact than if it were to not proceed.'

'The EIS inadequately presents even basic information regarding the physical dimensions of the final voids. The dimensions are not presented in the EIS, as they should be. It is barely possible to discern with any certainty the exact nature of the planned voids.'

As discussed in **Section 3.1.6.1**, in response to the submissions regarding final voids United has undertaken further work on the design of the final voids to minimise their impact and to ensure they will be safe, stable, non-polluting and sustainable.

Delay of existing rehabilitation commitments:

'The project will delay rehabilitation at both the United and Wambo mine sites.'

'This project has been developed at the expense of the owners of the United mine fulfilling obligations to close and remediate a mine that has not operated for six years and which was supposed to cease mining altogether four years ago.'

'Our objection to the proposed Project is based on the impact (and exacerbated impacts) that the proposed Project will have on post mining rehabilitation.'

'Manmade mountains are an eyesore even if the rehabilitation is done; it is not done to a satisfactory standard. The United Mine has failed to complete their rehabilitation commitments. United has been in "care and Maintenance" since 2010 and was due to cease mining in 2012. Instead of cleaning up and closing, United has not continued with its rehabilitation commitments, in anticipation of this project reopening the site.'

In regard to the closure of the United mine, substantive closure works have been undertaken including the closure and sealing of the underground mine and removal of some of the surface infrastructure. Significant rehabilitation works have been completed and as outlined in the EIS some of the rehabilitated vegetation areas now meet the listing criteria as an endangered ecological community (EEC) and a small area as a critically endangered ecological community (CEEC). Closure works at the site continue to progress.

As discussed above, the Project provides an opportunity to extract approximately 176 Mt of ROM coal, including an additional approximately 150 Mt, from within an area that has a long established history of mining. As per Section 6.13 of the EIS, United has committed to the timely and progressive rehabilitation of the site. With the Project, mining will continue at the site for another 23 years allowing for the recovery of the additional 150Mt of ROM coal. Due to the continued mining at the site, rehabilitation of some areas will be undertaken later than they would otherwise have been should open cut mining at Wambo cease in 2020. The Project will, however, result in an improved final landform outcome.

United's rehabilitation commitments will lead to a final landform and rehabilitation outcomes of better quality than that required under current approval requirements. This includes the establishment of an area of ecological rehabilitation that will meet the necessary criteria for classification as a CEEC.

Rehabilitation legacy:

'The void remaining after mining will be too large for the Company to rehabilitate economically and will be either left, or mine placed in caretaker mode or the taxpayers foot the bill.'

'The environmental damage will be horrific and who will clean up the mess when the coal mining industry is bankrupt.'

'Undoubtedly The Hunter mining industry has a sorry history of inadequate rehabilitation, a flight across this area shows a moonscape, something that bureaucrats who do not live in the area are content to inflict on those who do. Rehabilitation bonds have been shown to be woefully inadequate and the numbers of mines in "Care and Maintenance" to avoid rehabilitation obligation bears witness to this fact.'

'In Australia "final voids" are big open mining pits hundreds of metres deep and kilometres long that fills with water, act as a magnetic draw for water and sterilise the land from productive use. The pits become vast, ugly, saline lakes, and pose serious risks to local groundwater with the massive high walls compromise public safety. This proposed mine expansion has TWO such final voids. New research from Lock the Gate Alliance shows there are already at least 45 voids planned or approved in NSW, comprising 6,050 hectares that will remain unfilled in NSW once the coal mining boom ends, which combined form an area greater than Sydney Harbour. At the very least I call on the NSW govt - IF approving this new superpit in the Hunter with the coal destined for export- to take rehabilitation bond from Peabody that will cover the remediation of these two pits.'

Discussions about the justification for retaining the final voids and the size and design of the final voids are provided in **Section 3.1.6.1**.

The current legislative and policy regime in place in NSW avoids the risk of mine closure and rehabilitation not being completed and the costs imposed on the taxpayer. In accordance with mining lease obligations, United and Wambo are required to complete Rehabilitation Cost Estimates and submit these cost estimates to the DRE for approval on a regular basis. The Rehabilitation Cost Estimates are developed in accordance with DRE guidelines and utilise a cost estimation tool developed and approved by the DRE. Security is independently assessed by DRE following its review of the rehabilitation cost estimate. Mining operations cannot be undertaken in NSW unless appropriate security is held by DRE. Security is typically either held as cash or as a bank guarantee. As also discussed above, strong rehabilitation commitments have been made through the EIS and the Rehabilitation Cost estimate for the project will be based on these commitments. The ability for the State of NSW to access the security in the event of a default by a lease holder ensure that tax payers or the community do not bear the costs of any remediation.

Final voids are a major issue throughout the Hunter Valley. Attempts to minimise the issue with talk of future lakes and water-parks are flights of fanciful and unscientific fancy. Using examples drawn from Europe or USA is disingenuous in the extreme. Those countries do not permit voids of the size found in Australia and most importantly their climatic conditions of lower temperatures and high rainfall permit equilibration within reasonable time limiting the toxicity of the final sump, this is not possible in Australia's climate. This major problem must not be left for future generations to bear.

Future potential uses of voids and final land use are discussed in **Section 3.1.6.1**.

The Department has not provided adequate information for the public to determine whether final void criteria have been met.

Discussion relating to final voids is provided in **Section 3.1.6.1**.

Mine rehabilitation does not maintain connectivity in the short term nor provide the function in the medium or long term even. Re-establishment of the complexity of an ecosystem is still a nascent practice.

Rehabilitation of the mining operation will be undertaken progressively throughout the operational phase of the mine. As shown in Figures 3.11 to 3.15 of the EIS, the progressive rehabilitation will initially link up existing areas of rehabilitation and establish broader regional linkages. These broader regional linkages are shown in **Figure 3.5.** The indicative final land use plan for the Project has been designed to provide and enhance native vegetation corridors linking surrounding remnant vegetation areas, including future vegetation areas planned on rehabilitated mining land to the north and east. Key linkages will include:

- from the Wollemi National Park through the Project Area to the proposed native rehabilitation areas of HVO South mine to the north
- to the south of the Project Area, through to the proposed native rehabilitation area of the Warkworth mine
- to the southeast of the Project Area.

The EIS provides inadequate information to properly assess the impact and legacy of the Project's final voids. In this regard it is currently unfit for purpose. To properly describe the potential impacts that may result from the proposed voids, detailed water quality predictions would be required as well as a full impact assessment of the proposed high walls. In addition, feasibility studies and planning for future beneficial uses for the final voids would need to be conducted now to enable their outcomes to shape mine planning.

Discussion relating to final voids is provided in **Section 3.1.6.1**.

The proposed United Void will contain very significant high walls. Too little information is presented within the EIS to assess whether these will be stable over long durations. However, given the depth of the pits, they present a very substantial safety risk, because land slips can endanger nearby people, animals and structures. Unless high walls are removed from the final landform they place a perpetual burden upon future landowners should the mine site be sold or relinquished.

Discussion of the justification for retaining highwalls and the safety of highwalls is provided in the response to DRE provided in **Section 3.3**.

United has committed to mine closure criteria that includes the establishment of a safe, stable and non-polluting landform (refer to Table 6.42 in the EIS)**.** Specific works required to meet this closure criteria will be identified during the detailed mine closure process and be reflected in detailed requirements specified

in the MOP/RMP. Based on current regulatory requirements, security held by DRE will be updated to reflect the anticipated costs of any such works.

The EIS notes that a workshop with members of the local community was conducted to specifically address final landform and rehabilitation. This workshop identified utilisation of the water body in the final voids for aquaculture as a key issue that should be considered as part of the detailed mine closure planning. Such a use is completely at odds with the currently proposed final landform and predicted pit-lake water quality. To enable such a use would, at a minimum, require detailed assessments regarding water availability and quality. Potentially significant modifications to the final landform and water management plans would also be necessary. Therefore, these studies should be conducted as part of the EIS, and obviously should be conducted prior to commencement of the mine.

As discussed above, United completed a detailed final void options analysis as part of the EIS process and developed a mine plan that best suited the needs of the project and community, while also making the Project economically viable. The final voids identified in the EIS do not preclude aquaculture as a potential land use however, as noted in the submission, detailed assessments of the potential water quality constraints to different aquaculture options will need to be undertaken as part of the detailed mine closure process should aquaculture be identified as a preferred final land use option.

Further discussion relating to final voids is provided in **Section 3.1.6.1**.

4.10.2 Interest Groups

4.10.2.1 Environmental Justice Australia

'If the Project was to proceed and Wambo Coal found money for capital expenditure, increased mine-site disturbance would result. Additional financial assurance would be required for rehabilitation and Wambo Coal would likely contribute 50% of what is required. Wambo Coal's financial statements acknowledge significant concern about the ability to provide increased financial assurance. If the Wambo Coal and United Collieries cannot pay to rehabilitate the site, and if financial assurance is insufficient, the taxpayer could ultimately be left to finance rehabilitation. Or the site does not get rehabilitated at all.'

'Expansion is recognised as a way that coal companies can avoid closing and rehabilitation costs crystallising on balance sheets. The Project effectively expands the United and Wambo operations and therefore delays rehabilitation obligations and expenses. Effectively the Project buys time to sell assets to inexperienced and potentially more financially constrained operators who may not have the capacity to comply with mining leases.'

As discussed above, Rehabilitation Cost Estimates are submitted to the DRE for approval and security is held by the DRE to provide for financial assurance that areas disturbed by mining operations will be rehabilitated. This requirement applies irrespective of the operator.

Rehabilitation obligations are regulated through the MOP/RMP process.

The Project is not being proposed to 'avoid closing and rehabilitation costs' as suggested in the submission. The Project has undergone detailed technical and economic assessment and has been demonstrated to be of net benefit to the community. The Project will also result in an economic return for the Joint Venture. It is on this basis that the Project is proposed.

4.10.2.2 Hunter Communities Network

The requirement of the current Wambo Mine approval to develop a Final Void Strategy by Year 7 has not been met. There is no confidence that the regulatory system will cause any compliance with conditions relating to predictions or management of impacts of the proposed final voids for this super-pit project.

Wambo submitted a draft Final Void Management Plan to the Compliance Branch of DPE in June 2016. On submission of the document, it was noted this management plan would require revision to reflect the Project.

Compliance with conditions of approval is a legal requirement. United will operate the Project in accordance with any conditions imposed on the development application.

The EA for this proposal has a paucity of readily available information in regard to the size and long-term impact of two large final voids. The Wambo void is reported to be backfilled to 40 mAHD and the United void will remain at a depth of -155 mAHD. These figures should have been provided in more readily understandable format stating depth in metres. HCN considers that two permanent holes, one approximately 240m in depth over 260 ha, is an unacceptable legacy in the landscape that should not be approved.

Refer to answers above in the response to issues raised by DPE (**Section 3.1**), DRE (**Section 3.3**) and community submissions (**Section 4.10.1**).

The EA reports that final landform and land use have been identified by the community as key concerns. Public safety in relation to highwalls and final voids is a major issue for the Hunter community. The concept that a highly polluted water body could be used for future development of an aquaculture industry is fanciful and has not been assessed for feasibility.

Refer to previous responses regarding final void management and potential final void options (refer to **Sections 3.1** and **3.3**).

4.10.2.3 Hunter Valley Gliding Club

The United Wambo project will be mining much of the area to the south-west and west of the HVGC, so these areas will remain unsuitable as emergency landing areas during the mining phase, however we consider that post-mining, the area has strong potential for rehabilitation into one or more designated emergency landing areas with relatively smooth surfaces which are clear of obstacles. It is therefore requested that the project team consults with the HVGC and relevant experts and allocates and designs suitable emergency landing areas during the project's design phase; and subsequently constructs that area at the earliest possible time during the post-mining rehabilitation phase.

The Project does not impact upon nor create a requirement for emergency landing areas for the Hunter Valley Gliding Club activities. It is understood that the existing haul road between United and Wambo could be a suitable emergency landing area. Potentially suitable haul roads will be in place for the life of the Project until such time as it is rehabilitated. After the haul road is rehabilitated it will no longer be suitable as an emergency landing area.

The proposed final land use for much of the area is native vegetation providing biodiversity value. The proposed use of the site post closure as an emergency landing site would not be consistent with the proposed final landform or land use and is therefore not proposed, however, further discussion will be had with the Hunter Valley Gliding Club to further understand their request.

4.10.2.4 Lock the Gate Alliance

The discussion of options for final voids and mine design in the Environmental Impact Statement is absurd and self-serving. This project proposes to leave two final voids behind, which are expected to be a long-term hydraulic sinks. The proponent presents several options for mine layout and final voids that incorporate variables in different arrangement without detailing the hierarchies of objectives or management principles from which they were derived. This is not acceptable. The Department needs to present these mining companies with a clear policy that any new development consent must come with a commitment that there be no final voids left behind. Table 3.3 presents the void options in high level terms, arranging them and the arguments so as to portray the mine plan proposed by the proponent as the wisest choice. The option of backfilling one void, we're informed, was not selected because, "It was determined that this activity would incur prohibitive costs such that it would affect the overall viability of the Project," and that "designing the final landform to result in one or no final voids was not feasible." But there is no detail provided to substantiate these claims, nor has the proponent designed the mine's progress with rehabilitation of voids and landforms as a key informing design principle. The proponent does not discuss, for example, the significant employment and environmental benefit of back-filling all voids, creating more jobs and ensuring greater productivity of the land left behind after mining.

Discussion relating to final voids is provided in **Section 3.1.6.1**.

This project has been developed at the expense of the owners of the United mine fulfilling obligations to close and remediate the United mine site, where the proponent admits no rehabilitation work has been undertaken while preparations have been made to apply for this new development consent.

As discussed above, in regard to the closure of the United mine, it is not correct that closure works have not progressed. Substantive closure works have been undertaken including the closure and sealing of the underground mine and removal of some of the surface infrastructure. Substantive rehabilitation works have been completed and as outlined in the EIS, some of this rehabilitation has now been classified as an endangered ecological community (EEC). Closure works at the site continue to progress.

There is no evidence provided to substantiate the claim that it is not viable to back fill the voids, nor is sufficient information provided about the expected water quality of the voids. Wambo is already in breach of its consent by not having produced its Final Voids Strategy.

Further discussion of the viability of backfilling voids and the expected water quality of the voids is provided in **Section 3.1**.

Wambo submitted a draft Final Void Management Plan to the Compliance Branch of DPE in June 2016.

The proponent needs to spell out what effect this project will have on the rehabilitation already underway at Wambo, and the rehabilitation stalled at United, and include this impact in its assessment.

This issue has been addressed in the responses above.

The Department of Planning should require all the companies to contribute to the preparation of a map that stitches together the proposed final landforms of each operating mine and report on the likely hydrological and ecological effects of this jigsaw puzzle of commitments. If there are deficiencies, all the currently approved mining operations should contribute to fixing them. Certainly no further approvals should be granted without this information.

This comment is noted. Information regarding approved rehabilitation requirements and progressive rehabilitation commitments are provided to DPE and DRE as part of the development application and MOP/RMP processes.

Alternatives to leaving voids and requiring a best practice approach to rehabilitation such as that mandated under US law (Surface Mining Control and Reclamation Act 1977) were not adequately canvassed in the EIS. There is no detailed or transparent analysis on the impact of back filling the proposed voids on the mines' viability. There is no doubt the backfill would impact the operation's return to shareholders, but no detail has been provided as to the impact on cashflow versus actual viability. The document simply proclaims back filling to be unviable. Without this information, the determining authority cannot weigh up the relative costs and benefits of this project.

Further discussion of the viability of backfilling voids is provided in **Section 3.1.6.1**.

The proponents should provide the relative depths and areas of the proposed final voids for the combined and separate proposals, and summaries of the hydrological and other ongoing effects of each scenario to validate their claim of an improved outcome in regards to final voids from the combined proposal.

This issue is addressed in **Section 3.1.6.1**.

4.10.2.5 Nature Conservation Council of NSW

NCC has significant concerns with allowing final voids to be approved as a part of the final post-mining landscape. Mine voids can have significant long-term impacts on water due to elevated water acidity and high salinity. They fetter the financial options of future generations for centuries. There are also concerns in relation to the cumulative impacts of final voids in the Hunter landscape.

Discussion relating to final voids is provided in **Section 3.1.6.1**.

Given the uncertainty around the long-term impacts of final voids, and the clear recommendation from the PAC that these issues must be given further consideration by Government as a matter of priority, we strongly recommend that in accordance with the precautionary principle, no approval is given to mining applications that propose final voids as part of the project application until there is a clear and acceptable policy on final voids. Further, questions arise as to why mining companies are permitted to leave final voids in the landscape rather than properly fill and rehabilitate these areas.

As discussed above, no additional voids are proposed as part of the project. The potential impacts (and opportunities) associated with the voids proposed as part of the Project are assessed in the EIS and further information provided in this report. The detailed mine closure process will consider potential options for the voids.

By allowing final voids, the user (in this case the mining company) is not paying for the environmental legacy left behind after open cut coal mining. The miner takes the profits and leaves the environmental costs to the State, funded by future generations of NSW taxpayers.

This Proposal should not be approved unless further measures are put in place to avoid any final mine voids.

Refer to answers above in the response to issues raised by DPE (**Section 3.1**), DRE (**Section 3.3**) and community submissions (**Section 4.10.1**).

4.11 Social Impacts

Issues relating to social impacts were raised in 14 community submissions and in one interest group submission.

4.11.1 Community

Coal mining generally impacts property prices.

'Residents face the problem of being unable to sell their homes.'

Residence 344: 'There has been no assessment on the impact of our Property Prices in the Jerrys Plains area.'

Residence 47: 'Impact on property prices has not been assessed in the EIS.'

'Property devaluations are another concern in mining areas, and the impact on rural villages and the community is devastating.'

Residence 49: 'I firmly believe this project and current project will have and has had a negative impact on real estate values.'

'The closeness of the mine has already devalued our property way below its value.'

'The mine is significantly impacting on our property by virtue of reduced or static property value. Values are reduced on the basis of post code so while the rest of NSW flourishes with increased property values ours is diminished because of the mines and so that the mine's investors can make large sums of money.'

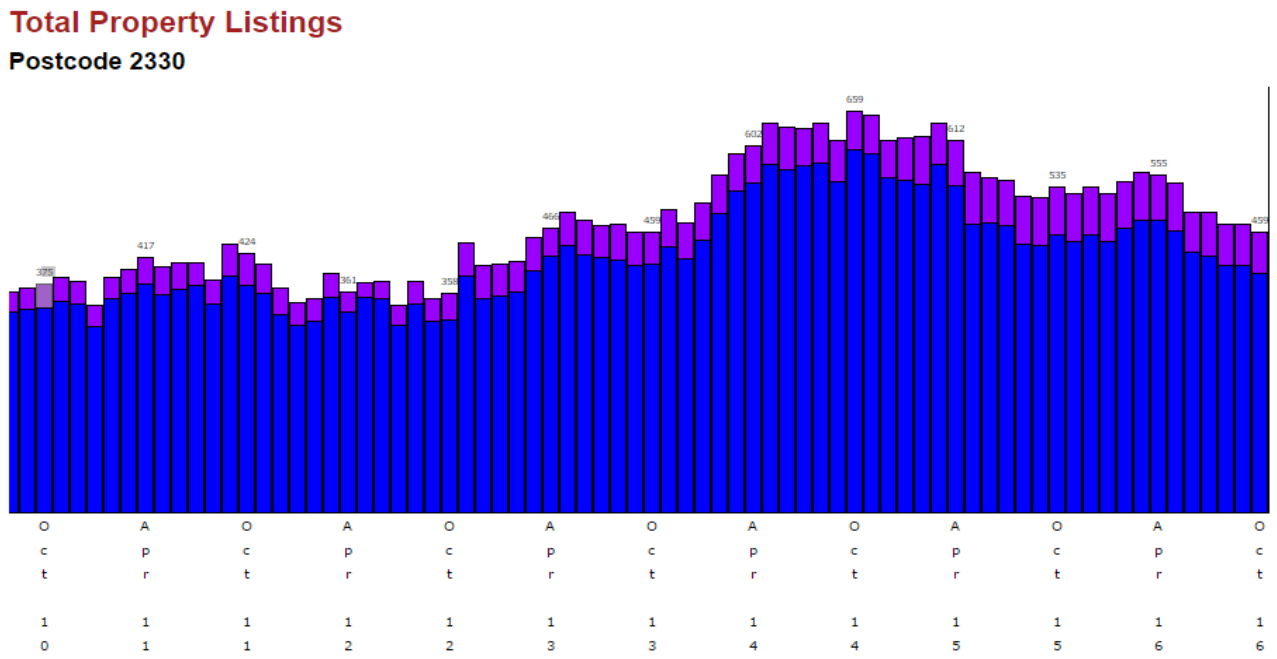
Concerns in relation to residential property values were raised during the community consultation phases of the EIS and have been included within the Social Impacts and Opportunities Assessment (SIOA) (e.g. refer to Section 3.7.2 and Section 3.7.4). During SIOA engagement program local community members who mentioned property prices had concerns in relation to the lack of buyers and reduced values, due to both the existing mining environment and the current Project.

The number of properties sold in Jerrys Plains between 2011-2016 by calendar year is presented in **Table 4.8**.

Table 4.8 Properties sold by calendar year – Jerrys Plains

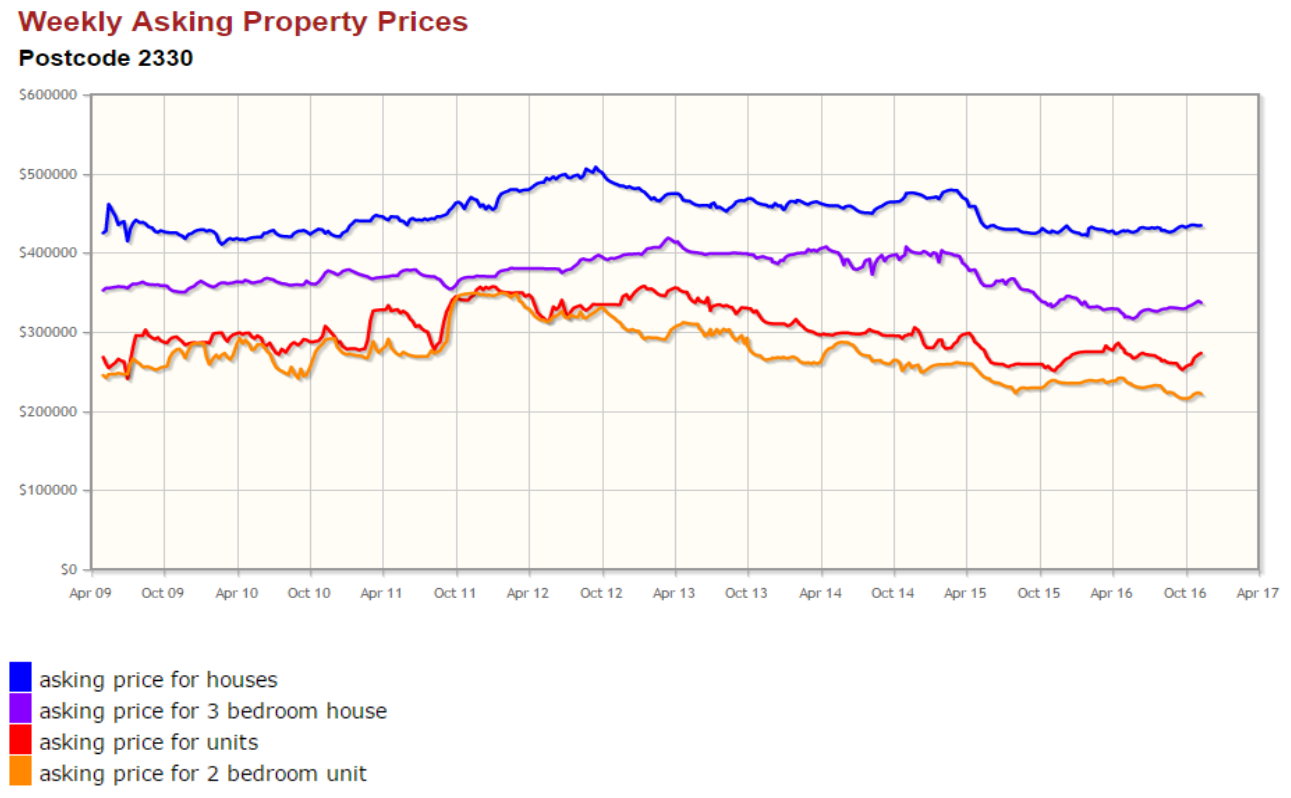
Calendar year	Number of properties sold
2016	5
2015	7
2014	6
2012	3
2011	9

As within **Table 4.8**, numbers of properties sold each year within Jerrys Plains has not had any notable spikes or troughs over the last seven years. Stock on market for Jerrys Plains was not available at the time of analysis. Stock on market for postcode 2330 of which Jerrys Plains is part is provided in **Graph 4.2** and analysis of weekly asking prices is provided in **Graph 4.3** and **Table 4.9.** Analysis of weekly asking rents is provided in **Table 4.10.** There is insufficient data to provide a reliable median sale price for Jerrys Plains beyond that provided in Section 3.7.2 of the SIOA.



Graph 4.2 Total property listings, postcode 2330

(source: SQM Research http://www.sqmresearch.com.au/total-property-listings.php?sfx=&postcode=jerrys+plains&t=1)



Graph 4.3 Weekly asking property prices

Table 4.9 Weekly asking prices index (SQM Research.com.au)

Weekly Asking Prices Index						
Week Ending 15 Nov 2016		**Change on prev week**	**Rolling month % change**	**Rolling quarter % change**	**12 month % change**	**3 year %change**
Postcode 2330	**All Houses 434.5**	0.5 ↑	0.2 % ↑	1.5 % ↑	1.9 % ↑	-5.7 %↓
	3br Houses 337.0	-2.0 ↓	1.4% ↑	2.7% ↑	1.1 % ↑	-14.7%↓
	All Units 273.0	2.0 ↑	5.8%↑	3.7% ↑	8.8% ↑	-13.1%↓
	2 br Units 228.1	-1.4 ↓	2.7% ↑	-3.8% ↓	-7.2% ↓	-16.6%↓

Table 4.10 Weekly rents index (SQM Research.com.au)

Weekly Asking Prices Index						
Week Ending 20 Nov 2016		**Change on prev week**	**Rolling month % change**	**Rolling quarter % change**	**12 month % change**	**3 year %change**
Postcode 2330	**All Houses 346.1**	3.9 ↑	-0.3% ↓	3.1% ↑	6.0% ↑	-3.9% ↓
	3br Houses 329.1	0.9 ↑	1.0% ↑	2.3% ↑	5.0% ↑	-6.4% ↓
	All Units 270.0	15.0 ↑	17.2% ↑	8.7% ↑	15.1% ↑	7.9% ↑
	2 br Units 249.4	5.6 ↑	13.2% ↑	5.4% ↑	10.2% ↑	1.2% ↑

As within **Figure 4.5, Figure 4.6** and **Table 4.9** and **Table 4.10**, the wider 2330 postcode (inclusive of the town of Singleton) has:

- more stock on market than in 2012, with available houses peaking in 2014
- asking prices for 'All Houses' for the 2330 postcode consistent with prices in 2010, having experienced a change of -5.7 per cent over the last three years
- rental prices for houses also decreasing over the last three years.

These wider, postcode level trends are reflective of the perceptions of reduced property prices within Jerrys Plains, and are part of the context within which concerns about Project related price impacts may occur. They are also likely reflective of the downturn in the mining industry over this time.

It is evident that there are a wide range of factors which affect property values including broader regional market trends. In regard to Project impacts, the assessment has found that in most surrounding areas there will be minimal changes to impacts from those currently experienced. The potential increased impacts on those very nearby residences are being addressed in accordance with the NSW government's policies (e.g. acquisition and mitigation policies). For other surrounding areas such as Jerrys Plains, the impacts are predicted to be consistent with those currently occurring and on this basis adverse effects on wider property values are considered unlikely.

Inadequate "benefits in non-monetary terms" are described in the social impact assessment. Some examples: "regular cleaning of dust impacted water tanks for nearby residents", "maintenance of Warkworth community hall", "Installing town signage" 'school excursions to the mine". EIS Appendix 4 Social Impact and Opportunity Analysis p 91. This mine is likely to further diminish community and individual wellbeing as people are forced to relocate or deal with the uncertainty of possible relocations and the other ongoing concerns to do with the project.

No residents will be forced to relocate as part of the Project. A total of six properties are proposed to be provided voluntary acquisition rights (refer to Section 5.1.3 of the SIOA). Should these residents not wish to sell their properties United will work with them to implement appropriate mitigation measures to reduce impacts. United has also committed to an ongoing community engagement program for the Project and has met with all of the residents within the affectation zone for the Project. One key purpose of this program is to minimise any uncertainty that community members may have about the Project, including possible relocations and other ongoing concerns related to the Project.

As noted within the submissions, a range of strategies and opportunities have been noted in Section 5.4 of the SIOA in relation to enhancing the sense of community within the local area. Many of these strategies and opportunities were identified by local community members during the SIOA and it is anticipated that further ideas from community members may arise during the life of the project (if approved). As outlined in Section 6.14.5 of the EIS, United will also negotiate a Voluntary Planning Agreement (VPA) with Singleton Council which will afford opportunities for the Project to contribute to programs designed to improve or address local community issues and perceived impacts through financial contributions to Singleton Council. Local community improvements have been highlighted in the Singleton Council Strategic Plan (2014), and further discussion will be held around prioritising the use of contributions in local areas around the Project, as well as in the broader LGA. Areas of opportunity that United will actively consider for implementation as an outcome of the VPA process, through the United Stakeholder Engagement Plan or as part of Glencore's ongoing community involvement program were provided in the EIS. United is committed to working with the community to enhance the benefits of the Project for the local community.

Land and residences purchased by the project are likely to attract tenants that are poor agricultural stewards.

Noting the assessed agricultural productivity of the surrounding lands, including mine owned lands and those within acquisition areas, when tenants are chosen for properties available for lease; decisions are made on a range of characteristics including their perceived ability to properly manage the relevant land holdings. Glencore often manage mine owned lands through Colinta Holdings, a subsidiary company with the purpose of managing a viable and sustainable beef cattle operation[2].

Many mine workers are not local, do not contribute to the local economies and are unlikely to care about those on whose homes they are encroaching.

Ensuring local employment was raised as an area of concern regarding the Project. This concern may have been influenced by the perception that contracting work opportunities in the mining sector in the Hunter Valley in recent years have not been awarded to local contractors and businesses, but to those living outside local communities.

United and Wambo are connected to the broader region through current social and economic linkages (e.g. employee place of residence, employee household expenditure, employee use of local services and participation in community life, supplier business linkages to the operations etc.). The Town Resource Cluster Analysis (TRC-Analysis) for the Project has found that not only are United and Wambo highly linked to the township and LGA of Singleton, but they also have strong connections with other nearby towns such as Maitland, Cessnock and Newcastle. These locations tend to be where most employees and contractors live and consequently where a significant proportion of household expenditure and use of local services occurs.

In summary, the TRC-Analysis has indicated that:

- most employees and contractors of the existing United and Wambo operations live in Singleton, Maitland, Cessnock and Newcastle
- Singleton and Maitland benefit the most from employees' participation in community groups, households accessing health services, and employees' use of educational institutions
- it is estimated that employees contribute approximately $13.26 million per annum in expendable wages to various local, regional and state economies, with expenditure greatest in Singleton ($3.5 million per annum) followed by Maitland ($2.8 million per annum) and Newcastle ($2.3 million annum).

The Project will require up to approximately 500 positions at peak production and new positions will become available as the Project develops and production increases. Of the 500 positions proposed for the Project, this will include continued employment of up to approximately 250 full-time equivalent employees from the existing Wambo operations. Recruitment for these positions will be advertised and managed as per the Glencore Recruitment Policy, with opportunities for maximising local employment to be incorporated into the Project recruitment strategy.

[2] Refer to http://www.singletonargus.com.au/story/3969835/big-miner-owns-big-beef/ for recent media coverage on Colinta

The Department has not provided adequate information for the public to determine whether social criteria have been met.

The social impacts of the Project have been assessed in the SIOA (refer to Appendix 4 of the EIS) in accordance with the SEARs. DPE considered the EIS adequate, including the SIOA and it is considered that comprehensive social assessment information is available to consider in the assessment of the Project.

Residence 25: The height of the spoil heaps will increase again, beyond the approval of the Wambo's current consent. This increase will impact mobile phone service. This is a potential danger to the community and workers.

The approved conceptual final landform at Wambo consisted of a single, broad ridgeline with a southeast to northwest alignment reaching approximately 160 mAHD flanked on the western side by two final voids. Under the Project, the Wambo final landform will be modified to provide an integrated landform which will result in changes to the previously approved final landform heights. As outlined in the EIS, the height of the overburden emplacement areas at Wambo will be maintained at a typical height of approximately 190 mAHD, with some more elevated emplacement being included at the southern end of the emplacement area so that stockpiled material can be later used to cap the Homestead and Main Homestead tailings storage facilities.

In regard to impacts on mobile phone service, the nearest Telstra 4G FFD band transmitter and receiver is located at the Telstra Exchange on Queen Street, to the north of Jerrys Plains. It is not known what impacts increased spoil heaps will have for specific residents as part of the Project, however, the majority of nearby residences are located north of the Project closer to this tower and will therefore be unaffected. There are a number of mobile phone service 'black spots' already identified in the vicinity of the Project and the Commonwealth government has a program in place to address these, with a 4G tower planned to be constructed in Bulga Village in 2017 which should improve mobile black spots in the area.[3]

In regard to the comments relating to potential dangers to the community and workers, United (and its parent company Glencore) take safety extremely seriously and have extensive controls, procedures and training in place to provide a safe working environment and to protect the safety of the community.

Residence 344: There has been no assessment on my business or others with businesses that will be impacted if this development proceeds.

The overall economic impact due to the Project has been assessed in detail within the Economic Assessment undertaken and included as Appendix 19 to the EIS. Section 5.4 of the Economic Assessment considers effects on other local industries. It is noted that there may be businesses or business owners who perceive that there may be impacts to their livelihoods (and those of their employees, if any) as a result of the Project.

United have committed to a range of measures to mitigate negative social impacts, maximise positive social impacts and monitor and evaluate changes in the local area (refer to Section 6.14.5 of the EIS). If particular individuals or groups have concerns in relation to specific business impacts they are encouraged to discuss these with United as the Project progresses (if approved).

[3] https://www.communications.gov.au/what-we-do/phone/mobile-services-and-coverage/mobile-black-spot-program

The business referred to is located at Residence 344 and is a family day care. United has consulted with Residence 344 and has committed to providing the same measures to the business as are available to the residence being located in the Active Management Zone for the Project to alleviate potential impacts on their business.

Loss of community:

'This area of the Hunter has been severely depopulated because of large scale mining, and further loss of farmers and private residents will cause ongoing destruction of regional social fabric.'

'The continuing loss of community with farmers and private residents will depopulate what is left of this regional social fabric.'

The population of Jerrys Plains as defined by the Australian Bureau of Statistics (ABS) increased from 561 to 688 over the years 2006 to 2011[4]. However there were boundary changes over this time which may influence the population numbers. More recent Estimated Resident Population (ERP) data from the ABS is not available at the state suburb level. The ERP for Singleton LGA has increased by approximately 1800 people from 2005 – 2015[5]. Available data does not support a claim of 'severe depopulation' in relation to the project site. In addition, enrolments at Jerrys Plains public school from 2008-2015 are provided in **Table 4.11.** Numbers of enrolments have not decreased since 2008, with a notable spike in 2015 to 36 enrolments.

Table 4.11 Total enrolments at Jerrys Plains Public School 2008-2015 (MySchool.gov.au)

Year	Total enrolments
2008	26
2009	22
2010	22
2011	24
2012	27
2013	21
2014	23
2015	36

Community sustainability is assessed within Section 5.2.6 of the SIOA.

The analysis in the SIOA found overall in relation to the sense of community within each of the neighbouring localities, that there is a perception that the Project may provide opportunities for improvement to the sense of community, largely driven by opportunities in Jerrys Plains including local employment opportunities and small business opportunities which would improve the sustainability of the

[4] ABS 2006 & 2011 *Australian Census of Population and Housing,* Quick stats http://www.abs.gov.au/census

[5] http://stat.data.abs.gov.au/Index.aspx?DataSetCode=ABS_ANNUAL_ERP_ASGS#

Jerrys Plains community. With regard to community sustainability, the localities assessed, as well as the broader Singleton LGA, were considered to have a high level of community sustainability.

Residence 343: Residence Land values in the area, including ours, are and will undoubtedly continue to be negatively impacted by current mining activities and the proposed Project. The Project will result in our property and another neighbour being completely surrounded by mining activity.

Refer to response on property values above.

Residence 343 is located to the northwest of Wambo Open Cut and to the south/southwest of HVO. These operations are currently approved and the Project does not change this.

Residence 343: Our family experiences mining impacts on a daily basis which destroy the serenity and enjoyment of our rural lifestyle. The cumulative environmental, social and health impacts of the surrounding mines need to be evaluated.

Experienced impacts are noted. Assessment of the environmental, social and health impacts of the Project were provided in Section 6 of the EIS.

Residence 7: Although already having an excellent relationship with both companies involved in this application we do have very high concerns as to the conditions we will have to endure after living here for over 33 years and now in our retirement years over the next 20 years or more.

Relationship with the companies and concerns are noted. United is committed to working with the community to minimise the impacts of its operations. United has also committed to an ongoing community engagement program for the Project, which is anticipated to provide information and mechanisms for communication in relation to issues of concern to the community if/as they arise in the future.

(Gloucester) The mental health issues experienced by residents living in the area is an untold story. Years of fighting to protect their homes and peace of mind. Communities divided by the invasion of multi-national companies.

Concerns in relation to mental health and community division are noted. Community values, sustainability and place were assessed within Section 5.2 of the SIOA.

Residence 44: We are already suffering with dust and noise and loss of amenity from the existing HVO and Wambo activities. We operate a horse breeding business which we believe has suffered over the years as a direct result of the proximity of the mines. The proposed project will come nearer and will increase the difficulties we are already experiencing.

It is noted that the Project will not move any closer to Residence 44 than the currently approved Wambo mine.

The dust, noise and amenity impacts of the Project were assessed in detail and the findings presented in Section 6.0 of the EIS. In accordance with NSW Government policy, it is expected that voluntary acquisition rights will be provided to owners of the most affected properties (a total of six properties). United has also committed to instigate a range of management mechanisms for other impacted properties to mitigate any impacts and difficulties experienced because of the Project (refer to Section 8.0 of the EIS). Discussions with these residences about the predicted impacts of the Project and the management measures proposed to be put in place have been undertaken throughout the Project planning and assessment phase and are ongoing.

Residence 44: The impact is so severe that our property is now unsaleable on the open market and the financial impact of this causes us a sense of hopelessness as it is outside of our control.

Issues with existing property sales impacts are discussed above. Project related impacts will be managed as committed to within Section 8.0 of the EIS.

Residence 49: In 1998 we purchased our property which is now approximately 2 kms from current mining. I commenced operations of a commercial cut flower farm specializing in Western Australian Eucalypts with a variety of 11 species. This property was sourced as being ideal for its Eco climate for this flora and I believe I am the only grower of these species within close proximity of the Sydney Flower Markets. Due to dust this may have an effect on a quality product.

Residence 49 is located off Redmanvale Road. A detailed assessment of the air quality impacts of the Project has been completed as part of the EIS and the results have found that cumulative dust impacts (with the Project included) at Residence 49 and surrounds will meet all relevant NSW Government air quality criteria. These criteria have been established to protect human health and amenity. Compliance with these NSW Government criteria which are designed to protect human health is expected to negate the risk of an adverse impact on a commercial cut flower business at this location. As discussed in **Section 4.2**, in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

I firmly believe this project and current project will have and has had a negative impact on the Jerrys Plains Community at large.

Comment noted. Community sustainability, values and place are assessed in Section 5.2 of the SIOA

Residence 320: The expansion of Wambo mine almost into our back paddock, with further expansion to come has made our future unhealthy and unrealistic.

Residence 320 is located to the northwest of the existing and proposed mining areas and will be one of the closest neighbours to the Project. The Project will not mine any closer to this residence than the existing approved Wambo Open Cut.

The residence falls within the active noise management zone for the Project. United has committed to a range of management measures to seek to minimise the impacts of the Project on this and surrounding residences and is committed to ongoing consultation with these residence to seek to minimise the impacts of the Project.

Residence 320: We spent time prior to purchasing our property driving our 4WD around the local National Park and fire trails along with some bush walking on the steeper tracks to be assured the training trails would meet our requirements, which they did at the time. This is now not the case with Wambo mine expanding, many of the trails have been fenced off lessening the varied terrain and routes we could train our horses on.

Previous activities and concerns about access to Wambo mine owned lands are noted. Access to mine owned lands is proposed to be restricted to authorised personnel in accordance with United and Wambo policies and procedures for the Project to provide for public safety. The Project will not affect direct access to the National park and will not involve any mining closer to the National Park than that currently approved at the Wambo Open Cut.

Residence 320: Darby Equestrian, our business is …(name removed).. only source of income which has greatly reduced due to the effects from the Wambo mine expanding. Our business and income is definitely impacted on by the expansion of the mine. Part of our income was generated from taking other people's horses to train. We no longer do this, considering the health and metabolic issues shown by some of our horses; it's our duty of care not to bring other horses into an environment that could affect their health. The main part of our income is from exporting quality horses overseas in 2016 a major sale did not go ahead due to the horse having a cough. The expansion of Wambo mine is accountable for our loss of income and life style, now with the proposed joint venture further expanding we demand a solution from Glencore as to how we can conduct our business in the same matter we did when we purchased our property.

As discussed in Section 4.1, the air quality criteria in place in NSW have been established to protect human health and natural resources and DPE (2016) has advised that it considers that these criteria are sufficient to assess and manage air quality impacts on the thoroughbred industry. Residence 320 is located approximately 1.5 kilometres to the northwest of the Project Area and the detailed air quality impact assessment for the Project has predicted that all relevant air quality criteria will be met at this location. On this basis, it is not predicted that the Project will result in an adverse health impact on the horses on the property. As discussed in **Section 4.2**, in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

Overall economic impact due to the project has been assessed within the Economic Assessment undertaken and included as Appendix 19 to the EIS. Section 5.4 of the Economic Assessment considers effects on other local industries. It is noted that there may be businesses or business owners who perceive that there may be impacts to their livelihoods (and those of their employees, if any) that may be impacted in unique and specific ways due to the project.

United commit to a range of measures to mitigate negative social impacts, maximise positive social impacts and monitor and evaluate changes in the local area (refer to Section 6.14.5 of the EIS). If particular individuals or groups have concerns in relation to specific business impacts they are encouraged to discuss these with United as the project progresses (if approved).

At a broader level, the site of the mentioned business is outside of the equine Critical Industry Cluster (CIC). The nearest boundary of this CIC is located approximately 6 kilometres northwest of the Project Area. This land appears to be associated with horse grazing, with the nearest more intense horse stud activities (Coolmore stud) being more distant, approximately 14 kilometres from the Project Area.

Residence 320: The information sheet provided regarding the United Wambo Open Cut Coal Mine Project states our property is within the affected areas that are being offered air conditioning and double window glazing. For our particular property this would be a waste of Glencore's finances due to the fact our equestrian business and lifestyle is outdoors. We put the question to Glencore how are you going to protect us from these elements outdoors?

In regard to the specific impact assessment findings for this location, the key findings include:

- the predicted cumulative dust impacts at this location are within all relevant criteria
- the blasting assessment has demonstrated that the relevant criteria will be met at this location
- as indicated in the comment above, the property is located within the active noise management zone for the Project and United has offered the resident a range of noise mitigation measures.

United has met with the resident and provided them with impact assessment findings specific to their property. United is committed to working with the residents of this property to address their concerns.

A once pretty village has been reduced to an industrial site. This needs to be balanced by compensation by those mines, not only in a financial way but in contributions to quality of life, the appearance of the village, assistance to property owners to maintain their property to alleviate the stresses imposed by the mine.

Measures to mitigate the range of impacts predicted to occur are detailed within Section 8 of the EIS. These include the range of social impact management and monitoring measures discussed further in Section 6.14.5 of the EIS.

Residence 163: The mine is significantly impacting on our property by virtue of quality of village life, aesthetic considerations of village/county lifestyle.

Measures to mitigate the range of impacts predicted to occur are detailed within Section 8 of the EIS. These include the range of social impact management and monitoring measures discussed further in Section 6.14.5 of the EIS.

4.11.2 Interest Groups

4.11.2.1 Bulga Culture Centre

Unfortunately the centralised money approach by Local Councils has left the most affected "Near Neighbours to Mining" with little or mostly nothing to show for decades of monetary compensation generously provided by most Hunter Valley Coal Mining Companies; except when Residents sell their Homes under favourable circumstances to Mining Companies.

The Project will negotiate a Voluntary Planning Agreement (VPA) with Singleton Council which will afford opportunities for the Project to contribute to programs designed to improve or address local community issues and perceived impacts through financial contributions to Singleton Council. Local community improvements have been highlighted in the Singleton Council Strategic Plan (2014), and further discussion will be held around prioritising the use of contributions in local areas around the Project, as well as in the broader LGA. It is, however, the discretion of Singleton Council to determine where funds are allocated.

United will also look at opportunities for local community funding through their Stakeholder Engagement Program or as part of Glencore's ongoing community involvement program. These opportunities include some of those identified by local residents as part of the Project stakeholder engagement program which are outlined in Section 6.14.5 of the EIS.

4.11.2.2 Hunter Communities Network

The central area of the Hunter where the proposal is situated has suffered significant loss of private land owners and farmers over the period of intensive increase in large open cut mining operations. The proposed increase in cumulative air and noise pollution from this additional super-pit is not acceptable. The identification of significant health impacts on an additional 7 private properties to the extent of requiring acquisition rights is a major cumulative social impact that has not been clearly assessed. The ongoing destruction of social networks and productive farming enterprises in this central area of the Hunter Valley has not been clearly identified or assessed for its cumulative costs. There is no long term plan for the future viability of the landscape across a vast area of the Hunter Valley floor. HCN considers the cumulative loss of social networks and farming activities in this heavily impacted area of the Hunter has not been clearly assessed or mitigated.

The comments in the submission regarding the ownership of lands associated with mining activities and the implications for ongoing farming of agricultural lands are noted.

Cumulative noise and air quality impacts are assessed within Section 6.6 and Section 6.4 of the EIS respectively. Assessment of voluntary acquisition rights as a social impact has been assessed within Section 5.1.3 and Section 5.2.6 of the SIOA.

Changing industry sectors in the Hunter Valley has been due to a range of factors, including deregulation of the dairy industry, risks in horticultural production with access to markets, and changing land ownership of some traditionally farmer-owned properties to larger, company owned properties that employ a farm manager. The assessment of impact to agriculture is undertaken in Section 6.3 of the EIS. While the assessment of the impacts of the Project, including cumulative impacts, has been undertaken as part of the EIS, an assessment of the broadscale changes currently affecting the agricultural industry in the Hunter Valley is beyond the scope of the current assessment. Predicted changes to social networks due to the

Project are assessed in Section 5.2 of the SIOA, with mitigation and management measures discussed further in Section 5.4 of the SIOA.

4.11.2.3 Hunter Valley Glider Club

Reduced membership numbers due wholly or in part to member's perceptions or concerns about the adverse effects of the poor air quality on their well-being.

As outlined in **Section 4.2.2**, the Project will result in increased dust impacts on the Hunter Valley Gliding Club. To address this issue United has committed to work with the Hunter Valley Gliding Club to develop an agreement (including a suitable air quality strategy) to manage the potential impacts at the Hunter Valley Gliding Club, acknowledging that the Hunter Valley Gliding Club is not continuously occupied. United will fund the implementation of the measures agreed and incorporated into the agreement.

The financial burden of significantly increased maintenance requirements on HVGC assets including aircraft, buildings, potable water systems, machinery and glider trailers, due to dust emissions from the proposed project on systems, machinery, trailers.

The Hunter Valley Gliding Club currently operates within an area dominated by mining operations, including the adjacent HVO South operations. Due to the proximity of the Hunter Valley Gliding Club facility, the Project will result in additional dust at the facility during periods of operations.

United has commenced discussions with the Hunter Valley Gliding Club regarding assistance with maintenance requirements. It is proposed that the agreed measures will be outlined in an agreement to be implemented by United.

The HVGC airstrip is currently not visible to travellers on the Golden Highway, meaning that the HVGC receives zero or little attention from travellers – a situation and amenity that the HVGC appreciates and enjoys. The relocated Highway however will result in the airstrip becoming easily visible to those using the highway, especially those travelling to the east. We anticipate that the increased visibility will result in increased trespassing, theft, vandalism and runway incursions. The HVGC does not welcome the increased negative attention and the inevitable inconvenience and financial burden of dealing with these impacts. The HVGC therefore requests that the Golden Highway relocation is designed to incorporate bunding or screening to fully shield the airstrip from highway view.

It is acknowledged that the realignment of the Golden Highway will result in the road being in closer proximity to the Hunter Valley Gliding Club facility than the current alignment.

United has commenced discussions with the Hunter Valley Gliding Club regarding the measures that could be put in place to minimise visibility of the facility, which may include screening and/or bunding. It is proposed that the agreed measures will be outlined in an agreement to be implemented by United.

The HVGC is concerned that the proposed development will diminish the value of the property and will limit opportunities for future developments at the airfield. The HVGC property has little value for agricultural or residential purposes but is of high value as an operational airfield in close proximity to major population centres, however its value as a desirable venue for aviators to visit will be diminished by the increased mining activity and resulting landscape degradation of the proposed development.

A discussion on potential impacts on residential property value is provided in **Section 4.11.1**.

The location of the airfield, being in mining buffer land, is advantageous to the Hunter Valley Gliding Club as there are minimal sensitive receivers in the vicinity and the noise generated by the facility is therefore unlikely to impact sensitive receivers. The Hunter Valley Gliding Club site is used for commercial purposes (an airfield) and the Project is considered unlikely to affect the value of the land for this use as such uses can continue to occur with the Project. It is also noted that the land is zoned for primary production and the ongoing opportunity for this type of land use is also unaffected by the Project.

As discussed in **Section 4.9.2.1**, the Hunter Valley Gliding Club property is located in an area that is dominated by mining activity and is adjacent to an existing open cut operation (HVO). While the United Open Cut will intensify the mining in the area, it will not change the overall visual character of the area and will not be inconsistent with the current views of active open cut mining operations.

United has commenced discussions with the Hunter Valley Gliding Club regarding the measures that could be put in place to minimise visual and other impacts on the facility. It is proposed that the agreed measures will be outlined in an agreement to be implemented by United to seek to mitigate amenity impacts on the club.

4.11.2.4 Lock the Gate Alliance

The "base case" does not consider the employment that would be generated by the closure and rehabilitation of the two mines, nor does the case for the project accurately reflect the employment that will eventuate should the project be approved.

There would be no employment generated by the closure and rehabilitation of the two mines. These activities would be undertaken by current employees, or a reduced workforce.

4.12 Transport and Traffic

Issues relating to traffic and transport were raised in 2 community submissions and one interest group submission.

4.12.1 Community

Residence 25: Rail traffic increases from six to eight trains per day.

As outlined in the EIS, product coal will continue to be transported off site via train from the existing Wambo train loading facility. The Project will utilise the existing approved rail infrastructure which connects Wambo to the Main Northern Rail Line via a privately owned rail line and loop. The Wambo rail loop is approved to transport up to 15 Mtpa product coal until 2025. The Project does not seek to change the approved maximum annual coal volumes transported via the Wambo rail loop. The Project does, however, seek to extend the approved life of the rail loop to correspond to the life of the Project and increase the maximum number of daily train movements from six to eight trains to allow flexibility in managing rail movements on the line.

As discussed in Section 6.6.9 of the EIS, the noise impacts from the operation of the Wambo train loading facility beyond 2025 were assessed and found to result in no change to the currently approved noise impacts associated with the facility. There are no changes proposed to the facility as part of the Project.

The potential increase to the approved number of trains from a maximum of six per day to eight per day will result in an approximate increase of 1 dB in the $L_{Aeq,\ day\text{-}time}$ and $L_{Aeq,\ night\text{-}time}$ noise emissions from the Mt Thorley to Main Northern Rail Line spur line during those periods when up to eight trains are required by the Project per day. As there will be no increase in the total annual capacity, any increase in daily movements will be offset by a decrease in daily movements at other times. The proposed change in the maximum number of trains per day will have no impact on the L_{Amax} by-pass noise level.

The inconvenience to the travellers local and others when the roads and the highways are closed/blocked for mine blasting are not acceptable, especially when it is only benefitting multinational Mining Companies.

Closures of the Golden Highway will be managed in consultation with HVO in order to minimise the frequency of closures for road users. United will limit road closures associated with the Project on the Golden Highway to a maximum of one per day, consistent with the requirements of the existing Wambo mine development consent. As a result, the Project will not increase the number of road closures that are currently approved.

United have also committed to development of a road closure management plan in consultation with RMS and Singleton Council.

4.13 Bushfire

Issues relating to bushfire were raised in one community submission.

4.13.1 Community

Residence 25: Consultants rely on information that is not accurate e.g. Wambo Coal bushfire management plan WCPL2013 has never been correct since first written.

The EIS provides a bushfire assessment, including a description of existing management practices at both Wambo and United, assessment of potential bushfire hazards applicable to the Project Area and details of the proposed bushfire management for the Project.

A bushfire threat assessment was undertaken and identified the bushfire threat across the Project Area based on the likely response of fire to fuel loads, slope and aspect. This assessment was undertaken independent of the Wambo Bushfire Management Plan. The assessment involved assessing the vegetation formations and the slope of the land to determine the appropriate Asset Protection Zones (APZs) for the Project as required in accordance with the methods prescribed in Planning for Bushfire Protection (PBP) 2006 (NSW Rural Fire Service 2006). It is noted that PBP 2006 was developed to provide a guide to the necessary planning considerations when developing areas for residential use which are likely to be affected by bushfire. Similarly, no specific set back distances are prescribed for industrial buildings in bushfire prone areas, nor does the Building Code of Australia (BCA) provide any bushfire performance requirements for Class 5 – 8 and 10 buildings (including offices, car park, trade buildings, non-habitable buildings etc.). Notwithstanding, all development is required to be consistent with the aims and objectives of PBP. While the requirements of PBP 2006 do not specifically apply to a Project of this nature, the methods for calculating APZs have been used as a guide in the assessment for the Project.

As outlined in Section 6.17 of the EIS, bushfire risk is currently managed within the Project Area through the Wambo Bushfire Management Plan 2013 (Wambo BMP) and the United Bushfire Management Plan (United BMP). These existing management plans have been developed in consultation with the NSW Rural Fire Service (RFS) and Singleton Council. United has committed to the preparation of an updated Bushfire Management for the Project.

4.14 Public Safety and Health

Issues relating to public safety and health were raised in 15 community submissions and in two interest group submissions.

4.14.1 Community Submissions

The health risk assessment has not been completed.

The SEARs for the Project identify public safety as an issue to be considered in the EIS including an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks, blasting impacts and the handling and use of any dangerous goods. Hunter New England Local Health District in its submission on the SEARs also identified human exposure to acute and cumulative impacts of noise, particulates and contamination of drinking water as issues for assessment. United met with Hunter New England Local Health to discuss the approach to the public safety and health assessment for the Project.

A risk screening based assessment approach to identifying potential adverse impacts on public safety, including health, was utilised during the assessment scoping phase and throughout preparation of this EIS (refer to Section 6.20 of the EIS). If a potential risk to public safety or human health was identified, further detailed assessment was completed as part of this EIS. The detailed assessment of each potential risk has been undertaken in accordance with relevant legislation and guidelines, and by appropriately qualified specialists. Where relevant, potential risks to public safety or human health have been assessed against accepted safety or health based assessment criteria established by the NSW government. Where relevant criteria are predicted to be met or where NSW government policy stipulates mitigation measures that are to be implemented (e.g. imposition of voluntary acquisition clauses in any development consent granted), no further detailed health risk assessment was determined to be required. This screening type evaluation

of public safety and health risks using published guidelines was undertaken considering the tiered assessment approach outlined in *Environmental Health Risk Assessment – Guidelines for Assessing Human Health Risks from Environmental Hazards* (enHealth 2012).

Residence 344: I am very concerned about the health concerns for the children I have in care, particularly, as I have six asthmatic children who will be affected by the increase of dust from this development.

Detailed air quality and noise assessments were undertaken as part of the EIS for the Project. At Residence 344, the relevant air quality impacts are predicted to meet relevant criteria, with these criteria designed to protect human health. As discussed in **Section 4.1**, in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

As outlined in the EIS, United has committed to a range of best practice air quality management measures to minimise the dust generation from the Project. As discussed in **Section 4.2**, in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

It is noted that noise impacts are predicted to exceed relevant noise criteria at this residence placing it in the Active Noise Management Zone for the Project. United has therefore committed to active noise mitigation measures at this residence (subject to the agreement of the owner) which may include receiver based treatments of controls such as air conditioning or façade treatment.

It is known that a home day care facility operates at Residence 344. United will consult with the landholder in relation to mitigation measures that may be available.

Residence 49: I firmly believe this project and current project will have and has had a negative impact on our health and wellbeing. My major concerns are the effects to my overall health and wellbeing, in particular is air quality in regard to the long term exposure and cumulative effects of fine particles….. This has also resulted in stress at times as I feel uncertain about my future.

Residence 49 is located approximately 2 kilometres northwest of the Project Area and approximately 2.75 kilometres from the approved Wambo Open Cut. Mining activities will not be any closer to Residence 49 as a result of the Project. The approved Wambo Open Cut is an approved mining operation that may continue regardless of the Project. As discussed in **Section 4.1**, in this area no change in air quality as a result of the Project is predicted compared to the existing situation.

The Air Quality Impact Assessment found the relevant air quality criteria will be met at Residence 49.

It is noted that Residence 49 is located within the active noise management zone for the Project and as such will be offered reasonable and feasible noise mitigation measures, which may include measures such as double glazing, insulation or air conditioning. United will continue to consult with landholders in relation to their concerns.

Health impacts generally:

'I actively oppose this development citing health impacts as the most important negative effect'.

'Our objection to the proposed Project is based on the impact (and exacerbated impacts) that the proposed Project will have on the cumulative health effects of mining in the region. The cumulative environmental, social and health impacts of the surrounding mines need to be evaluated'.

As discussed above, health risks were assessed as part of the EIS. The assessment found that in most cases the relevant criteria that have been designed to protect human health will be met at private residences, with predicted air quality exceedances at one privately owned residence in Warkworth Village. This residence is currently affected by the existing and approved mining operations and has existing voluntary acquisition rights for these surrounding mines. This residence will also be granted voluntary acquisition rights for the Project. In terms of rented properties, United has committed to ongoing air quality monitoring and provision of results and health dust risk information to owners and tenants. United will also provide no-penalty lease exit clauses for any tenants of properties the Joint Venture owns should they be affected by dust. United has also committed to inspection and cleaning of water tanks for surrounding residents.

In regard to noise impacts, based on the outcomes of the relevant assessments, six private residences are predicted to be significantly affected, this includes the private residence at Warkworth discussed above which has existing voluntary acquisition rights. A further 18 residences are considered to have moderate noise impacts.

United has also committed to a range of mitigation measures to manage the potential impacts of the Project on the community. In terms of the significantly affected residences, this will include granting of acquisition rights and United has discussed this option with each of the affected residents. Residences that are considered to be moderately noise impacted will have noise treatments made available for the properties to mitigate impacts. This may include measures such as double glazing, insulation or air conditioning.

In terms of social impacts, these were assessed in detail in the Social Impacts and Opportunities Assessment prepared as part of the EIS.

Anonymous: With this project progressing, we request an acquisition of our property in the interest of our son's health. The current levels of noise and dust from the mine has been marginally bearable however with this merger they will increase & we'd prefer not to wait until they exceed the acceptable levels until an acquisition is made, as obviously, by this point, they would be quite significant. Our biggest concern is for our 2 year old who has already been admitted to Singleton emergency for respiratory problems and who suffers from daily coughs and congestion from environmental factors. Not to mention that even in recovery his sleep in interrupted by mine noise. It is always amusing to hear representatives sound surprised to hear that the mine notice levels are intolerable at times. I'd happily welcome these individuals to spend a night in our home & see if their opinion varies. Legitimately, our gravest fear and concern is the further deterioration of our son's health if dust levels increase. Medical records will be provided upon request.

This submission was submitted anonymously and therefore a specific response with predicted noise and dust levels cannot be provided.

If the residence was located within the acquisition zone (or within a management zone) for the Project, United would have discussed this with the landholder to date.

If details are provided, United will consult with this landholder on their concerns. Further discussion about dust related health impacts is provided above.

4.15 Economics

Issues relating to economics were raised in 26 community submissions and in seven interest group submissions.

The response to the submissions related to the economic assessment has been prepared by DAE is and provided in **Appendix 8**.

4.16 Cumulative Impacts

Issues relating to cumulative impacts were raised in 26 community submissions and in one interest group submission.

4.16.1 Community

Cumulative impacts:

'Coal projects such as the United Wambo Open Cut Coal Mine Project contribute incrementally to rising greenhouse gas emissions, air pollution, water contamination and loss of agricultural land. The proponent is unlikely to avoid the problem of adding to the cumulative local health burden from multiple projects in an area already at risk.'

'United Wambo is a joint venture superpit in an area of the Hunter Valley where cumulative impacts of mining are already too great.'

'Cumulative social and environmental impacts have not been adequately accounted.'

'Cumulative impacts on the region need to be taken into consideration.'

'This area in the Hunter Valley has too many open cut mines already and the cumulative impact by adding another to the existing three mines in our area is unacceptable.'

'This part of the Hunter cannot cope with any more damage to its air and water and bushland. The cumulative impacts of open cut mining are already appalling. The proponent has not adequately addressed the cumulative social and environmental impacts.'

Assessment of cumulative impacts is an integral part of the environmental impact assessment and were addressed throughout the EIS for all key issues.

The SEARs for the Project required the EIS to include:

> an assessment of the likely impacts for all stages of the development, including appropriate worst case scenarios and consideration of any cumulative impacts, and having regard to any relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice.

Section 6.0 of the EIS contains a description of the existing environment and a comprehensive analysis and assessment of the key environmental, social and economic issues relevant to the Project, including the Project specific and cumulative impacts. Cumulative assessments have been undertaken for all key issues including air quality, noise, blasting, water resources, biodiversity, heritage and traffic.

A key objective of the Project was to conduct mining in an environmentally responsible manner to minimise Project specific and cumulative environmental and social impacts. The EIS includes commitments by United to the implementation of comprehensive management, mitigation and offset measures to minimise and counterbalance the predicted impacts of the Project, including cumulative impacts.

It is noted that the Project will occur within an existing mining area at the site of two existing mines. The Project will not increase the existing total annual production of the existing Wambo complex. The location of the mine within an existing mining area and the proposed limits on the combined production from the United and Wambo mines (i.e. no change from existing total complex production) are considered to reduce the contribution of the Project to cumulative impacts.

The cumulative effects of dust, noise, vibration and aesthetics on Jerrys Plains will be much worse if this project development is granted.

Detailed assessments for air quality, noise, blasting and visual were undertaken as part of the EIS. These included assessment of cumulative impacts. The predicted cumulative impacts of the Project are outlined in Section 6.0 of the EIS.

Comprehensive air quality management controls have been incorporated into the design of the Project to minimise the contribution of the Project to impacts on local and regional air quality. With the Project, cumulative dust levels and other air quality parameters are predicted to comply with the relevant criteria at all surrounding private residences, with the exception of a single private residence in Warkworth village. This residence has current acquisition rights for Wambo and is expected to be afforded acquisition rights for the Project. A proactive and reactive dust control strategy will be implemented to minimise dust emissions over the life of the Project. The Project is not predicted to exceed air quality criteria in Jerrys Plains over the life of the Project and as discussed in **Section 4.1**, no change in air quality as a result of the Project is predicted compared to the existing situation in this area.

As part of the design of the Project, United has incorporated a range of noise controls to minimise noise impacts. Operational noise levels are predicted to exceed the noise impact criteria at a number of surrounding private residences. Six private residences (previously seven but one was recently purchased by United) are predicted to be significantly affected (i.e. more than 5 decibels (dB) above the criteria) - this includes the private residence at Warkworth noted above, which has existing acquisition rights. Moderate impacts (i.e. 3 to 5 dB above criteria) are expected at 18 private residences. The Project also has potential to contribute to cumulative noise impacts in Warkworth, Maison Dieu and at the nearest private residences to the northwest of the Project Area. Noise impacts will be managed through the implementation of a proactive noise management and monitoring program which will be used to adaptively manage mining operations as required to minimise noise impacts. The Project is predicted to meet the relevant noise criteria in the village of Jerrys Plains over the life of the Project and the contribution of the Project to noise levels in Jerrys Plains are predicted to be consistent with that of the existing Wambo operations.

Blasting activities will be managed so that relevant blast criteria are not exceeded at private residences or at blast sensitive infrastructure. Any impacts in excess of these criteria would only occur where a negotiated agreement is in place. The Project is predicted to meet the relevant blast criteria in Jerrys Plains over the life of the Project.

Views of the existing mining operations are currently available from residences to the south, northwest, northeast and along the Golden Highway. Similar views will remain with the Project, with overburden emplacement areas increasing in height in some areas and remaining visible as the Project progresses. The active mining face within the approved Wambo Open Cut will be the most visible element for residences to the northwest (including Jerrys Plains) and from the Golden Highway as mining progresses through the main ridgeline. This mining activity is currently approved. The progressive rehabilitation of emplacement areas and shaping of the final landform using natural landscape principles is expected to reduce the visual impact of emplacement areas. Additional tree planting is proposed to assist in screening views of the Project from the Golden Highway.

Residence 44: The entire industry and the planners continue to ignore the cumulative impact of these large mines in close proximity to one another. The community of Jerrys Plains is literally under siege from three directions. We believe there is sufficient scientific evidence available to support our view that each project cannot be assessed as stand alone. The modelling should include data from neighbouring operations.

As discussed above, detailed cumulative impact assessments were undertaken as part of the EIS for the Project.

The cumulative impacts on community health for the communities of the Hunter is being impacted with every new or enlarged coal mine development - this is not sustainable for good health outcomes.

An assessment of public safety and health was undertaken as part of the EIS (refer to Section 6.20 of the EIS). The detailed assessment of each potential risk has been undertaken in accordance with relevant legislation and guidelines, and by appropriately qualified specialists. Where relevant, potential risks to public safety or human health have been assessed against accepted safety or health based assessment criteria established by the NSW government.

With the implementation of proposed management and mitigation measures including potential voluntary acquisition rights, the Project is predicted to meet relevant health based criteria.

The massive water consumption and pollution is a huge issue. No combined water impact statement has ever been done in the Hunter. Water is our most precious resource and it needs to be monitored not given away willy nilly.

The Project will interact with both surface waters and groundwater, and the effective management of this valuable natural resource was a key consideration in Project planning. To assess the potential impact of the Project on water resources, comprehensive assessments of the potential surface water impacts and groundwater impacts were undertaken by Umwelt and AGE and are provided in Appendices 11 and 12 respectively of the EIS. These assessments were prepared in accordance with the SEARs issued for the Project and have also had regard to the specific issues raised by DPI Water, EPA and DoEE and included assessment of cumulative impacts.

As outlined in Section 6.8 of the EIS, the Project exists within a well-regulated system that has been designed to provide for the sustainable management of the State's water resources. This includes licensing of allowable water take with consideration of environmental flow requirements of watercourses and the

needs of other water users; control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges; and guidelines that govern the appropriate design of water management systems for mines to provide for appropriate water quality in accordance with EPL requirements.

As also outlined in Section 6.8 of the EIS:

- The Project is not predicted to have significant impacts on downstream water quality, flows, flooding or water users.
- The Project will make a minor contribution to impacts on alluvial groundwater systems. The Joint Venture has adequate water licences for the predicted groundwater take for the Project.
- One private bore has the potential to be impacted as a result of the Project, however, this bore is not currently serviceable and is located on a property within the noise affectation zone and is therefore expected to be subject to a voluntary acquisition clause for the Project. United has committed to make good arrangements with the owner of the bore should the potential impact be realised.

The cumulative impact of CO_2 emissions by digging up more coal have not been adequately accounted.

To satisfy the SEARs, a detailed Greenhouse Gas and Energy Assessment (GHGEA) has been completed for the Project, including a quantitative assessment of the potential Scope 1, 2 and 3 emissions associated with the Project; a qualitative assessment of the potential impacts of these emissions on the environment; and an assessment of reasonable and feasible measures to minimise greenhouse gas (GHG) emissions and energy use. This assessment calculates the greenhouse gas emissions from the Project and those associated with the use of the product coal.

Residence 150: We have lived here for a very long time and the impacts are becoming greater. We feel that another huge mine in the area will be so overpowering that the environment and community will not be able to cope with this monster mine that Wambo United are proposing.

Residence 150 is located in Jerrys Plains approximately 6 kilometres northwest of the Project Area. There are no predicted adverse impacts on Residence 150 as a result of the Project and any impacts that do occur at this location will be consistent with those currently experienced from the Wambo operations.

As outlined in Section 6.14.5 of the EIS, a number of strategies and management measures are proposed to be implemented to mitigate the impacts of the Project. Specifically in regard to potential social impacts on Jerrys Plains, measures are proposed to mitigate the potential negative social impacts and/or enhance the positive social impact over time. The social strategies and management actions are proposed to be implemented by United through the Stakeholder Engagement Plan. The Project will also negotiate a Voluntary Planning Agreement (VPA) with Singleton Council which will afford opportunities for the Project to contribute to programs designed to improve or address local community issues and perceived impacts through financial contributions to Singleton Council.

The Historic Rural Communities of Lemington, Warkworth and Ravensworth do not exist anymore, with Camberwell and Bulga battling to survive. These are only some in the Singleton Shire Rural Villages to lose their historic history to coal mining, not to mention other communities in other Shires. Please DO NOT destroy Jerrys Plains too, the cumulative impacts are too great.

The village of Jerrys Plains is located approximately 6 kilometres northwest of the Project Area. The Project will not result in mining any closer to Jerrys Plains than the existing Wambo Open Cut operations. As discussed above, the Project is not predicted to result in any significant impacts on Jerrys Plains and any impacts that do occur at this location will be consistent with those currently experienced from the Wambo operations.

4.16.2 Interest Groups

4.16.2.1 Hunter Environment Lobby

The location of the United and Wambo Mines is already very heavily impacted by large open cut and underground mining operations. The cumulative impact of this proposed large combined operation is too great. This impact has not been properly assessed and cannot be adequately offset or mitigated.

As identified by the Hunter Environment Lobby, the Project is located in an area that has a long history of coal mining, with the Project Area itself subject to over 55 years of mining activity. The Project Area is also surrounded by a number of other mining operations including the Wambo underground, HVO South and Mount Thorley Warkworth, with the area being a well-established part of the Hunter Valley coalfield which is the largest coal-producing region in NSW.

Existing land uses and land use planning forms a major constraint to coal mine development in the Hunter Valley. The development of a coal mine and associated infrastructure is limited, by its nature, to the location of the coal resource. The Project seeks to maximise resource recovery from an existing operational mining area, limiting the potential for conflicts with other land uses. The Project is adjacent to other major mining operations, with much of the surrounding land owned by mining companies, resulting in substantial separation distances to private land being in place. The Project is located within one of the most active mining areas in the Upper Hunter Valley.

Key Project objectives include maximising the use of previously disturbed areas and existing mining infrastructure and further development of existing environmental mitigation and management strategies to mitigate and manage the predicted impacts associated with the Project, thereby limiting potential for conflicts with other land uses.

United, on behalf of the Joint Venture, has actively engaged with stakeholders including the local community, to seek to understand the key concerns and issues associated with the Project and to assist with managing these issues through appropriate Project design.

As discussed above, a detailed assessment of cumulative impacts was undertaken for the Project and the findings outlined in the EIS. The EIS also outlines detailed impact mitigation measures to minimise the impacts of the Project and proposed offsets to counterbalance Project impacts.

4.16.2.2 Nature Conservation Council of NSW

The EIS attempts to make some assessment of the cumulative impacts of the Project across various parameters including air pollution, noise pollution, and water impacts.

However we are concerned that there is no robust assessment of the cumulative impacts of decades of coal mining in the region on biodiversity, for example, how much of the Central Hunter Valley Eucalypt Forest and Woodland CEEC has already been cleared in the area, or how much core habitat for critically endangered species has been cleared? We note that OEH has undertaken a cumulative impact assessment (CIA) and risk assessment on threatened ecological communities, populations and threatened species listed under the EPBC Act and the TSC Act that may be impacted by the implementation of the Draft UHSA Biodiversity Management Plan. However, we understand this is not publically available. Again, we do not think the project should proceed until the UHSA has been finalised and all relevant information made publically available.

The proposed impacts on biodiversity are outlined in Section 6.9 and Appendix 13 of the EIS.

Comments in relation to UHSA will be addressed in Part B of the response to submissions.

4.16.2.3 Ryde Hunters Hill Flora and Fauna Preservation Society

This proposal is expanding within an area of the Upper Hunter earmarked for as many as 16 new or expanded open cut mines. The cumulative impacts of such vast areas of open cut mines on air and water quality will be felt for many years ahead. These adverse impacts will affect the health and lifestyle of many Hunter Valley residents. The wider remediation costs and financial burden on our health system will be costs paid by all NSW taxpayers.

It is unclear which area is referred to in the submission, however, there are not 16 new or expanded open cut mines in the vicinity of the Project Area.

As discussed above, a detailed assessment of cumulative impacts was provided in the EIS for the Project, in accordance with the SEARs. The Economic Assessment has considered the financial implications of the proposed impacts associated with the Project and concluded that the Project would be of net benefit to NSW.

4.17 Ecological Sustainable Development

4.17.1 Interest Groups

Ecologically sustainable development:

National Parks Association of NSW

'The project is not an ecologically sustainable development.'

Nature Conservation Council of NSW

'The principles of ecologically sustainable development and inter-generational equity prohibit the development of any further fossil fuel projects in the Hunter Valley.'

Section 9.3 of the EIS includes a comprehensive assessment of the Project against the principles of ecologically sustainable development.

It is assumed that the statement that there should be no further fossil fuel developments in the Hunter Valley is raised in relation to climate change impacts associated with the mining and combustion of coal. A detailed Greenhouse Gas and Energy Assessment (GHGEA) was undertaken to consider emissions from the Project. The outcomes of this assessment are discussed in the EIS and the full GHGEA is attached to the EIS as Appendix 8.

As discussed in the EIS, given the nature of the proposed operations, the Project will contribute to global emissions, however the extent to which global emissions and atmospheric concentrations of greenhouse gases have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions which includes all major emission sources and sinks.

The need for the Project is driven by global demand for coal as an energy source; the Project itself does not result in the combustion of the product coal, nor does it drive demand for coal. Put another way, the global demand for coal will be unaffected by whether or not the Project proceeds.

Consistent with international agreements, there is a need to reduce global emissions of greenhouse gases such as CO_2 to meet agreed national and global climate targets. The GHGEA found that the Project is unlikely to impact National Greenhouse Gas Policy objectives due to the relatively small contribution the Project will make to National emissions on an annual basis. Externalities from Scope 1 and Scope 2 emissions associated with the Project have also been costed in the Economic Impact Assessment (Economic Assessment) (refer to Section 4.3 in the Economic Assessment, Appendix 19 of the EIS). The Economic Assessment concluded that the Project has positive economic benefits for the State even when the costs associated with climate change impacts associated with the Scope 1 and 2 emissions from the Project are internalised.

In an increasingly 'carbon constrained' World, it is expected that the demand for coal will reduce with time however most energy source projections do not anticipate any significant reduction in overall global demand for coal as an energy source over the timeframe that the Project is proposed (refer to, for example, the World Energy Outlook 2016 (International Energy Agency 2016) which predicts a 0.2 per cent per annum increase in global coal demand under the 'New Policies' scenario over the period to 2040). It is however expected that there will be a transition from less efficient coal combustion towards cleaner, more efficient combustion. In this regard, the thermal coal from the Project is considered to have a relatively higher calorific value than from some other areas in the World and the use of coal from the Project will have a lower impact on climate change than lower caloric value coal from other parts of the

World. Reduced supply of coal from the Hunter Valley would only lead to a change in the source of coal to meet the global demand and this may be met through more polluting coal. Alternative sources of coal are likely to have higher CO_2 emissions per unit of energy produced. Hunter Valley thermal coal is typically low in sulfur and ash content by World standards and is less polluting than other sources of coal. An arbitrary restriction of the supply of coal from the Hunter Valley (or NSW more broadly) will not affect global demand for coal, will have little to no impact on global emissions and may have the perverse effect of increasing greenhouse gas emissions and/or other pollution due to less clean sources of coal being sourced to meet the demand; this outcome is not consistent with the principles of intergenerational or intergenerational equity.

4.18 Other responses

4.18.1 Community

Peabody's Financial capability:

'Financial unsuitability of one of the foreign investors.'

'Peabody Energy is bankrupt and not fit to hold a mining lease.'

'Peabody Energy, now in bankruptcy, is not fit and proper to hold a mining lease.'

'Peabody Coal is in bankruptcy. We have no confidence this company will be able to carry out the necessary rehabilitation required nor manage the many ongoing impacts such mine voids.'

'It is unbelievable that the company Peabody Energy, now in bankruptcy, could be considered "fit and proper" under the Mining Act to have this expansion approved. Wollongong Coal is already being investigated by the NSW government under the NSW Mining Act (1992) for its financial insecurity and so should Peabody Energy (2). IF Peabody cannot pay now a rehabilitation bond for filling in the final voids at the end of the mine's life THEN THIS project cannot be approved.'

'With coal in structural decline a very careful assessment also needs to be made of the company's capacity to meet ALL of its obligations should this mine become a stranded asset.'

The following statement regarding Peabody's financial status is provided. Also refer to recent Wambo project approvals SSD 6764 Draft Assessment Report for PAC Review and DA 305-7-2003 Modification 12 Determination PAC Report.

Peabody Energy voluntarily filed petitions under Chapter 11 for the majority of its United States (US) entities in the United States Bankruptcy Court for the Eastern District of Missouri on 13 April 2016. No Australian entities are included in the Chapter 11 filings and Peabody Energy plans for its Australian operations to continue as usual. The Australian operations have access to separate funding arrangements enabling it to continue operations at Wambo.

Peabody Energy has made available to its Australian platform a committed US$250 million revolving Intercompany Loan Facility. The Intercompany Loan Facility is designed to provide additional liquidity to support the ongoing operations of the Australian business during Peabody Energy's Chapter 11 re-organisation, with draw amounts being tied to operating budgets and subject to certain availability restrictions.

As such, the circumstances surrounding the Chapter 11 bankruptcy protection sought by Peabody Energy Corporation and related US entities will not impact on Wambo's ability to meet its financial obligations.

Strictly speaking, DPE (or a local Council) is not required by the EP&A Act to consider the financial viability of any applicant in determining a development application. This is because, the development consent relates to 'land', rather than a 'person'. It is noted that the Mining Act 1992 requires that applicants for mining leases must satisfy a 'fit and proper person' test. Further, there are mechanisms in place to ensure that the site is effectively rehabilitated. DRE holds substantial security deposits for the rehabilitation of every operating mine in NSW, including Wambo. The security deposit is designed to cover the full cost of undertaking rehabilitation, and may be 'called in' by DRE in the event that a leaseholder fails to meet rehabilitation requirements set by the Mining Act 1992 and within the relevant mining lease. Wambo has lodged a security deposit for its Wambo mining operations which addresses all mining operations covered by its current Mining Operations Plan.

Wambo's environmental and compliance record:

Residence 25: 'Wambo has a poor compliance record with Singleton Council and the Department of Planning. Repairs have not been done, monitoring was not done. How can we be assured that this poor practice will not continue with this joint venture?'

'Wambo Coal has a long record of action outside its consent conditions.'

Residence 25: 'Wambo has also shown continued failure to comply with conditions of consent set to protect the creeks and aquifers. The creeks and the aquifers are still not being monitored and repair to both the land and the aquifers has yet to be adequately performed. Subsidence is ongoing despite the allegations by Wambo and its consultants.'

'Wambo mine has a history of unacceptable impacts and inadequate or no response, including the collapse of a wall which was, apparently, unknown to the DoPE. (refer to my previous objection which was followed by a call for information from the Dept.)'

'Concerned that fines or apologies will not remedy non-compliance with dust, vibration and noise impacts.'

The following statement of environmental record has been provided by Wambo:

Wambo has a strong record of compliance with its environmental obligations for its mining operations under the Wambo mine development consent and Controlled Action Approval (EPBC 2003/1138). Wambo has established and is committed to continuing open and constructive dialogue with the local community and stakeholders regarding environmental management as part of its operations.

The Annual Environmental Management Reports are available on the Wambo Coal Mine website (http://www.peabodyenergy.com/content/422/australia-mining/new-south-wales/wambo-mine/approvals-plans-and-reports-wambo-mine).

The environmental monitoring program results over recent years have shown that Wambo's management of its operations at the Wambo mine provides effective management of potential impacts from the mine's operations and achieves compliance.

On 1 August 2014, Wambo was convicted in the Singleton Local Court for an offensive odour offence under section 129(1) of the NSW Protection of the Environment Operations Act 1997 for a blast fume incident associated with the open cut mining operations which occurred on 24 July 2012. Wambo was ordered to pay a fine of $13,000 and the NSW EPAs costs in the amount of $24,000.

Wambo also pleaded guilty to an offensive odour offence under section 129(1) of the Protection of the Environment Operations Act 1997 for a blast fume incident associated with the open cut mining operations which occurred on 14 May 2014. The proceedings in respect of this offence were brought by the NSW EPA in the Land and Environment Court of NSW. Wambo was ordered to pay a fine of $60,000 and the NSW EPAs costs.

No approval under environmental protection legislation has been revoked or suspended in the 5 years immediately prior to this application being made.

Life of the Project:

'The proposed development is for a period of 23 years which is a significant period of time to be impacted by air quality due to dust, noise and vibration.'

'Committing to an approval for 23 years of 10Mtpa is unacceptable.'

Coal mining projects are generally long-term operations and the life can be dependent on a number of factors including the size of the resource being targeted, mining conditions and market conditions.

The Project will maximise resource recovery by combining the lease management of two mines and removing operational constraints, enabling extraction of an additional approximately 150 Mt of ROM coal over 23 years.

The 23 year life being sought under the Project is not inconsistent with other mining approvals in NSW.

The Project is anticipated to deliver up to 10 Mtpa of ROM coal from the combined operations of the United and Wambo Open Cuts. It is noted that Wambo currently has approval to produce up to 14.7 Mtpa ROM coal. The Project combined with the separately managed Wambo underground will remain within this existing limit. That is, no change is proposed to total maximum production that is already approved for the Wambo complex.

Have political donations lodged with the DA been cross referenced with the NSW electoral commission.

The information provided in the political donation forms is accurate at the time of signing. The Proponent cannot provide any indication on whether the political donation forms have been checked with the NSW electoral commission as this is not their responsibility.

Residence 343: When we purchased the property, there was a 5 year mine life and if the proposed Project is approved, this will extend significantly by approximately 23 years.

It is understood that Residence 343 was purchased on 16 June 2015. It is noted at the time the property was purchased the Project had been publically announced and information was available on the proposal.

Residence 343: The Wambo mine representatives have mentioned to us that we are out of their noise, dust and blast parameters, which does not accord with what we actually physically see and hear and inhale on a daily basis which brings into question the accuracy of the parameters associated with our property under the EIS.

The comments relating to existing impacts from the Wambo mine are noted.

In regard to the Project, detailed noise, dust and blast assessments were undertaken as part of the EIS for the Project. At Residence 343, the relevant air quality and blasting impacts are predicted to meet relevant criteria. Noise impacts are, however, predicted to exceed relevant noise criteria. This places Residence 343 in the Active Noise Management Zone for the Project.

The noise management zone is applicable where the predicted noise levels exceed the target Project Specific Noise Levels by up to 5 dB. Management procedures that can be implemented in the Active Noise Management Zone for moderate impacts between 3 and 5 dB above the PSNL include:

- prompt response to any issues of concern raised by community
- noise monitoring on-site and within the community
- making changes to operational noise mitigation measures, where practicable, to further reduce noise impacts
- consideration of receiver based treatments of controls such as air conditioning or facade treatment.

As outlined in the EIS, United has committed to implementation of noise mitigation treatments at all properties within the Active Noise Management Zone should they be accepted by the owner. United has sought to engage with all of those residents in the management zone.

Should future monitoring indicate that the criteria set for the Project in a development consent are being exceeded by the Project, then further measures would be taken to achieve compliance, or, if compliance could not be achieved a range of measures would be available to the landholder including potential voluntary acquisition rights if it was demonstrated that the Project was resulting in significant noise impacts.

In relation to existing impacts, Wambo will continue to consult with the community in relation to any current concerns relating to their operations.

This Mine Project and other mining projects in the area all state that any potential impacts can be managed and will have no negative affects to the environment and to the community, however these goals are not achievable. This will be no different this time and any special conditions put in place will not be managed to an acceptable level.

The EIS does not state that there will be no negative affects to the environment or to the community. The predicted impacts of the Project are detailed in Section 6.0 of the EIS and the appendices to this document and identify that the project will generate dust, noise, blasting, visual and a range of other impacts on the community and environment.

The Project has also been designed, however, to avoid impacts where practicable and to minimise impacts where they are not avoidable. For example, measures incorporated into the design of the Project to minimise noise and dust generation. Where impacts could not be avoided, mitigation measures or offsets have been proposed to ameliorate the impacts of the Project.

With the implementation of the management, mitigation and offset measures proposed by United, the assessment has concluded that the Project would result in a net benefit to the NSW community. As noted above, however, the EIS does not conclude that the Project will result in no impacts.

Residence 320: Taking into account the dust, noise and water pollution impacts from Wambo mine, the disruption to our outdoor lifestyle, the adverse effects and income loss to our business Darby Equestrian, the potential health hazards to our family and horses that Glencore should include our property into the Acquisition zone and assist us with relocation to a property with equal facilities to conduct our business.

The Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (NSW Government 2014) describes the NSW Government's policy for voluntary mitigation and land acquisition to address noise and dust (particulate matter) impacts from State significant mining, petroleum and extractive industry developments. Properties proposed for acquisitions based on predicted impacts from the Project have been determined in accordance with this policy.

At Residence 320, the relevant air quality and blasting impacts are predicted to meet relevant criteria. Noise impacts are, however, predicted to exceed relevant noise criteria by up to 5dB. This places Residence 320 in the Active Noise Management Zone for the Project.

The noise management zone is applicable where the predicted noise levels exceed the target Project Specific Noise Levels by up to 5 dB. Management procedures that can be implemented in the Active Noise Management Zone for moderate impacts between 3 and 5 dB above the PSNL include:

- prompt response to any issues of concern raised by community
- noise monitoring on-site and within the community
- making changes to operational noise mitigation measures, where practicable, to further reduce noise impacts
- consideration of receiver based treatments of controls such as air conditioning or facade treatment.

As outlined in the EIS, United has committed to implementation of noise mitigation treatments at all properties within the Active Noise Management Zone should they be accepted by the owner. United has sought to engage with all of those residents in the management zone.

Should the Project be approved, if monitoring indicates that the criteria are being exceeded by the Project, then further measures would be taken to achieve compliance, or, if compliance could not be achieved a range of measures would be available to the landholder including potential voluntary acquisition rights if it was demonstrated that the Project was resulting in significant noise impacts.

In relation to existing impacts, Wambo will continue to consult with the community in relation to any current concerns relating to their operations.

4.18.2 Interest Groups

4.18.2.1 Environmental Justice Australia

We expect the ultimate approving authority to deny the application on the basis that the 50:50 joint venture lacks the requisite financial capacity and integrity, and its participants are not fit and proper. United Collieries is 95% owned by Abelshore Pty Limited (Abelshore). Abelshore last submitted a financial report to ASIC in 2001. Its financial position is opaque. We do not allege any illegality, but authorities may wish to consider its links to Bermuda and the opacity of United Collieries' structure with respect to 'fit and proper' status.

United Collieries Pty Limited is owned 95 per cent by Abelshore Pty Limited, a wholly owned subsidiary of the Glencore group, and 5 per cent by the CFMEU and is managed by Glencore. Glencore plc is a listed company and reports on its financial position annually; those reports are publically available. Abelshore Pty Limited is a party to a Deed of Cross Guarantee with its parent entity, Glencore Operations Australia Pty Limited. Under ASIC Class Order 98/1418, Abelshore Pty Limited is not required to prepare and lodge financial statements under Chapter 2M of the Corporations Act 2001 (Cth).

Peabody's US Chapter 11 bankruptcy proceedings:

Peabody sought protection from creditors under US Chapter 11 bankruptcy provisions in April 2016. Peabody is the ultimate controlling entity of Wambo Coal, and by virtue of seeking to take advantage of US bankruptcy laws and the joint venture relationship, is not a fit and proper person for the purposes of this application. Analysts doubt the Chapter 11 bankruptcy proceedings will make Peabody's operations profitable. Peabody itself acknowledges that its US bankruptcy proceedings may disrupt or impede its operations in Australia. The auditors of Wambo Coal Pty Ltd and other Peabody Australian companies state 'there is significant uncertainty whether the company and / or the consolidated entity will continue as a going concern'.

Peabody in its 10 August 2016 'five-year business plan' allocated US$100 million to 'life extension capital totalling [sic] ~$100M for projects that deliver volume beyond 2021' in Australia. This Project and the Wambo Longwall Expansion are two such projects. Collectively they are expected to cost Wambo Coal $693 million. Aside from the fact that US$100 million is clearly inadequate to ensure Wambo Coal has the financial capacity to comply with its obligations in the joint venture partnership and Longwall Expansion, the presentation of Peabody's financial position in its five-year business plan is, according to the Institute of Energy Economics and Financial Analysis (IEEFA), 'misleading'. IEEFA expect instead of successfully trading out of the Chapter 11 bankruptcy proceedings, Peabody will simply go bankrupt again.

Refer to response above regarding Wambo's financial status (refer to Section **4.18.1**).

The Project is estimated to cost $84 million. If costs are shared equally between Wambo Coal and United Collieries, as one would expect in a 50:50 joint venture, Wambo Coal would need to spend $42 million. However, Wambo Coal's 2015 financial statements show that it does not have the financial capacity to undertake the expansion. At 31 December 2015 the applicant had only $4.6 million in cash. Its traditional line of credit has expired. Emergency funding provided on the eve of Peabody's bankruptcy is insufficient to cover expansion costs. Regardless, that U$250 million loan services the entirety of Peabody's Australian operations. Those operations collectively lost $1.2 billion dollars in 2014 and $2.7 billion in 2015. At 31 December 2015 the top-level Australian consolidated holdings company had negative shareholders' equity of $6.5 billion. Peabody Holdco is subject to serious questions about its status as a going concern. Wambo Coal's financial problems are compounded by concurrent plans for the 'Southern Longwall Expansion' which is still yet to be approved. Wambo Coal estimated that project to cost $651.9 million.

Refer to response above regarding Wambo's financial status (refer to Section **4.18.1**).

Given the financial constraints on Peabody and Wambo Coal, we also query the adequacy of Wambo Coal's statement in response to concerns about financial capacity for the Southern Longwall Expansion.

This does not relate to the Project.

Wambo Coal has been involved in a number of recent incidents of environmental malfeasance. The applicant pleaded guilty to releasing nitrogen oxides from a May 2014 blast event with unexpected consequences and the penalty judgment is pending. The most recent environmental failure was in January 2016. A temporary erosion and sediment control dam failed releasing 3 mega litres of sediment-laden water into a creek and river system. Formal legal interviews have been requested with staff and compliance action may be taken. In light of recent cost savings initiatives we expect the applicant will struggle to avoid serious environmental failures in the future.

A statement on Wambo's environmental performance is provided in Section 7.4.2 of the EIS and **Section 4.18.1**. Further information about the status of the dam failure incident referenced in the submission is provided in **Section 3.1**.

4.18.2.2 Hunter Communities Network

HCN is not confident that Peabody is suitable to have 'fit and proper' status under s 380A of the Mining Act 1992 (NSW). Wambo cannot demonstrate it has the financial capacity to comply with obligations under current or future mining rights. Response to questions about financial capacity refer to a US$250 million loan provided for operational liquidity to the Australian business. However, the loan documents do not permit that money to be used for capital expenditure, or expansion plans.

Refer to response above regarding Wambo's financial status (refer to Section **4.18.1**).

HCN notes that the United Mine suspended operations in June 2010 and has provided no public benefit in the form of royalties and jobs since that time, despite having approval to operate until 2012. This approval was based on previous assessment that demonstrated viable coal production. The Department of Resources and Energy (DRE) have approved the extension of United's suspension of operations until 4 June 2016. This approved suspension is now out of date. The associated Mining Operations Plan expires in December this year. Under the current planning approval, United should be undertaking closure and rehabilitation of the mine site. Any proposed changes to mining operations should have occurred prior to 2012 to ensure the 'orderly and economic use and development of land' under the objectives of the *NSW Environmental Planning and Assessment Act 1979*. It is unacceptable that a mining project can be allowed to extend beyond its current approval dates while not producing any economic benefit to the state. The United Mine should now be closed with rehabilitation commenced. This ad hoc approach to planning decisions and conditions of consent provides no certainty for the community and other industries in the Hunter region.

As discussed above United has been actively working on mine closure and substantive works have been completed.

Detailed concept and pre-feasibility studies have been completed for the Project, considering mining options, layouts, overburden emplacements and infrastructure arrangements to optimise the Project's final design. During each of these studies, environmental and community impacts were key considerations that informed the Project design. These studies have been completed since United went into a period of suspended operations and United has been transparent throughout this time that further exploration and mine feasibility investigations were ongoing. The emphasis was on developing a Project that was technically, environmentally, socially and economically sound.

It is also noted that DRE has confirmed in a letter dated 29 June 2015 that the resource is considered a significant coal resource, stating:

> *The Division considered the coal deposit a significant coal resource which will continue to bring economic benefits to the State and the region. The Division supports the proposed Project as a responsible utilisation of the State's valuable coal resources and supports the project proceeding through the State's comprehensive development assessment and approval process.*

The cost benefit analysis determined that the Project had a net benefit of $414 million (in NPV terms) over the life of the Project.

Mod 12 is still under assessment with DPE and no formal decision has been made. HCN finds it highly inappropriate for the United Wambo proposal to be placed on exhibition prior to the completion of the decision-making process for Mod 12.

Modification 12 was approved on 12 December 2016.

Modification 12 only related to the Wambo Open Cut in as far as the extension of life from 2017 to 2020. The intent of including the extension of life to the Wambo Open Cut in Modification 12 was to provide contingency for the ongoing operation of the Wambo Open Cut if the Project is not approved or if there is a delay to the approval process.

While referencing Modification 12, the Project and the relevant assessments, did not rely upon Modification 12. That is, a conservative approach was taken in respect to the relevant impact assessments

which covers all impacts associated with the Project regardless of whether or not Modification 12 was approved.

4.18.2.3 Hunter Valley Glider Club

The relocation of existing 330kV and 66kV power lines to a new position just 250 m from the south western end of the airstrip will present a significant hazard to aircraft operating at the HVGC. We therefore request that these power lines are not relocated to the proposed corridor, but are routed well away from the airstrip.

During the planning phase of the Project, the location of the 330kV transmission line was redesigned to avoid the potential for impacts on the Hunter Valley Gliding Club based on consultation and feedback. The 330kV transmission line has been designed in accordance with the *Civil Aviation Safety Regulations 1998*. United provided the Glider Club with a preliminary layout of the relocated transmission line route and after feedback was received from the Glider Club moved the line further from the airfield and supplied an updated draft layout.

If the transmission line is not moved from its current, it would have significant impacts on the Project, including:

- reduced coal recovery compared to the Project
- poorer final landform outcome as operations and landforms not integrated
- potentially additional final voids
- reduced mine life and therefore reduced employment and other economic benefits.

It is understood that the proposed location of the 330kV transmission line is located within a safe and manageable distance from the Hunter Valley Gliding Club.

It is also noted that HVGC has requested that any transmission lines or powerlines installed in the vicinity of the airfield are fitted with high visibility markers and the towers fitted with daylight visible strobe lights. United commits to implementing these design features subject to the agreement of the infrastructure owners (e.g. TransGrid).

HVGC is very concerned about any new obstacles or changes to landform in the vicinity of the airfield as such changes have potential to protrude above the glideslope required by gliders and other aircraft during routine and emergency manoeuvres at the airstrip. We request that the United Wambo Project design team consults with the HVGC during the design of any obstacle or landform changes in the vicinity.

United will continue to consult with the Hunter Valley Gliding Club in relation to the Project, including any obstacle or landform changes proposed.

HVGC anticipates that the Golden Highway construction activity will result in a degree of interaction with construction personnel, some planned and authorised and some unplanned and unauthorised. The HVGC requests that the project team implements suitable interaction protocols and security arrangements to protect the HVGC's property and to minimise risks to aviation safety.

As outlined in Section 6.15.1 of the EIS, a construction road traffic management plan will be developed in consultation with Singleton Council and RMS prior to the commencement of construction activities. The plan will identify the measures to be implemented to manage potential construction related traffic impacts, including any temporary construction access points. This plan will also include appropriate protocols and security arrangements that will be put in place during the construction of the Golden Highway realignment, determined in consultation with the Hunter Valley Gliding Club.

As discussed in various sections through **Section 4.0** of this report, United has committed to work with the Hunter Valley Gliding Club to develop an agreement that identifies the measures that United can put in place to minimise impacts on the club. United will fund the implementation of the agreement.

The proposed development will result in the clearing of a large area of trees and vegetation that is likely to be current wildlife habitat, especially to kangaroos. The HVGC is concerned that with the removal of this habitat, the wildlife will be forced to move to alternative areas, and that some of the wildlife will adopt the adjacent HVGC property as their new habitat, making the airfield's already significant kangaroo hazard even worse than it was prior to the development.

It is requested that the United Wambo Project implement a wildlife control program to limit wildlife numbers to their pre-development numbers.

It is acknowledged that the clearing works associated with the Project will result in displacement of some wildlife. Clearing of the site will, however, occur incrementally reducing the likelihood of large scale displacement and areas of rehabilitation will also provide wildlife habitat, particularly for kangaroos, including in the early phases of rehabilitation where new vegetative growth occurs providing attractive foraging habitat.

It is also noted that the abundance of fauna on any area of habitat is generally limited by the carrying capacity of that habitat, be it the Project Area or adjacent properties. Therefore any increase on an individual property due to displacement would likely be of a short-term nature prior to the population restabilising at a level consistent with its carrying capacity.

Based on the above considerations, it is deemed unlikely that the Project will result in a significant kangaroo displacement effect on neighbouring properties, however, should any impacts arise with regard to kangaroos being displaced during clearing United would work with the Hunter Valley Gliding Club to address this impact. This commitment would be included in the agreement to be developed with the Gliding Club that identifies the measures that United can put in place to minimise impacts on the club. As noted above, United will fund the implementation of the agreement.

4.18.2.4 Lock the Gate Alliance

The relationship between this project and the existing consent for Wambo open cut and its modification 12 is ambiguous. Misleading information is presented claiming employment of the Wambo workforce as a benefit of this project when in fact, the Wambo MOP anticipates mining continuing there until 2025.

Modification 12 is discussed in Section 2.2.3 of the EIS while Sections 3.2.2 and 3.2.3 of the EIS outline the interaction of the Project with Wambo and the key features of the Harmonisation Modification. As discussed above, it is considered that the EIS is clear on the relationship between the Project and the Wambo mine consent and that the Project can be assessed independently to the assessment of Modification 12. The Project is not contingent on Modification 12.

The recent approval of Modification 12 extended the life of operations in the Wambo Open Cut from 2017 to 2020. The intent of including the extension of life to the Wambo Open Cut in Modification 12 is to provide contingency for the ongoing operation of the Wambo Open Cut if the Project is not approved or if there is a delay to the approval process. Modification 12 also extended the life of the Wambo CHPP and underground operations from 2025 to 2032.

In regard to employment, as outlined in Section 3.12 of the EIS, once at full operation, the Project will provide employment for a total workforce of up to approximately 500 positions during peak production, including up to approximately 250 additional operational positions. The Joint Venture's workforce will include existing Enterprise Agreement employees at the Wambo Open Cut operation and it is anticipated that additional mine worker positions will be created as the Project operations are developed. Without the Project the existing employment for the approximately 250 Wambo Open Cut personnel would cease in 2017 (or 2020, pending approval of Modification 12 of the Wambo mine development consent). The proposed operational workforce will peak at up to approximately 500 in the first seven years of the Project before reducing to up to approximately 450 for the remainder of the Project life.

5.0 Additional Environmental Management and Monitoring Measures

Section 8.0 of the EIS included a summary of all the proposed environmental management and monitoring measures for the Project. As a result of submissions received on the EIS, United has committed to additional environmental management and monitoring measures and refined some of the measures outlined in the EIS in this response to submissions (Part A). These additional or refined measures are outlined below.

Air Quality

In addition to the measures outlined in Section 8.0 of the EIS, the following measures in relation to air quality have been committed to in this response to submissions report.

- As part of the implementation of the Project, United will undertake a campaign of $PM_{2.5}$ monitoring to provide local $PM_{2.5}$ monitoring data. The campaign monitoring would include:
    - monitoring of $PM_{2.5}$ using a beta attenuation mass (BAM) monitor concurrently and co-located with the PM_{10} TEOM monitor located at AQ01 (refer to Figure 4 of the AQIA). The rationale for this location is that it is downwind of mining operations under the prevailing northwest winds and therefore more likely to measure contributions from activities at the Project Area
    - campaign monitoring for a period forecast to be 3 to 6 months pending a review of whether suitable northwest winds have been observed during that time
    - comparing the $PM_{2.5}$ concentration estimates to the EPA's 25 $\mu g/m^3$ criterion
    - identifying whether further $PM_{2.5}$ monitoring would be required to confirm on-going compliance with the EPA's $PM_{2.5}$ criteria.

    If further $PM_{2.5}$ monitoring is required as a result of the campaign monitoring above, then United would develop an implementation program at this time in consultation with DPE.

Groundwater

The wording of the groundwater measures have been amended based on the DPE submission and are provided below:

- Management of groundwater for the Project involves the establishment of a robust surface and groundwater level and quality monitoring program, for relevant groundwater and surface water sources. Monitoring will also include routine quarterly monitoring of groundwater levels and quality within all potentially affected bores on land not owned by Wambo or United, where access is provided by the relevant landholder. Results will be reviewed on a quarterly basis for early detection of potential impacts. The results will also be documented within annual reporting for key stakeholders.

    Should monitoring indicate the changes in groundwater levels and quality, and surface waters are more extensive or significant than predicted, mitigation measures will be considered. Mitigation measures that will be considered following discussion with relevant government authorities include:

- modifications to the water management systems
- revision to the mine plans and dewatering options
- grouting and cut off measures
- supplying supplementary water from other groundwater and surface water sources
- obtaining additional water licence allocations
- reuse of mine water within the water management system.

If mitigation measures are not feasible, 'make good' measures with affected land owners will be carried out. Make good measures will include ensuring the bore owner has access to a similar quantity and quality of water for the water bore's authorised purpose. This will be achieved through a range of options, including:

- bore enhancement by deepening the bore or improving its pumping capacity
- constructing a new water bore
- providing a supply of an equivalent amount of water of a suitable quality by piping it from an alternative source.

- The groundwater monitoring program prepared for the Project will consider the monitoring locations and parameters outlined in **Appendix 4**.
- During development of the groundwater monitoring program for the Project, United will consider the benefits of presenting and analysing:
  - further hydrographs for bores within the monitoring program as part of annual groundwater reporting requirements
  - changes in water 'type' as part of annual groundwater reporting requirements.

Rehabilitation and Closure

In addition to the measures outlined in Section 8.0 of the EIS, the following measures in relation to rehabilitation and closure have been committed to in this response to submissions report.

- United will recover topsoil and other ecological resources from existing rehabilitation areas where appropriate.
- Should PAF material or other material with elevated levels of contaminants be identified, the following management strategies will be implemented (note that for PAF material further management may not be required where operational blending is determined to be sufficiently effective):
  - avoid placing PAF / material with elevated levels of contaminants within five metres of the natural ground level in out-of-pit emplacement areas to isolate it from any water flow along the interface between the overburden and natural ground
  - for PAF, mixing of acid neutralising materials (limestone and/or high ANC NAF overburden and interburden) with PAF material to increase lag times before onset of acid conditions

- selective placement of PAF material / material with elevated levels of contaminants at least 100 metres back from the outer perimeter of the emplacement area with a thick (not less than 20 metre) outer zone of non-acid forming (NAF) materials and for PAF materials, incorporate strategies to limit oxygen transfer to and fluctuating moisture conditions in PAF materials

- selective placement of PAF materials / material with elevated levels of contaminants in-pit below the long term recovery water table to allow inundation at closure and prevent long term exposure to atmospheric oxidation.

Heritage

- As outlined in the EIS, United will develop and implement a Heritage Management Plan for the Project. This will incorporate the management measures and details of the commitments in relation to heritage items that are presented in **Table 3.25**, which have been refined based on the comments from the Heritage Division.

Hunter Valley Gliding Club

- United will prepare an agreement in consultation with the Hunter Valley Gliding Club which will identify measures to mitigate the potential impacts of the Project on the facility. United will fund the ongoing implementation of the agreement as it relates to the Project. The agreement will include consideration of aspects such as visual amenity, dust, blasting (including management of exclusion areas), noise and implications for security.

- Subject to the agreement of the infrastructure owner (e.g. TransGrid), the transmission lines and power lines installed in the vicinity of the Hunter Valley Gliding Club airfield will be fitted with high visibility markers and the towers fitted with daylight visible strobe lights.

6.0 References

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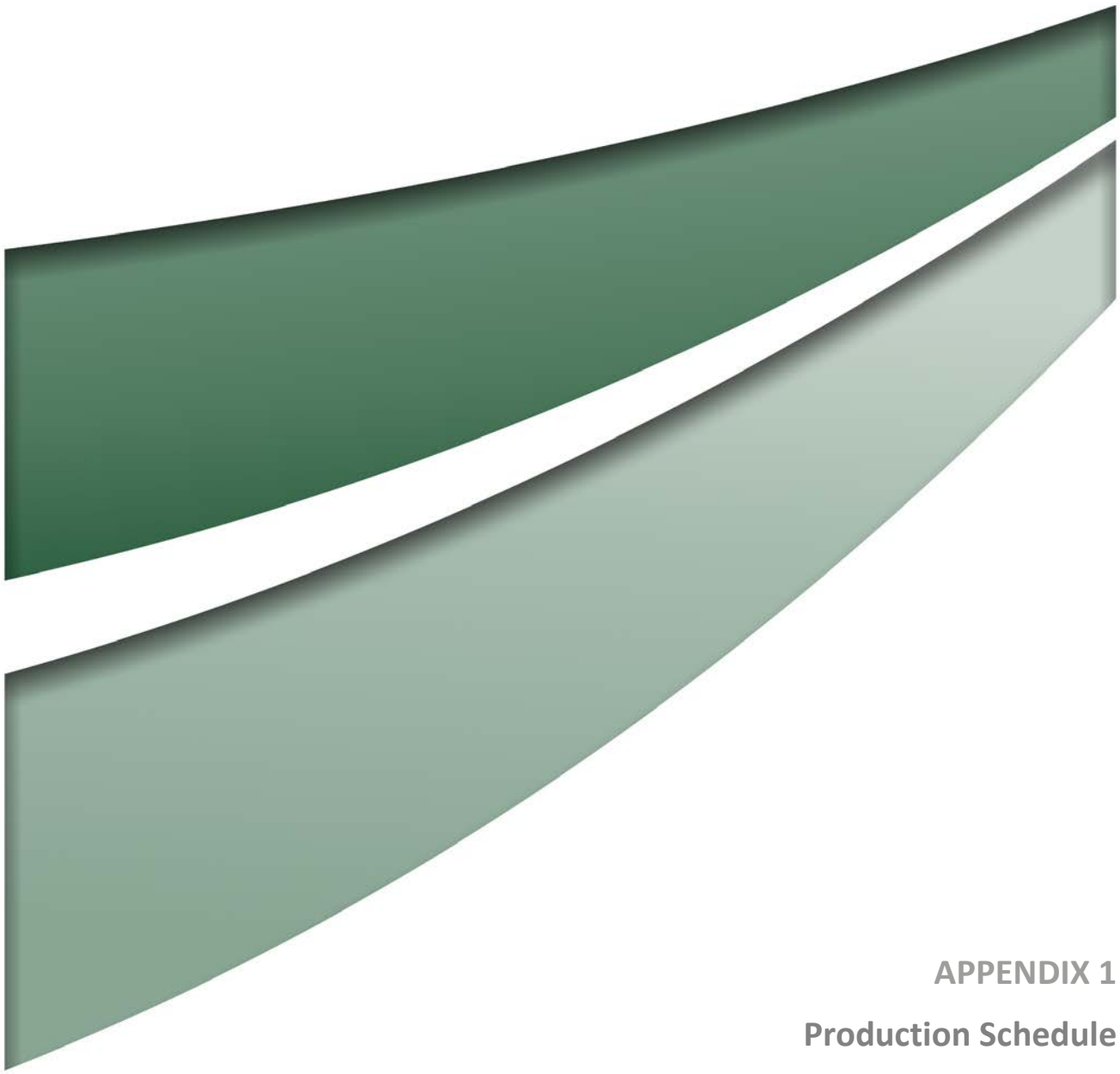


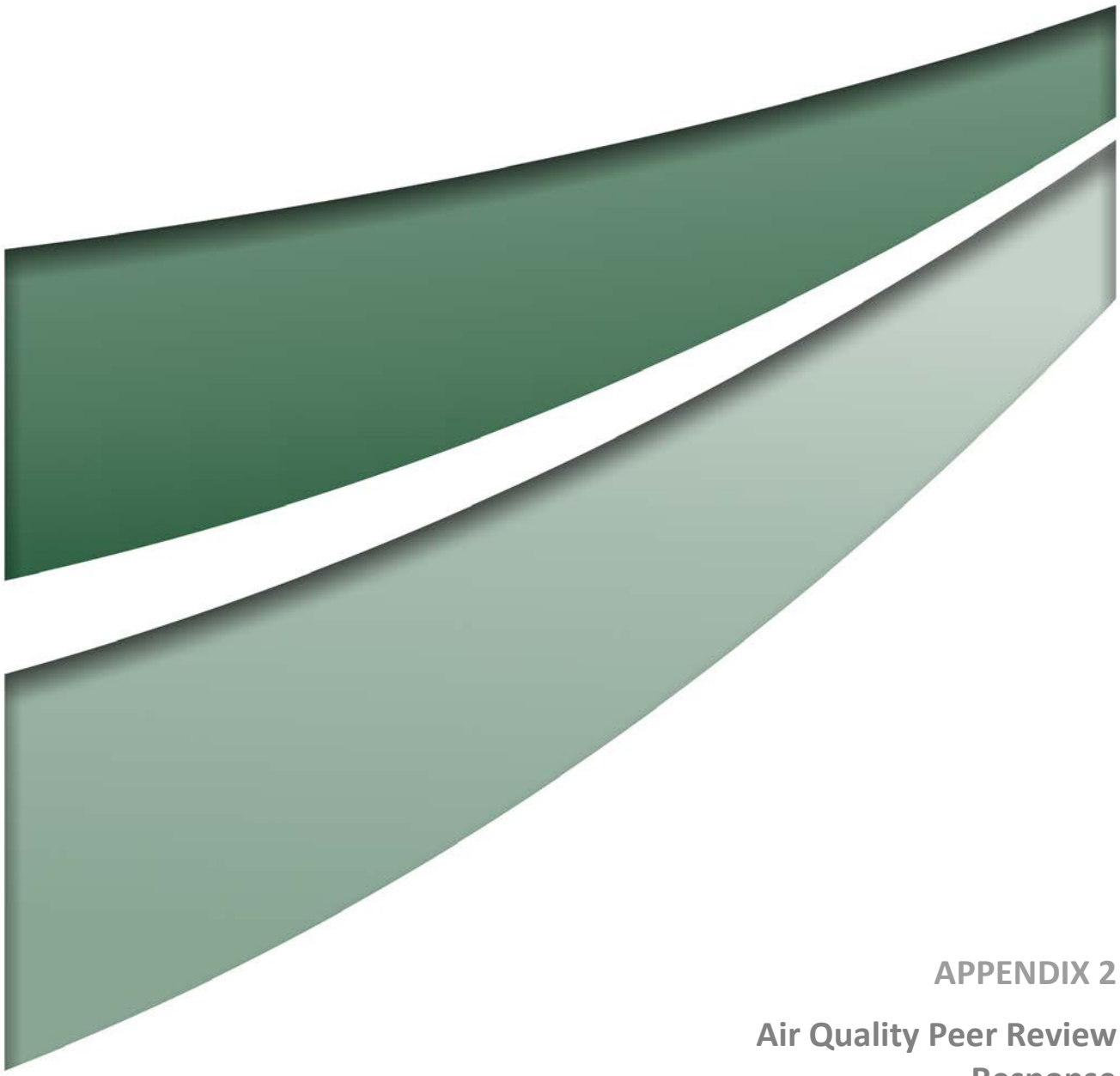
APPENDIX 1

Production Schedule

			Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
SCHEDULE QUANTITIES								
Open Cut Complex								
	Total Waste	bcm	29,172,950	51,838,322	54,261,455	47,024,512	46,662,602	43,745,827
	ROM Coal Tonnage	t	3,714,725	8,046,997	9,077,383	9,101,460	9,642,337	10,079,738
	PROD Coal Tonnage	t	2,384,156	5,080,121	5,855,593	6,031,289	6,188,010	6,769,380
ROM Quantities								
ROM Waste Volume	United	kbcm	13,310	33,842	34,550	34,942	34,728	30,933
	Wambo	kbcm	15,863	17,996	19,711	12,083	11,935	12,813
	OC Complex	**kbcm**	**29,173**	**51,838**	**54,261**	**47,025**	**46,663**	**43,746**
ROM Coal Tonnage	United	kt	1,517	5,371	6,429	7,345	7,876	8,115
	Wambo	kt	2,198	2,676	2,648	1,756	1,766	1,965
	OC Complex	**kt**	**3,715**	**8,047**	**9,077**	**9,101**	**9,642**	**10,080**
Product Quantities								
Product Coal Tonnage	United	kt	914	3,208	4,356	4,983	5,047	5,531
	Wambo	kt	1,470	1,872	1,500	1,048	1,141	1,238
	OC Complex	**kt**	**2,384**	**5,080**	**5,856**	**6,031**	**6,188**	**6,769**
Coarse Reject	OC Complex	kt	1,033	2,323	2,496	2,342	2,683	2,504
Tailings	OC Complex	km3	457	990	1,117	1,120	1,187	1,241

Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17
43,261,651	42,916,070	46,367,406	46,077,746	48,007,622	46,750,877	47,364,279	46,542,350	49,061,069	43,055,616	48,581,253	49,136,601
9,547,816	10,002,453	9,596,973	9,111,463	9,151,738	8,603,955	8,458,388	7,399,424	7,288,666	7,647,552	6,525,554	6,761,172
6,203,576	6,574,359	6,335,143	6,087,446	5,958,531	5,603,344	5,598,491	4,815,894	4,557,929	4,880,956	4,076,538	4,290,850
29,590	30,608	33,335	32,148	34,384	32,920	33,344	21,672	22,998	23,065	23,893	22,978
13,671	12,308	13,033	13,930	13,623	13,831	14,021	24,870	26,063	19,990	24,688	26,158
43,262	**42,916**	**46,367**	**46,078**	**48,008**	**46,751**	**47,364**	**46,542**	**49,061**	**43,056**	**48,581**	**49,137**
7,448	7,902	7,697	6,802	6,852	6,122	6,382	3,187	3,086	3,382	2,847	3,174
2,100	2,100	1,900	2,309	2,300	2,482	2,076	4,212	4,203	4,266	3,678	3,588
9,548	**10,002**	**9,597**	**9,111**	**9,152**	**8,604**	**8,458**	**7,399**	**7,289**	**7,648**	**6,526**	**6,761**
4,920	5,259	5,150	4,611	4,547	4,073	4,297	2,123	2,005	2,122	1,756	1,930
1,284	1,315	1,185	1,477	1,412	1,531	1,301	2,693	2,553	2,759	2,321	2,361
6,204	**6,574**	**6,335**	**6,087**	**5,959**	**5,603**	**5,598**	**4,816**	**4,558**	**4,881**	**4,077**	**4,291**
2,580	2,628	2,494	2,295	2,461	2,312	2,183	1,992	2,148	2,155	1,927	1,929
1,175	1,231	1,181	1,121	1,126	1,059	1,041	911	897	941	803	832

Year 18	Year 19	Year 20	Year 21	Year 22
49,668,517	47,211,275	46,878,173	39,538,545	9,589,437
7,116,202	6,197,771	6,123,874	4,780,360	2,530,928
4,475,351	4,001,367	4,242,758	3,183,290	1,729,326
23,819	11,851	10,330	2,634	0
25,849	35,360	36,548	36,905	9,589
49,669	**47,211**	**46,878**	**39,539**	**9,589**
3,537	2,581	2,310	789	0
3,579	3,617	3,814	3,992	2,531
7,116	**6,198**	**6,124**	**4,780**	**2,531**
2,171	1,680	1,512	504	0
2,304	2,322	2,731	2,679	1,729
4,475	**4,001**	**4,243**	**3,183**	**1,729**
2,072	1,701	1,391	1,215	599
876	763	754	588	311



APPENDIX 2

Air Quality Peer Review Response

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JACOBS

Umwelt (Australia) Pty Limited
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Teralba NSW 2284

Attention: John Merrell

16/01/2017 -

Dear John

United Wambo Open Cut Coal Mine Project – Response to Ramboll Environ Peer Review

Please see attached for information to address the requested information or queries contained in the Air Quality Impact Assessment Peer Review by Ramboll Environ (letter report dated 30/09/2016).

Throughout this response the Air Quality Impact Assessment (Jacobs 2006) has been referred to as the AQIA.

Yours sincerely

Shane Lakmaker
Senior Associate (Air Quality)
(02) 4979 2663 shane.lakmaker@jacobs.com

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1. Selection of $PM_{2.5}$ Background

3.1 Selection of $PM_{2.5}$ background

Recommendation: A more appropriate ambient $PM_{2.5}$ background concentration for the local air shed should be derived and adopted to assess cumulative $PM_{2.5}$ impacts.

The AQIA had to, necessarily, make some assumptions on the background levels that would apply at nearest sensitive receptors without double-counting the contribution from modelled sources. A value of 20% was used to estimate the hourly $PM_{2.5}$ from the hourly PM_{10} data collected at AQ03 in 2014. This approach was based on data collected in the vicinity of Hunter Valley mining operations which showed that ambient $PM_{2.5}$ has been in the order of 12% of the PM_{10} (SPCC 1986). It was also informed by a review of the Project emission inventories which indicated that $PM_{2.5}$ emissions are between 15 and 19% of the PM_{10}.

It is acknowledged that the $PM_{2.5}$ data collected by the OEH at Singleton, Camberwell and Muswellbrook since 2011 have shown higher ratios of $PM_{2.5}$ to PM_{10} than 20%, at least from a regional perspective. The data presented by the peer review (refer to Figure 1 of the peer review) have indicated a range between 30 and 50%. The effect of an alternative assumption on the $PM_{2.5}$ to PM_{10} ratio has been tested. Specifically, the background hourly $PM_{2.5}$ levels have been recalculated on the assumption that 40% of the PM_{10} is $PM_{2.5}$. Muswellbrook data should be excluded from the derivation of an appropriate fraction due to an increased influence of wood smoke at that location.

Figure 1 and **Figure 2** show the predicted cumulative 24-hour average and annual average $PM_{2.5}$ concentrations, based on the assumption that 40% of the PM_{10} is $PM_{2.5}$. There are no changes to the conclusions of the assessment from this investigation. That is, Property 19 is still predicted to experience $PM_{2.5}$ concentrations above the EPA's criteria while all other private sensitive locations are predicted to comply with the EPA's criteria.

The conclusions with respect to $PM_{2.5}$ impacts are also consistent with results from the OEH's $PM_{2.5}$ monitoring, specifically for stations located near mining operations. Camberwell is located within two kilometres of the Ashton and Glendell mines, and also downwind of these operations under the prevailing northwest winds. However the $PM_{2.5}$ concentrations at Camberwell show very little difference to the concentrations measured at Singleton. This further emphasises the regional nature of $PM_{2.5}$ and that the predictions for Residence 19, by dispersion modelling, are likely to be over-estimates of levels that will be experienced in reality.

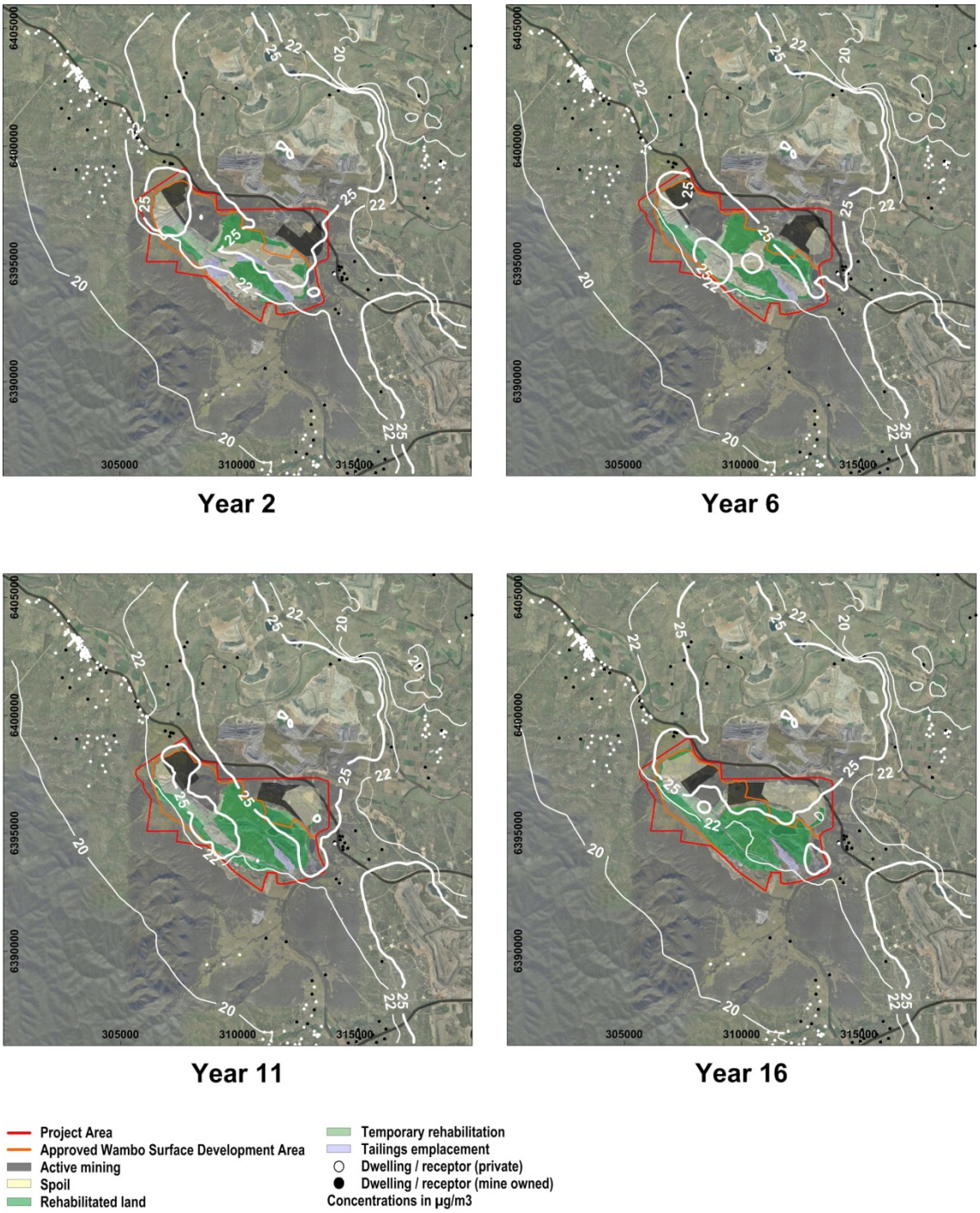

Figure 1 Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to all sources (with background assuming 40% $PM_{2.5}$ to PM_{10}) in future years

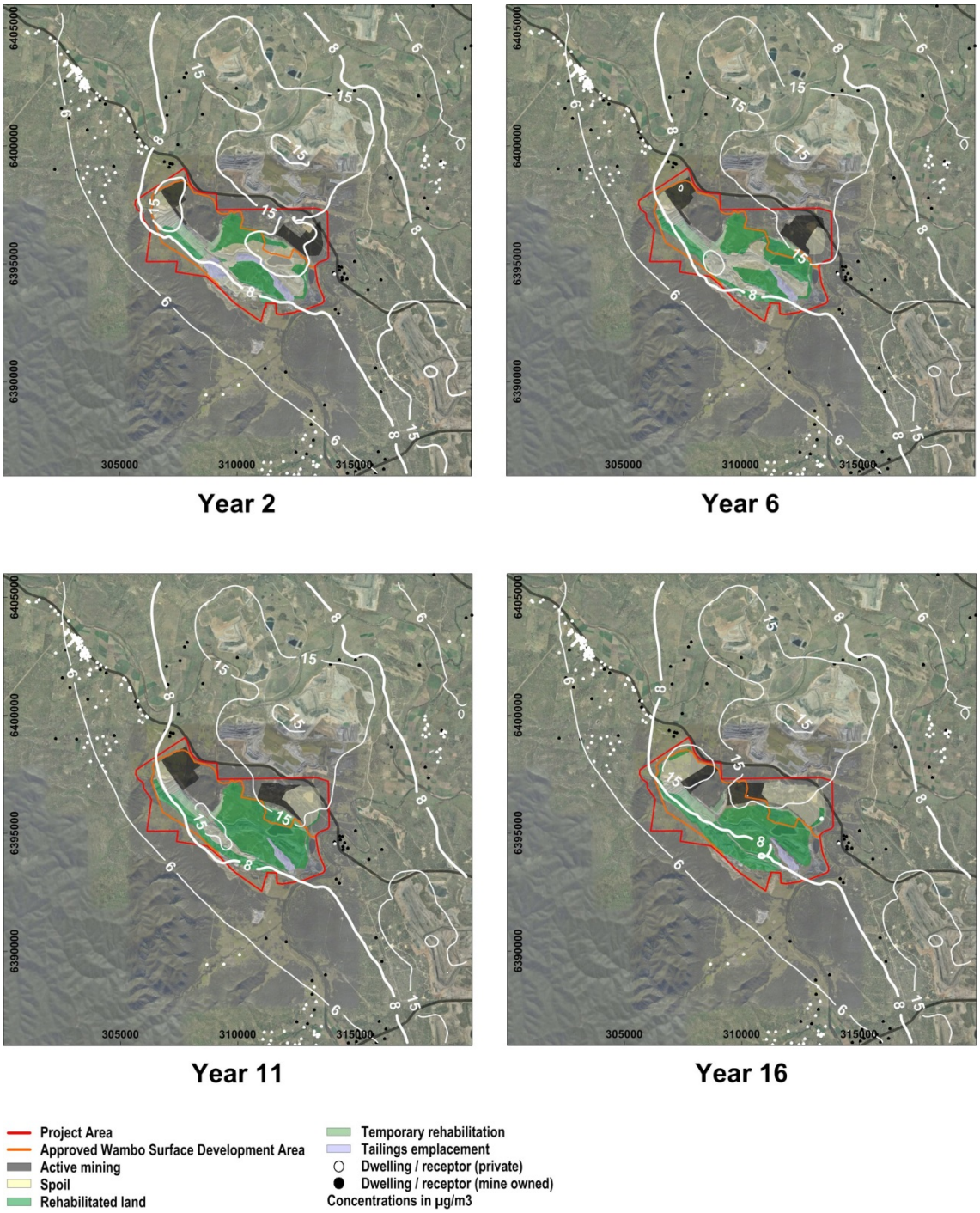

Figure 2 Predicted annual average $PM_{2.5}$ concentrations due to all sources (with background assuming 40% $PM_{2.5}$ to PM_{10}) in future years

2. Fugitive Dust Emissions Inventory

3.2 Fugitive dust emissions inventory

Recommendation: The unpaved road emission factors adopted should be clarified. Discrepancies between emission results tables should be clarified.

The reviewer requested a reference for the wheel-generated dust emission factor of 4 kg/VKT. The reference is as follows:

- SPCC (1983) "Air Pollution from Coal Mining and Related Developments". PM_{10} and $PM_{2.5}$ emission factors were derived from the TSP emission factor by applying the PM_{10}:TSP and $PM_{2.5}$:TSP ratios that are derived from the US EPA AP-42 equation for wheel-generated dust.

This approach was adopted for the following main reasons:

- The emission factor was derived specifically from monitoring downwind of mining activities (that is, haulage) in the Hunter Valley. It represents the contribution from both wheel generated particulates and the exhaust particulates.
- The emission factor has been used extensively in air quality impact assessments for the Hunter Valley since the mid-80's until present, and with successful outcomes in terms of mining operations which can demonstrate actual impacts within their originally predicted impacts. From around 2010 there has been an increased use of the US EPA AP-42 emission factor equation for wheel-generated dust for proposals in the Hunter Valley, however this approach has not undergone the level of verification that assessments based on the SPCC emission factor approach have undergone.
- The US EPA AP-42 emission factor equation for wheel-generated dust is sensitive to the prescribed road silt content. The silt content has, at least in recent times, been derived by limited spot samples. In some cases the silt content may have been measured several times over the course of a year, but in most cases only one or two samples per year are available. This low resolution is insufficient to resolve actual variations in silt content on mine haul roads. For example, the silt content can change daily depending on the environmental conditions, such as recent rainfall, or due to the application of gravel and subsequent compaction. The SPCC emission factor was originally developed to derive a long term, annual average estimate of emissions per kilometre travelled. This factor accounts for long term variations in the silt content.

There is a discrepancy in the reported total annual PM_{10} emissions presented in Table 15 and Table 26 of the AQIA. This discrepancy was due to a correction in Project definition data for Table 15 prior to finalisation of the report which, by error, did not get updated in Table 26. The corrected Table 26 is below. The data below are almost identical to the data in Table 26 from the AQIA. There are no changes to the conclusions in Section 8.7.1 of the AQIA as a result of this correction.

Table 1 Estimated PM_{10} emissions from diesel exhausts (revised Table 26 from AQIA)

Item	Value by year			
	Year 2	Year 6	Year 11	Year 16
Total fuel used (litres)	55,252,654	48,734,531	42,302,025	40,643,667
Diesel exhaust emission factor (kg/kL)	2.84	2.84	2.84	2.84
Diesel exhaust emissions - trucks only (kg/y)	82,637	77,362	63,736	58,922
(1) Total site emissions (from Table 15) (kg/y)	1,354,525	1,292,109	1,265,919	1,295,987
(2) Total site emissions assuming 85% control not applied to truck exhaust (kg/y)	1,424,766	1,357,868	1,320,095	1,346,071
Per cent change between emission calculation approaches (1 and 2) (%)	5%	5%	4%	4%

3. Diesel Fuel Combustion Emissions

3.3 Diesel fuel combustion emissions

Recommendation: The annual $PM_{2.5}$ emissions for haul trucks should be revised and modelling updated to assess the impacts in the surrounding environment. While the increase in PM_{10} from diesel exhaust is relatively minor, for completeness of assessment, the modelling for PM_{10} should also be revised accordingly.

This recommendation is not accepted. As noted in Section 8.7.1 of the AQIA, for trucks travelling on unsealed roads, the emission factors represent the contribution from both wheel generated particulates and the exhaust particulates. The purpose of the discussion in Section 8.7.1 was to address a potential concern that the assessment may underestimate diesel particulate emissions by applying a control factor of 85% to the emissions from haulage. The testing of assumptions in Section 8.7.1 was not intended to be inferred that emissions were underestimated.

The AQIA maintains that the emission factors, including with control factors, are based on measured emissions which include diesel particulates in the form of both PM_{10} and $PM_{2.5}$. In addition the emission factors are likely to include more diesel exhaust particulate than from a modern truck as the factors were developed on the basis of emissions from trucks measured in the 1980's (that is, older trucks). This is the main reason why the emissions data used in the modelling were not modified.

The 75% control factor for "Level 2" watering of haul roads (from the NPI) was developed from measurements which included the contribution from both wheel generated particulates and the exhaust particulates. Todoroski Air Sciences has also reported (TAS 2016) that several studies, reported to the EPA, confirmed that a control factor of 85% can be maintained, representing all components of the truck haulage emission. For this reason, and for the reasons described above, the emissions data used in the modelling were not modified. More importantly, the AQIA showed that the predicted particulate matter concentrations were over-estimated when compared to the measured concentrations. This provided further evidence that the emissions were not underestimated.

The recommendation from the peer review is for a revision to the PM_{10} and $PM_{2.5}$ modelling with alternative assumptions. It is the AQIA author's opinion that this will not resolve potential $PM_{2.5}$ issues with any more certainty than is presented in the AQIA. The prediction of $PM_{2.5}$ has necessarily had to rely on several assumptions which led to increased uncertainty in the $PM_{2.5}$ assessment. These uncertainties have mainly arisen from an absence of relevant monitoring data.

As noted previously the conclusions with respect to $PM_{2.5}$ impacts are consistent with results from the OEH's $PM_{2.5}$ monitoring. That is, $PM_{2.5}$ concentrations at Camberwell show very little difference to the concentrations measured at Singleton, even though Camberwell is located within two kilometres, and downwind, of the Ashton and Glendell mines. This emphasises the regional nature of $PM_{2.5}$ and that the predictions, by dispersion modelling, are likely to be over-estimates of levels that will be experienced in reality. Glencore is proposing a campaign of $PM_{2.5}$ monitoring to provide additional clarification to this issue.

4. Analysis of cumulative 24-hour average concentrations

3.4 Analysis of cumulative 24-hour average concentrations

Recommendation: The likelihood of additional exceedance of 24-hour average assessment criterion as a result of project emissions should be analysed and presented.

Appendix E of the AQIA provided model results for all monitors and residences. Appendix E also included predictions of the number of days above 50 µg/m^3 for PM_{10}. From examination of these results there are two private residential properties which are predicted to experience additional days above 50 µg/m^3:

- Property 19, and
- Property 28

Both of these properties were identified in the AQIA, specifically in Table 23. A copy of the relevant section of this table is shown below in Table 2. The criterion has been corrected.

Table 2 Locations with potential additional exceedances of PM_{10} criteria

Residence ID	Cumulative					Criteria
	2014	Year 2	Year 6	Year 11	Year 16	
Number of days above 50 µg/m^3						
19	4	52	64	41	13	No additional exceedances
28	3	6	3	3	3	

Both Property 19 and Property 28 have been afforded acquisition rights and are now no longer being assessed as sensitive receptors.

References

Jacobs (2016) “United Wambo Open Cut Coal Mine Project – Air Quality Impact Assessment”. Prepared for United Collieries – Glencore, dated 13 July 2014. Reference IA084400.

SPCC (1983) “Air Pollution from Coal Mining and Related Developments”. State Pollution Control Commission of NSW (now EPA).

SPCC (1986) *“Particle size distributions in dust from open cut coal mines in the Hunter Valley”.* Report number 10636-002-71. Prepared for the State Pollution Control Commission of NSW (now EPA) by Dames and Moore.

TAS (2016) “Review – Air Quality Impact Assessment – Mt Owen Continued operations Project”. Prepared by Todoroski Air Sciences for the NSW Department of Planning & Environment. Dated 29 April 2016. Job Number 15090470.

APPENDIX 3

Compliance Noise Model

Briefing Note

To: Aislinn Farnon
From: Tim Proctor
Author: Tim Proctor
Date: 30 January 2017
Subject: Noise Modelling for Wambo Coal Pty Limited

1.0 Background

United Collieries Pty Limited (United) and Wambo Coal Pty Limited (Wambo) operate neighbouring mining operations located approximately 16 kilometres west of Singleton in the Hunter Valley region of NSW. Under a Joint Venture arrangement, United and Wambo propose to develop the United Wambo Open Cut Coal Mine Project (the Project) which will involve combining the existing open cut operations at Wambo with a proposed new open cut coal mine at United. The Project is currently being assessed as a State Significant Development (SSD 7142), with the Environmental Impact Statement (EIS) for the Project was placed on public exhibition from 11 August 2016 to 22 September 2016.

The Project seeks to combine the existing open cut operations at Wambo with a proposed new open cut coal mine at the United Collieries. The continued operation of Wambo's Coal Handling and Preparation Plant (CHPP), train loading facility and underground mine will continue to be owned and operated by Wambo and subject to the existing Wambo development consents and Environment Protection Licence (EPL). It is noted however, that an extension to the life of operation of the CHPP and coal terminal post closure of the underground mining operations forms part of the Project, as modifications to the existing Wambo approvals, and has been assessed in the EIS.

Accordingly, the existing noise criteria for the Wambo mine will continue to apply until such time as mining operations commence under a development consent which is granted for the Project (i.e. the Development Consent and Environment Protection Licence should include both noise criteria that apply to Wambo prior to the commencement of mining operations under a development consent granted for the Project, and noise criteria that apply following the commencement of mining operations under a development consent granted for the Project).

This will provide for ongoing operation of the Wambo Open Cut under its existing approvals until mining operations comprising the Project have commenced (i.e. to allow time for gaining necessary supplementary NSW and Commonwealth government approvals, approval of any required environmental management plans, construction works and transfer of operational control from Wambo to United).

In its submission on the Project, the Environment Protection Authority (EPA) requested information relating to the predicted noise levels of the Wambo mine

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without the Wambo Open Cut for the purposes of establishing noise criteria for the Wambo mine should the Project be approved. As agreed in further discussions with DPE and EPA a compliance noise model has been developed to identify the contribution of the Wambo infrastructure and underground mine.

To address this request a compliance noise model has been developed to identify the noise contribution of the Wambo infrastructure and underground mine, including the recent approved modifications to Wambo mine (Wambo MOD 12, approved on 16 December 2016). The modelling approach and results are provided in this advice.

2.0 Description of WCPL Operations

Further details on the description of approved Wambo operations considered as part of this assessment is included in the following sections.

Coal Handling and Preparation Plant

The CHPP is capable of processing approximately 1,800 t/hr of ROM coal. A product coal stockpile with an approximate capacity of 500,000 t is used to stockpile product coal, prior to reclaim and loading to trains for transport off-site. The CHPP operates up to 24 hours per day, seven days per week.

Train Loading Facility

The Wambo train loading facility (and rail loop) is capable of loading product coal onto trains at a rate of 4,500 t/h. Product coal is reclaimed from the product coal stockpile at three reclaim points and is transferred via conveyors to the train load-out bin. The train loading facility operates up to 24 hours per day, seven days per week. An average of four trains is loaded each day, with a maximum of six trains per day being loaded during peak coal transport periods. It is noted that the Project seeks to increase the maximum number of trains per day from six to eight. It is noted that train movements on the rail loop have been assessed as industrial noises in accordance with the NSW Industrial Noise Policy (INP) (EPA 2000).

South Bates Underground Mine

Development of the South Bates Underground Mine commenced in October 2014 and longwall mining commenced in the South Bates (Whybrow Seam) Underground Mine (i.e. Longwalls 11 to 13) in February 2016. Mining operations will progress to the South Bates (Wambo Seam) Underground Mine, with longwall mining scheduled to commence in June 2017.

Access to the approved South Bates Underground Mine is via the Bates South open cut pit wall. ROM coal is conveyed to a stockpile where it is loaded into haul trucks and hauled to the ROM bin or the ROM coal stockpile.

The South Bates Underground Mine is scheduled for completion at the end of 2018 (Wambo Coal Pty Limited (2015) Mining Operations Plan 2015 – 2020).

South Wambo Underground Mine Modification

The mining of the South Wambo (Arrowfield and Bowfield Seams) Underground Mine was assessed as part of the Wambo Development Project Environmental Impact Statement (2003 Wambo EIS) and approved under the development Consent (DA 305-7-2003). As part of the recently approved Modification 12 (MOD 12), a rearrangement of South Wambo Underground Mine (MOD 12) involving the realignment and extension/relocation of the approved Mine longwall panels and mining of the

Woodlands Hill Seam rather than the Bowfield Seam. The approved layout of surface facilities of the South Wambo Underground Mine and CHPP is shown on **Figure 1**. The approved life of mine of the South Wambo Underground Mine has been extended by 7 years up to 2032.

3.0 Modelling Scenarios

ROM coal production rate from the South Wambo Underground Mine will increase from approved 7.5 to 9.75 Mtpa in accordance with MOD 12. It is noted that MOD 12 does not involve any changes to approved South Bates Underground Mine.

The following three operating scenarios have been considered in this assessment:

- 2019 incorporating the CHPP, train loading facility and South Bates underground mine;
- 2023 incorporating the CHPP, train loading facility and South Wambo underground mine; and
- 2028 incorporating the CHPP, train loading facility and South Wambo underground mine.

The compliance noise model was used to predict the noise contribution of the Wambo mine at sensitive receivers in the region surrounding the mine (refer to **Figure 2**), which for ease of reference are the noise receiver areas defined for the Project in the EIS and accompanying Noise Impact Assessment (NIA). As a 24 hour 7 day per week operation, the Wambo mine would need to comply with EPL noise criteria under the following meteorological conditions:

- wind speeds up to and including 3 metres per second
- F-class stability conditions with wind speeds up to and including 2 metres per second.

The compliance noise model was run for 139 multi-variable meteorological conditions that would be licensable within EPL noise criteria meteorological conditions. The 139 multi-variable meteorological conditions used are the licensable conditions within the multi-variable meteorological conditions used in the assessment of the Project.

As a 24 hour 7 day per week operation, the achievable criteria for the Wambo mine would be set at the maximum predicted noise levels for the licensable multi-variable meteorological conditions.

4.0 Noise Sources

The noise sources incorporated into the ENM noise models of the Wambo operations are detailed in **Table 1**. The noise sources are shown on **Figure 1**, with ventilation fan and bleeder noise sources shown in **Figure 3**.

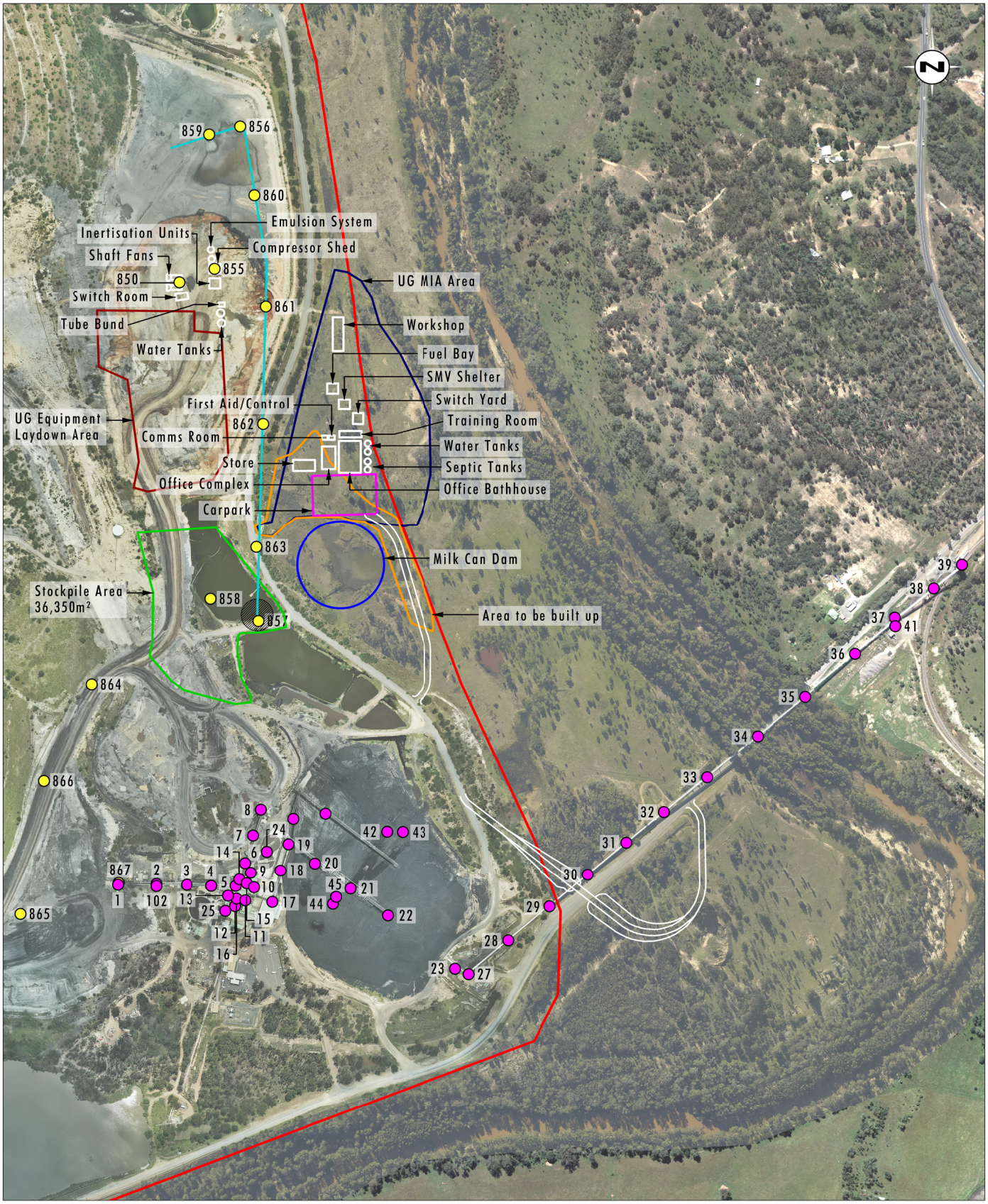


Image Source: AAM (2012), United (2016)
Data Source: Glencore (2017)

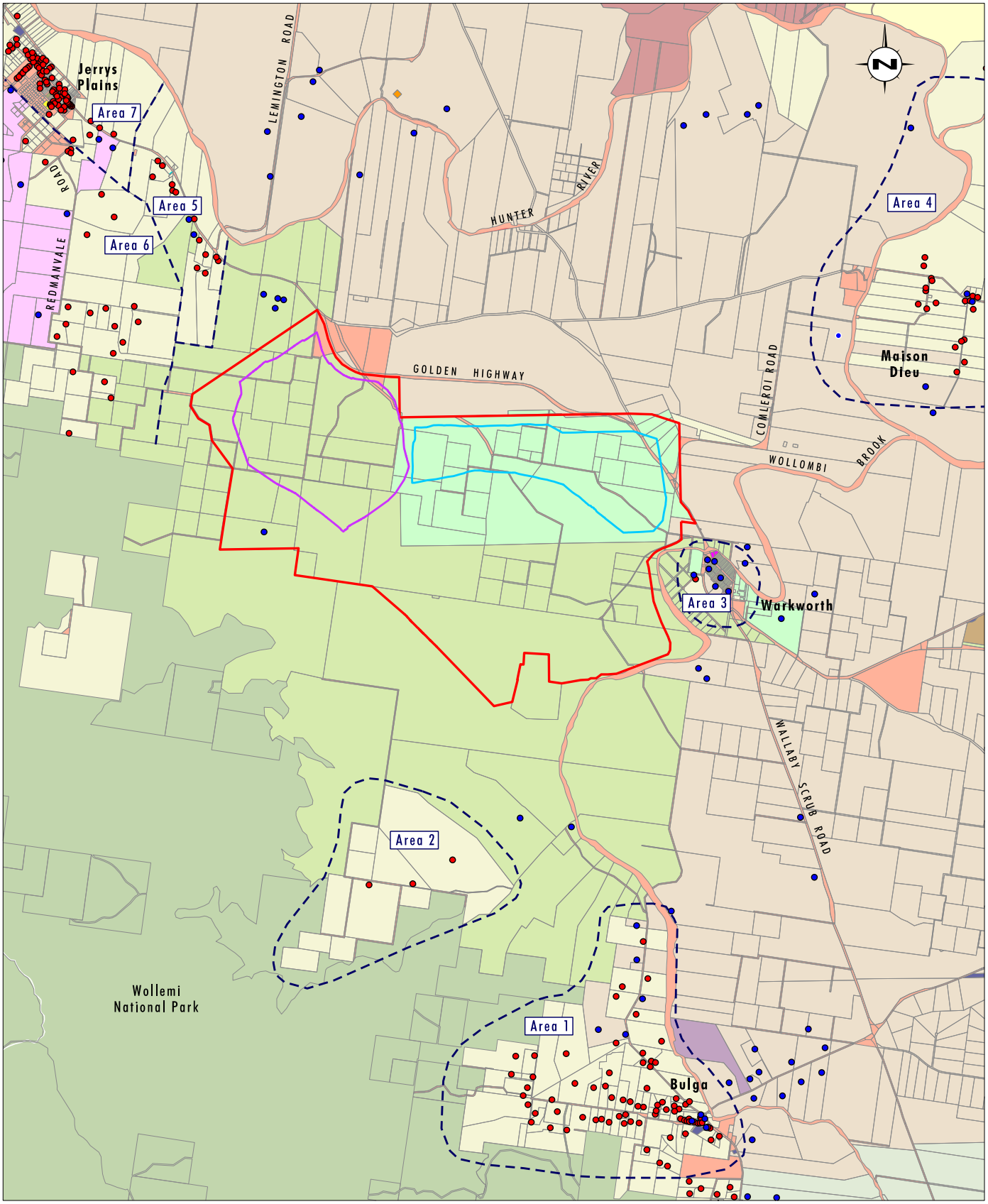
0 100 200 400m
1:8000

Legend

Project Area

FIGURE 1

Noise Source Locations



Data Source: LPMA (2009), Department of Natural Resources (2005)

0 1.0 2.0 4.0km

1:90 000

Legend

- Project Area
- Proposed Conceptual United Open Cut Pit
- Proposed Conceptual Wambo Open Cut Realignment
- Receiver Area
- Mine Owned (Ashton)
- Mine Owned (Bulga)
- Mine Owned (Coal and Allied)
- Mine Owned (Doyles Creek)
- Mine Owned (Glencore)
- Mine Owned (Integra)
- Mine Owned (Peabody)
- Mine Owned (Ravensworth)
- Mine Owned (Wambo)
- AGL Energy
- Ausgrid
- Bulga Community Centre
- Government Authority (Federal, State or Local)
- Department of Education and Communities
- Diocese of Newcastle
- National Parks and Wildlife Service
- Private
- Redbank Energy
- Singleton Council
- Telstra
- Wanaruah Local Aboriginal Land Council
- Private Residence
- Mine Owned Residence

FIGURE 2

Receiver Areas

File Name (A4): R19/3509_548.dgn
20160512 14.05

Table 1 – Equipment Sound Power Level, dB(A) for modelled scenarios

Operation	Equipment Description	CHPP, Coal Terminal plus South Bates U/G, approx. 2019	CHPP, Coal Terminal plus South Wambo U/G, approx. 2023	CHPP, Coal Terminal plus South Wambo U/G, approx. 2028
Coal Handling and Preparation Plant	Receival Bin/Feeder	111	111	111
	Raw Coal Conveyor	81 dB(A)/m	81 dB(A)/m	81 dB(A)/m
	- Drive	100	100	100
	Washery plus Secondary/Tertiary Crushers	120	120	120
	Reject Bin and Drive	100	100	100
	Reject Conveyor	77 dB(A)/100m	77 dB(A)/100m	77 dB(A)/100m
	Product Conveyor - Skyline 1	80 dB(A)/100m	80 dB(A)/100m	80 dB(A)/100m
	- Drive	100	100	100
	Product Conveyor - Skyline 2	80 dB(A)/100m	80 dB(A)/100m	80 dB(A)/100m
	- Drive	100	100	100
	ROM Front-end Loader - CAT 992	117	117	117
	Clean Coal Dozers - CAT D11	117	117	117
Train Loading System	Reclaim Conveyor	87 dB(A)/m	87 dB(A)/m	87 dB(A)/m
	- Drive	107	107	107
	Train Loadout Conveyor	87 dB(A)/m	87 dB(A)/m	87 dB(A)/m
	- Drive	107	107	107
	Train Loadout Bin	107	107	107
	Locomotive Set	111	111	111
South Bates Underground	Ventilation Fans	128	-	-
	Stackout Conveyors	110	-	-
	- Drive	103	-	-
	Front-end Loader - CAT 992	121	-	-
	Haul Trucks - CAT 789	123	-	-
South Wambo Underground	Shaft Fan	-	97[2]	97[2]
	Bleeder Fan	-	117 [1]	97[2]
	Pit Conveyor	-	112	112
	- Drive	-	98	98
	Ramp Conveyor	-	112	112
	- Drive	-	103	103
	Front-end Loader - CAT 992	-	117	117
	Haul Trucks - CAT 789	-	120	120

Note 1: Reduced from 125 dB(A) as per MOD 12 commitment to optimised outlet/louver orientation to achieve at least 8 dB noise attenuation at the nearest private receivers (refer to Table 2).

Note 2: Reduced from 105dB(A) as per MOD 12 commitment to optimised outlet/louver orientation to achieve at least 8 dB noise attenuation at the nearest private receivers (refer to Table 2).

South Bates Underground Mine

South Bates Underground Mine ventilation fan and associated conveyors have been located within the South Bates open cut mine adjacent to the underground mine high wall portals.

South Wambo Underground Mine Ventilation System

The South Wambo Underground Mine modification includes the construction and operation of five ventilation shafts (refer to **Figure 3**). The construction and operation of the ventilation shafts would be staged with the progression of mining and may be used as upcast shafts (including installation of fans) or downcast shafts, depending on the location of mining.

Up to four gas drainage boreholes would be required per longwall. This would typically consist of two pre-drainage and two goaf gas drainage boreholes. The gas drainage boreholes and associated infrastructure would be progressively constructed, operated and decommissioned with the staged progression of mining. MOD 12 includes the construction and operation of two centralised gas plants. Only one gas plant would be operational at any time.

The sound power levels for the ventilation fans and bleeders and indicative noise mitigation requirements are presented in the MOD 12 EA (2016) and reproduced in **Table 2**.

Table 2 - MOD 12 Ventilation System Indicative Sound Power Levels, dB(A)

Year	Ventilation System Component					
	Shaft No.	Mitigation	SWL	Bleeder No.	Mitigation [1]	SWL
2019	1	High performance silencer [1] plus optimised outlet/louver orientation [2]	105	n/a		
2023	2		105	1	Optimised outlet louver orientation [2]	125
2028	3		105	2	High performance silencer [1] plus optimised outlet/louver orientation [2]	105

Note 1: Customised high performance silencer to achieve an overall SWL of 105 dBA at maximum fan operating duty.
Note 2: Optimised outlet/louver orientation to achieve at least 8 dB noise attenuation at the nearest private receivers.
(Source: MOD 12 EA NIA Table 5)

The location of the fan shafts and bleeders are shown on **Figure 3**.

The construction activities associated with the South Wambo Underground Mine Modification are addressed in the MOD 12 Development Application.

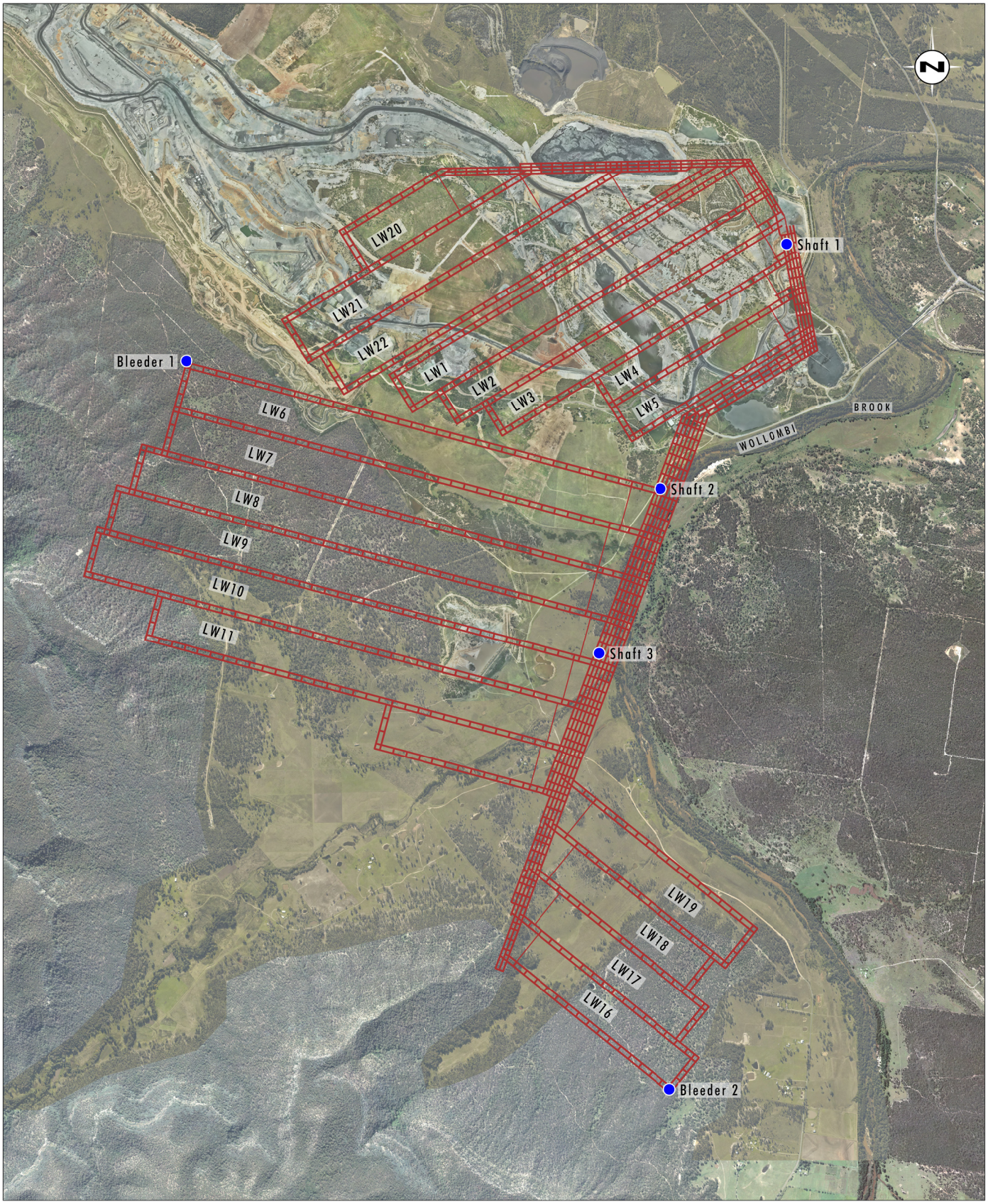


Image Source: AAM (2012), United (2016)
Data Source: Glencore (2017)

0 0.5 1.0 2km
1:40 000

Legend

South Wambo Underground

FIGURE 3

Location of the South Wambo Underground Fan Shafts and Bleeders

File Name (A4): R19/3509_554.dgn
20150309 9.47

5.0 Noise Modelling Results

The modelling results for all the sensitive receivers in the region surrounding Wambo, as identified in the Project EIS are presented in **Appendix 1**.

The modelling results are the maximum expected noise levels[1] as predicted for the multi-variable meteorological conditions used in the United Wambo EIS that would be licensable within an EPL. That is:

windspeed up to and including 3 metres per second

F-class stability conditions with wind speeds up to and including 2 metres per second.

The modelling results take into account the commitments to noise attenuation as detailed in MOD 12 for ventilation infrastructure as part of the South Wambo underground mining operations.

Under the INP, the minimum noise criteria is 35 dB(A). Therefore, to inform the assessment of suitable noise criteria for Wambo mine, all results in **Appendix 1** over 35 dB(A) have been highlighted. A review of the results indicates:

The maximum expected noise level in Area 1 under licensable meteorological conditions would be 35 to 38dB(A) at Property 3 and 35 to 37dB(A) at Properties 7 and 379 in 2028 of the operation. Maximum expected noise levels in the evening and night would be less than the current consent criteria. Maximum expected noise levels at Residences 3, 7 and 379 in the day would be above the current consent criteria of 35 dB(A).

The maximum expected noise level in Area 2 under licensable meteorological conditions would be 38 to 39 dB(A) at Property 25 and 35 to 37 dB(A) at Property 35a. Maximum expected noise levels in the evening and night would be less than the current consent criteria. Maximum expected noise levels at Residences 25 and 35 in the day would be above the current consent criteria of 35 dB(A).

The maximum expected noise level at Property 19 in Area 3 under licensable meteorological conditions would be 57 to 59 dB(A). This is consistent with the results in the 2003 Wambo EIS where the predicted noise level under adverse meteorological conditions was 57 dB(A). It is noted that this property is subject to an existing voluntary acquisition clause in Wambo development consents.

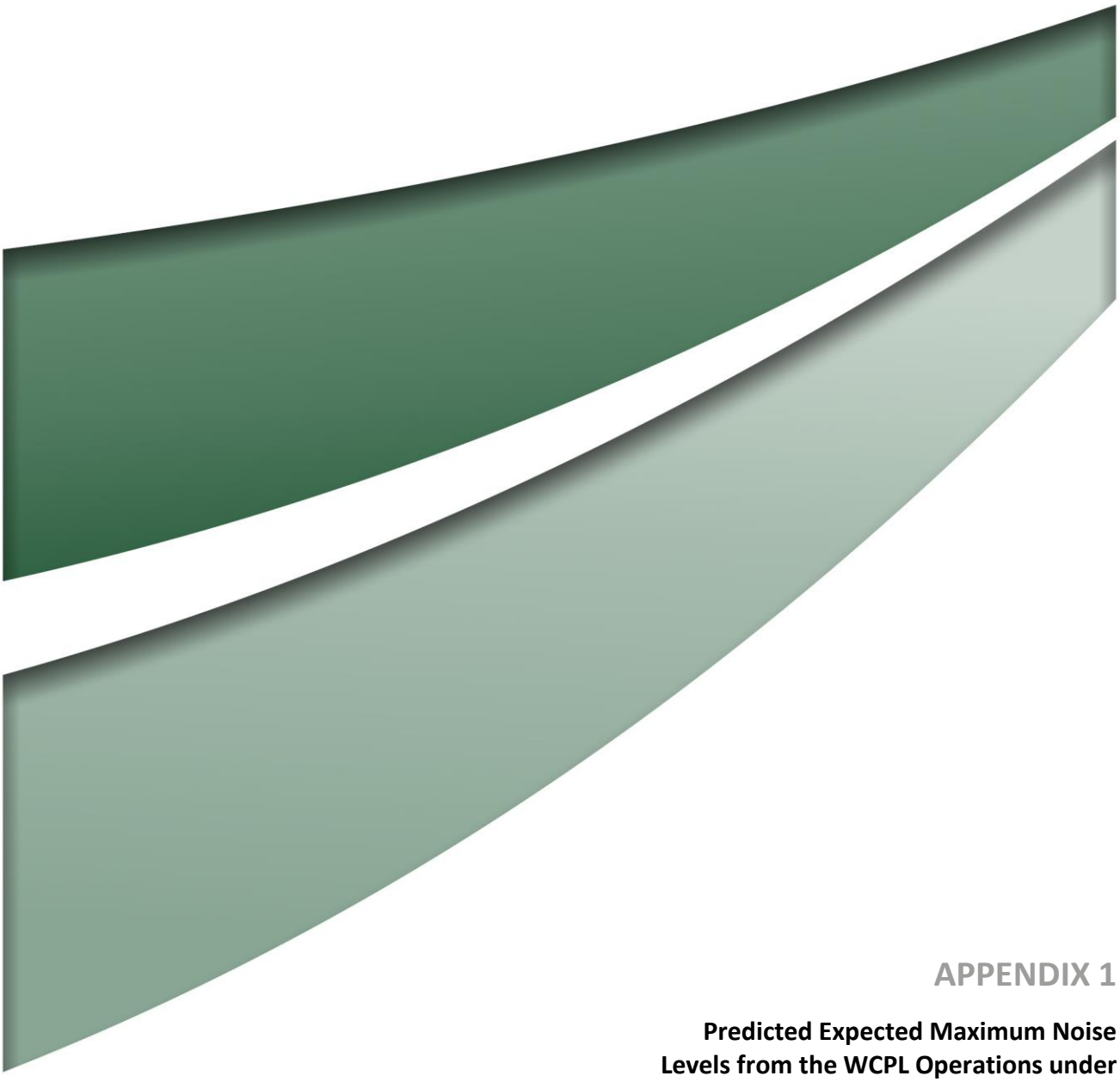
The predicted noise levels at all other properties in Area 4, 5, 6 and 7 under all licensable meteorological conditions would be less than 35 dB(A).

In relation to expected noise levels during the day, it is noted that the 2003 Wambo EIS only modelled non-adverse conditions in the daytime period (annual wind speed of 0 m/s and a temperature gradient of 0°C/100 m) compared to the multi-variable meteorological conditions used in this assessment.

As aforementioned, the modelling results presented take into account the commitments to noise attenuation as detailed in MOD 12 for ventilation infrastructure as part of the South Wambo underground mining operations. The MOD 12 EA (2016) Noise Impact Assessment recommended that WCPL undertake a review of the ventilation system acoustical design for Fan Shaft 3 and Bleeder 2 prior to construction of these system elements. Based on the modelling results this recommendation should be adopted by WCPL to reduce the maximum expected noise level in Area 1.

[1] Taken as the 1st percentile noise result.

The maximum predicted noise levels in the northern section of Area 1 and Area 2 is due to the combined contribution from the ventilation infrastructure and the mobile equipment (coal haulage truck and front end loader). With noise controls in place on the ventilation infrastructure, to achieve a net reduction in the predicted noise levels, noise controls should also be considered for the coal haulage fleet. A 6 dB reduction in the SWL of the coal haulage fleet would reduce the maximum expected noise level at Property 3 by approximately 2 dB and Property 25 by approximately 3 dB.



APPENDIX 1

Predicted Expected Maximum Noise Levels from the WCPL Operations under Licensable Meteorological Conditions, dB(A)

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
Area 1 - R_AGL	Day	35	31	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 1 - R003	Day	35	36	-	-	-
	Evening	40	-	36	-	-
	Night	40	-	-	35	38
Area 1 - R006	Day	35	34	-	-	-
	Evening	39	-	33	-	-
	Night	39	-	-	33	35
Area 1 - R007	Day	35	36	-	-	-
	Evening	39	-	35	-	-
	Night	39	-	-	35	37
Area 1 - R013	Day	35	30	-	-	-
	Evening	36	-	< 30	-	-
	Night	36	-	-	< 30	31
Area 1 - R379	Day	35	36	-	-	-
	Evening	38	-	35	-	-
	Night	38	-	-	35	37
Area 1 - R380	Day	35	32	-	-	-
	Evening	37	-	32	-	-
	Night	37	-	-	31	33
Area 1 - R381	Day	35	30	-	-	-
	Evening	36	-	30	-	-
	Night	36	-	-	< 30	31
Area 1 - R382	Day	35	32	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	31	32
Area 1 - R383	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 1 - R384	Day	35	31	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	< 30	31
Area 1 - R386	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 1 - R388	Day	35	30	-	-	-
	Evening	35	-	30	-	-

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Night	35	-	-	< 30	31
Area 1 - R389	Day	35	30	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	< 30	31
Area 1 - R390	Day	35	31	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 1 - R395	Day	35	31	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	30	32
Area 1 - R396	Day	35	31	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	30	32
Area 1 - R397a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	30
Area 1 - R397b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	30
Area 1 - R400a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	30
Area 1 - R400b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	30
Area 1 - R401	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	30
Area 1 - R402	Day	35	30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	31
Area 1 - R404	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	30
Area 1 - R495	Day	35	30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	31
Area 2 - R025	Day	35	39	-	-	-

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Evening	40	-	38	-	-
	Night	40	-	-	38	39
Area 2 - R035a	Day	35	37	-	-	-
	Evening	38	-	35	-	-
	Night	38	-	-	35	37
Area 2 - R035b	Day	35	35	-	-	-
	Evening	38	-	34	-	-
	Night	38	-	-	34	35
Area 3 - R019	Day	-	58	-	-	-
	Evening	-	-	57	-	-
	Night	-	-	-	57	59
It should be noted that this Residence 19 is subject to existing voluntary acquisition clause in Wambo development consents.						
Area 4 - R474a	Day	35	31	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	32
Area 4 - R474b	Day	35	30	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 4 - R483	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 4 - R485	Day	35	31	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	31	32
Area 4 - R486a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	30
Area 4 - R486b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	30
Area 4 - R487a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	31
Area 4 - R487b	Day	35	30	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 4 - R487c	Day	35	31	-	-	-

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Evening	35	-	31	-	-
	Night	35	-	-	31	32
Area 4 - R487d	Day	35	31	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	31	32
Area 4 - R488	Day	35	30	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 4 - R489	Day	35	30	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 4 - R490	Day	35	30	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 4 - R491	Day	35	30	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 4 - R492	Day	35	30	-	-	-
	Evening	35	-	30	-	-
	Night	35	-	-	30	31
Area 4 - R493a	Day	35	31	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	30	32
Area 4 - R493b	Day	35	31	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	30	32
Area 4 - R495	Day	35	32	-	-	-
	Evening	35	-	32	-	-
	Night	35	-	-	31	32
Area 4 - R496	Day	35	31	-	-	-
	Evening	35	-	31	-	-
	Night	35	-	-	31	32
Area 4 - R497	Day	35	32	-	-	-
	Evening	35	-	32	-	-
	Night	35	-	-	32	33
Area 5 - R016	Day	35	< 30	-	-	-
	Evening	40	-	< 30	-	-
	Night	40	-	-	< 30	< 30

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
Area 5 - R017	Day	35	< 30	-	-	-
	Evening	38	-	< 30	-	-
	Night	38	-	-	< 30	< 30
Area 5 - R028a	Day	35	< 30	-	-	-
	Evening	40	-	< 30	-	-
	Night	40	-	-	< 30	< 30
Area 5 - R028b	Day	35	< 30	-	-	-
	Evening	40	-	< 30	-	-
	Night	40	-	-	< 30	< 30
Area 5 - R039	Day	35	< 30	-	-	-
	Evening	40	-	< 30	-	-
	Night	40	-	-	< 30	< 30
Area 5 - R040	Day	35	< 30	-	-	-
	Evening	40	-	< 30	-	-
	Night	40	-	-	< 30	< 30
Area 5 - R043	Day	35	< 30	-	-	-
	Evening	37	-	< 30	-	-
	Night	37	-	-	< 30	< 30
Area 5 - R044	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 5 - R050a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 5 - R050b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 5 - R050c	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 5 - R056	Day	35	< 30	-	-	-
	Evening	36	-	< 30	-	-
	Night	36	-	-	< 30	< 30
Area 5 - R133	Day	35	< 30	-	-	-
	Evening	36	-	< 30	-	-
	Night	36	-	-	< 30	< 30
Area 6 - R029	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Night	35	-	-	< 30	< 30
Area 6 - R030	Day	35	< 30	-	-	-
	Evening	38	-	< 30	-	-
	Night	38	-	-	< 30	< 30
Area 6 - R033	Day	35	< 30	-	-	-
	Evening	40	-	< 30	-	-
	Night	40	-	-	< 30	< 30
Area 6 - R041a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 6 - R041b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 6 - R042	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 6 - R046	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 6 - R048	Day	35	< 30	-	-	-
	Evening	39	-	< 30	-	-
	Night	39	-	-	< 30	< 30
Area 6 - R049	Day	35	< 30	-	-	-
	Evening	38	-	< 30	-	-
	Night	38	-	-	< 30	< 30
Area 6 - R061	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 6 - R075	Day	35	< 30	-	-	-
	Evening	38	-	< 30	-	-
	Night	38	-	-	< 30	< 30
Area 6 - R163	Day	35	< 30	-	-	-
	Evening	37	-	< 30	-	-
	Night	37	-	-	< 30	< 30
Area 6 - R170	Day	5	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 6 - R287	Day	35	< 30	-	-	-

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 6 - R320	Day	35	< 30	-	-	-
	Evening	40	-	< 30	-	-
	Night	40	-	-	< 30	< 30
Area 6 - R343	Day	35	< 30	-	-	-
	Evening	39	-	< 30	-	-
	Night	39	-	-	< 30	< 30
Area 6 - R344	Day	35	< 30	-	-	-
	Evening	37	-	< 30	-	-
	Night	37	-	-	< 30	< 30
Area 6 - R346	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 6 - R348	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R004	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R047	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R052a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R052b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R054	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R058a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R058b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
Area 7 - R059	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R060	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R062	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R068	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R098	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R105	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R106	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R107	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R113a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R113b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R115	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R116	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R135	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Night	35	-	-	< 30	< 30
Area 7 - R143	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R144	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R146	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R148a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R148b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R150	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R151	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R156a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R156b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R168	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R171	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R174a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R174b	Day	35	< 30	-	-	-

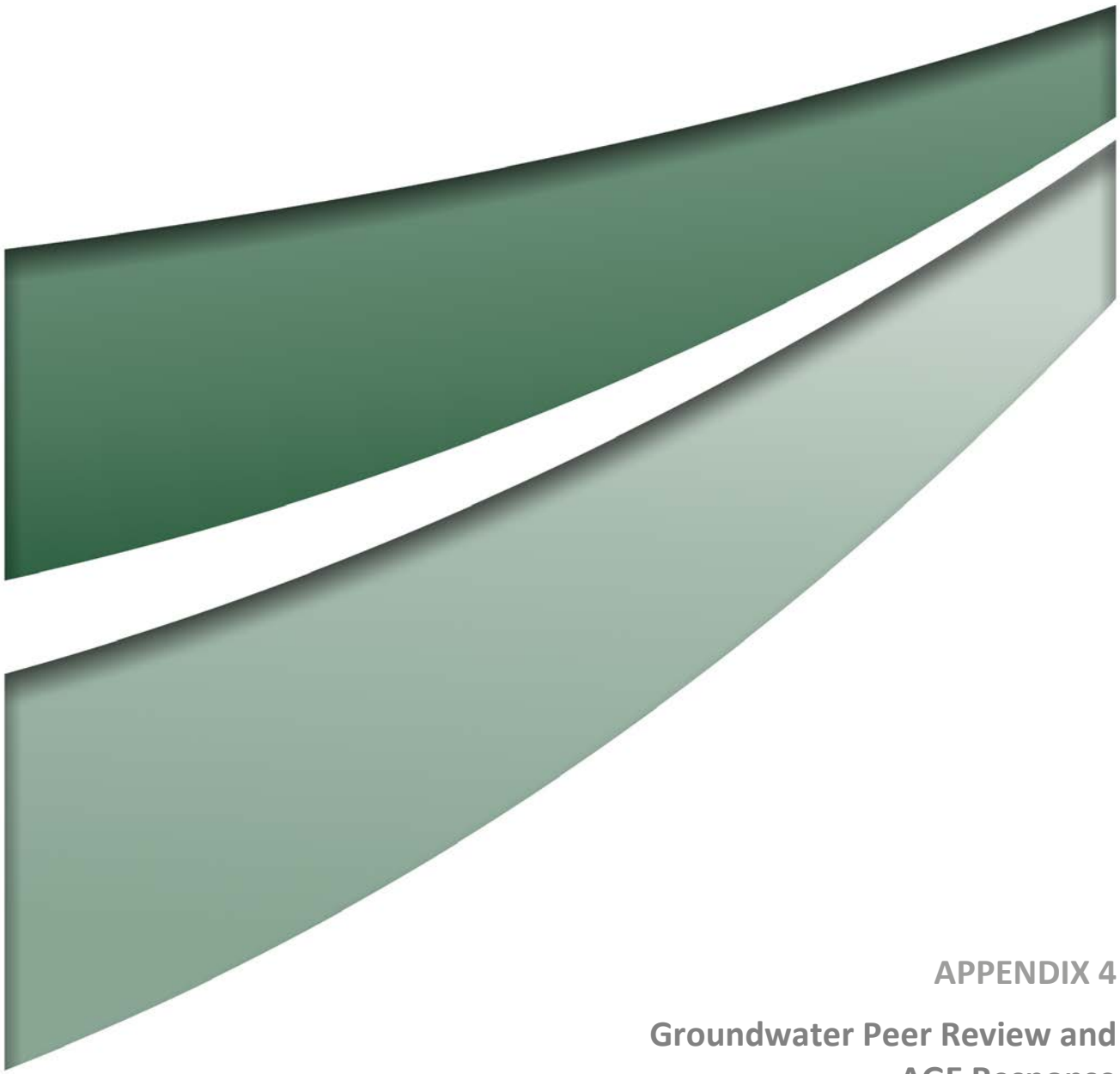
Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R175	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R180	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R186	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R187	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R198	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R202	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R204	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R205	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R206	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R211a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R211b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R240	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
Area 7 - R256	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R261	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R276	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R277	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R280	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R281	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R282a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R282b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R283	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R286	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R291	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R325	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R326a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Night	35	-	-	< 30	< 30
Area 7 - R326b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R326c	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R327	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R328	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R329	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R330	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R332	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R333	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R334	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R335	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R336	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R337	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R338	Day	35	< 30	-	-	-

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R352	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R353	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R355	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R356	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R357	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R358	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R362	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R363	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R364	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R365	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R366a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R366b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30

Receiver ID	Period	Existing WCPL Criteria[1]	All Seasons Day	Non-winter Evenings	Non-winter Nights	Winter Night
Area 7 - R367a	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R367b	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R368	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R370	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30
Area 7 - R504	Day	35	< 30	-	-	-
	Evening	35	-	< 30	-	-
	Night	35	-	-	< 30	< 30



APPENDIX 4

Groundwater Peer Review and AGE Response

KALF AND ASSOCIATES Pty Ltd
Hydrogeological, Numerical Modelling Specialists

KA Additional Peer Review of AGE 2016 Groundwater Impact Assessment of the United Wambo Coal Mine Project

Dr F. Kalf
B.Sc. M.App.Sc PhD
24 November 2016

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Background and Key Issues Summary

This report is the Kalf and Associates Pty Ltd (KA) peer review commissioned by Umwelt (Australia) Pty Ltd for the Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) hydrogeological and groundwater modelling assessment of the United Wambo Open Cut Coal Mine Project. The AGE report is part of the impact assessment being prepared for the Project EIS. This KA review of the final AGE report and associated documents follows on from a request made by the Department of Primary Industries (DPI 2016) for *"an additional external peer review of the groundwater model"* because of the first peer reviewer's input into several stages of the United Wambo Open Cut Coal Mine modelling process, and also previous groundwater assessments and numerical models for the associated Wambo Coal Mine developed by the peer reviewer.

For the modelling review herein the available Modelling Guideline documents (NWC 2012, MDBC 2001) content have been taken into consideration in this assessment. A modelling appraisal checklist is provided herein as an attached Appendix.

Current and proposed mining operations in the region occur within the underlying geological Wittingham Coal Measures overlain by weathered overburden with adjacent alluvial sediments associated with the Hunter River, Wollombi Brook, and to a minor extent in other tributary streams.

The stratigraphic sequence of coal seams in the area from the top to bottom include: Whybrow; Redbank Creek; Wambo; Whynot; Blakefield and Glen-Munro; Woodlands Hill; Arrowfield and Bowfield; Warkworth; Mt Arthur; Piercefield, Vaux, Broonie and Bayswater seams. The coal seam nomenclature differences used by Wambo, HVO South and United are outlined in Section 4.2.6 AGE (2016).

The previous and current operations of the Wambo Coal Mine commenced in 1969 whilst the adjacent United Collieries operations were established in 1989. Wambo Coal mining under Development Consent DA 305-7-2003 commenced in 2004 and currently both open cut and underground operations are conducted at Wambo. Since that time a number of approvals have been made for modifications for underground mining in 2013, 2014 and 2015. Wambo underground mining has primarily recovered coal from the Wambo and Whybrow seams, but at South Wambo the Arrowfield and Bowfield seams have also been approved for mining into the higher Woodlands Hill seam. Wambo Open Cut has accessed the Whynot, Whybrow and to a lesser extent the Wambo seam. The existing United Open Cut has also previously accessed the Whynot and Wambo seams (1989 to 1992) and in an underground operation that has accessed the Arrowfield seam (called Woodlands Hill by United) from 1992 to 2010.

The United Wambo Open Cut Project seeks to combine existing open cut operations at Wambo with a new proposed open cut coal mine at United. This will require modification of the Wambo Development Consent (DA 305-7 2003) approved until 2015. That is, United is seeking approval for two open cut areas that include the United Open Cut to mine down to and including the Vaux seam and modifications in the approved Wambo Open Cut for access to deeper seams that include the Whynot, down to the base of the Warkworth seam (AGE 2016 Sections 1.1.2, 6.1.1 and Figures 5-13, 5-14). Figures 5-13 and 5-14 present conceptual geological sections west to east and south to north showing the conceptual drawdown/depressurisation influence the respective open cut mines will have on the surrounding groundwater system in the region.

Wambo Open Cut Mine and the proposed United Open Cut mine is relatively near to existing and past operations. Adjacent mines include the northern Hunter Valley Operations (HVO) South and North and further to the south-east the Mt Thorley Warkworth (MTW) operations. Other mines operations north of the Hunter River are shown in Figure 3-7 AGE (2016). Complete list of mining in the area is given in Table 3-2 AGE (2016).

Groundwater quality in the region of the mine site is variable ranging from fresh to saline but predominately moderately saline (1500 to 7000 mg/L) and therefore mostly unsuitable for irrigation due to component concentrations of manganese although productive alluvium groundwater is suitable for stock but 'less productive' alluvial groundwater is not suitable (AGE 2016 Section 5.4.2). The naturally occurring variability in salinity in groundwater is thought to be due to evapotranspiration of a watertable at shallow depth, intermittent influence of better quality runoff and rainfall and naturally occurring higher salinity groundwater in the Permian interburden strata emerging into better quality alluvial groundwater. Local private water usage is predominately from surface water sources.

Based on two modelled scenarios[1] and calculated differences between them, AGE have presented in Figures 7-2 to 7-6 the maximum predicted drawdown in the Alluvium and the maximum depressurisation in the Wambo, Glen Munro, Arrowfield and Vaux coal seams due only to the Project. Also shown in those figures is the 1m depressurisation extent (the dotted lines) of the approved cumulative mining that includes open cut and underground mining at Wambo and United and the surrounding influence of HVO South and North, Ravensworth and MTW. Complete contour fill of the approved cumulative mining extent plus the Project are presented in Figures 7-14 to 7-18 for drawdown in the Alluvium and depressurisation in the Wambo, Glen Munro, Arrowfield and Vaux coal seams as discussed in Section 7.2 (AGE 2016).

For the Project only, the simulation indicates significant but isolated drawdown influence of the alluvial watertable within the area of the Hunter River meander mapped as alluvium north of the Wambo Open Cut but also along the edges of the Wollombi Brook alluvial meander east of the proposed United Project Open Cut (Figure 7-2).

The approved cumulative mine influence including that produced by the Project covers a broad area with an apparent increased significant drawdown of the watertable north of Wambo within the meander bend alluvial sediments adjacent to the Hunter River; along the edges of Wollombi Brook and lower reach of North Wambo Creek. The mitigating factor for the Hunter River alluvium is that these "drawdowns" are not equivalent to the saturated thickness of the notated sediments but those produced in the model cells beneath the sediments according to AGE (Section 7.1.2, 2016)[2]. Also these "drawdowns" are not all influenced by the Wambo and United approved works and the Project but also due to mining in the northern adjacent mining zone based on previous modelling by AGE examined by KA. It would have been better if AGE had represented the drawdown within the alluvial sediments and the Permian weathered zone, that may have indicated much less watertable decline influence in these sediments than is depicted in the figures in the AGE (2016) report. However, AGE (KA pers. comm.) have indicated that no specific water level data from bores/wells is available in this Hunter River meander alluvial zone even though Figure B-9 shows apparently interpolated groundwater levels in this region (See also *'Groundwater Monitoring and Mitigation'* section and *'Review Issues'* below for additional comments and suggested additional monitoring).

[1] A third simulation without current Wambo and United cumulative input was also run, but this is irrelevant because Wambo and United have already received approvals for those operations (AGE 2016).

[2] *"It should be noted that the drawdown levels are a reflection of drawdown through the model cells irrespective of actual saturated thickness of the groundwater systems"* (Section 7.2.1 paragraph 2 AGE 2016).

The report indicates that only one private bore GW060780 is predicted to be affected in excess of the 2m maximum (i.e. 6.1m) as stipulated in the Aquifer Interference Policy (AIP) due to the Project. The approved cumulative mining influence plus Project maximum drawdowns in privately owned bore GW060780 and Coal and Allied bore GW060750 are predicted to be 6.7m and 4.3m respectively.

The modelling results have indicated that the proposed mining may influence a number of vegetation types some of which could possibly be dependent on groundwater (AGE 2016 Sections 5.5.2, 7.1.7).

Permian groundwater inflows into all currently approved open cut and underground operations and for the Project only in the Wambo and United open cuts is illustrated in Figure 7-1 (AGE 2016). For the Project only, inflow to the United open cut will increase steadily to a maximum in year 5 to about 1.6 ML/day and decrease progressively thereafter until year 20. At Wambo open cut the inflow would peak at year 8 to about 0.21 ML/day. For the currently approved mining including the Project the inflow from the Permian reaches a maximum in year 5 of about 4.9 ML/day then decreases during the next 4 years to about 3 ML/day followed by an approximate exponential decrease from year 15 to year 24.

As noted in the AGE report, mine inflow of Permian brackish and higher salinity groundwater is beneficial as it captures such pre-mine flow at Wollombi Brook from contaminating better quality groundwater in the alluvial sediments sourced mainly from rainfall recharge and outflow of high stage stream flow. The (a) Project and (b) currently approved Wambo and United operations would reduce flow from the Permian to Wollombi Brook alluvium by (a) 40 ML/year and (b) 175 ML/year respectively (AGE 2016 Section 7.1.3). Along the Hunter River the alluvium overall loses groundwater to the Permian strata with a predicted additional 58 ML/year captured due to mining depressurisation with 45 ML/day due to currently approved Wambo and United operations. However, KA notes that the alluvium within the meander bend north of Wambo Open Cut is marked as an area of *"Gaining (flow from the Permian to the alluvium)"* in Figure 3-6 and therefore any drawdown in this area would mitigate such higher salinity Permian groundwater outflow.

Consequent loss of surface water baseflow at Wollombi Brook due to approved mining is predicted to increase to a maximum of 180 ML/year at the end of mining while loss due only due to the Project will increase from 1 ML/year to about 37 ML/year in Year 8 (i.e. 3% of total baseflow) and then decrease to less than 20 ML/year thereafter (Figure 7-9). Baseflow reduction of the Hunter River due to the approved operations at Wambo and United is predicted to increase steadily to 46 ML/year at the end of mining while for the Project alone, loss increases to 58 ML/year in Year 11 (i.e. 2% of total baseflow) decreasing to just under 40 ML/year at the end of mining (Figure 7-10, AGE 2016).

The AGE report indicates that the predicted groundwater inflow capture (i.e. 'take') from alluvium and North Coast fractured and porous rocks is within the currently held entitlements based on the currently approved and Project operations (AGE 2016 Section 7.1.5).

At completion of mining and rehabilitation there would be two final voids within the post-mining landform within the Wambo Open Cut and the United Open Cut footprint with rehabilitated spoil base elevations of 40m AHD and -150m AHD respectively. The consequent lakes are predicted to have a final water level of 55m AHD in the Wambo void and 20m AHD in the United void, that is 30m to 50m below pre-mine watertable levels. The United void would act as a groundwater 'sink' in perpetuity with no escape of contained void water. The Wambo void would not intercept groundwater as groundwater would flow preferentially toward the deeper United void. The 15m of water in the Wambo void would be derived from rainfall/runoff infiltration according to AGE (KA pers. comm.). Equilibrium in the

final United void would be achieved in just over 300 years according to predicted recovery of pit lake water level.

The Stygofauna survey indicated "*the drawdown for all sites that recorded stygofauna is expected to be negligible as they are outside of the area of predicted drawdown. Therefore the stygofauna community is unlikely to be adversely impacted by drawdown".*

KA summarised key issues of the AGE report above are based on the AGE reporting, data presented, figures and model predictions and not on a model audit.

Peer Review Assessment

Previous Studies and Reviews

Previous and related studies are listed in the AGE Section 11 'References' in the AGE (2016) report.

Hydrogeological and Modelling Description

The hydrogeological description of the region and modelling work described in the AGE (2016) report is detailed, extensive and has been conducted in a professional manner in my opinion.

The report covers a wide range of topics that are included within the main headings of: Introduction; Regulatory framework; Environmental setting; Geological setting; Hydrogeology; Numerical groundwater model; Model predictions and impacts assessment; Compliance with NSW government policy; Compliance with Commonwealth Government policy; Groundwater monitoring and management plan; References; Glossary and Acronyms. Appendices include: A – Fieldwork; B – Numerical Modelling Report; C –Study Requirements [Department Regulation Requirements]; D – Peer Review Report [HydroAlgorithmics 2016]; E – Stygofauna Assessment.

Model Conceptualisation and Simulation Methods

AGE have used a method of cell construction that is the basis of a relatively new groundwater modelling computer code issued by the United States Geological Survey known as MODFLOW-USG as opposed to the availability of the well-known MODFLOW-SURFACT (MS) code previously used by AGE. AGE has also used software, 'AlgoMesh' developed by HydroAlgorithmics (HA 2016), for generating cell mesh.

One of the main advantages of USG code is that it is possible to focus into the overall mesh with much higher resolution cells in various orientations compared to MS as well as allowing, a significant reduction in cell count. While the mesh generation is different to MS, practically all of the boundary conditions applied are similar to those used in the MS computer code. AGE has indicated (pers. comm.) that they have used the variable saturated 'upstream weighting' method for simulation rather than the Vadose method (variable saturated VG parameter method).This is considered suitable and desirable.

However, one of the disadvantages of using USG code is that it is no longer an easy matter of displaying pressure contours in cross-sections as it was with the MS code because of the irregular nature and distribution of varying sized cells in the USG code compared to the rectilinear orientation of the cells in MS. However this is not a major distraction in the analysis conducted by AGE as a second best approach using conceptual model influence has been used instead. It is suggested however that a methodology be developed by AGE

for allowing pressure head contours to be displayed in hydrogeological sections using USG code in future update simulations.

Model conceptualisation for currently approved mining and the Project by AGE is considered suitable as well as the model layering configuration described in the AGE report. The number of layers (34) used exceeds the number normally accepted for this type of simulation. Use of the MODFLOW–USG code has allowed a large modelled area to be included yet with very detailed resolution within the mining zone while maintaining cell count to a reasonable number close to 860K.

The boundaries chosen for the model area are suitable and would not influence mine drawdown calibration and predictions because of the large modelled area and therefore large distances to these boundaries. The depiction of the various ephemeral and perennial stream channels is also suitable. Rivers have been modelled using the USG 'river' package with a constant stage and the ability to set stage in the creeks to act either as 'Gaining 'or 'Losing' streams. This is considered suitable for the modelled area.

The model used the recharge package for rainfall recharge plus evapotranspiration package. The maximum evapotranspiration rate (ET) was set at 365mm/year and extinction depth at 1.5m. Based on additional assessment, KA considers that the ET rate and extinction depth is low. The rate depends on one listed by the Bureau of Meteorology (BOM) which is based on an average over a large area but does not account for shallow watertables where the evapotranspiration rate would be at a maximum or close to the ground surface. At these shallow depths the rate will approach some upper percentage (possibly 75%) of the max potential evaporation rate. Also the extinction depth, if it is to include trees with moderate tree roots depths could be in the range 3 to 5m or more. It would have been of interest to determine the relative change in shallow watertable drawdowns using a higher value of ET and greater extinction depth in the current model.

Steady-state simulation was used to set up initial conditions and was combined with transient runs in the AGE model. This is a suitable and desirable methodology. Open-cut mining was simulated using the standard 'drain' methodology with subsequent spoil infilling and changes in hydraulic parameters and rainfall recharge. Spoil fill recharge was delayed until at the end of mining. This is more suitable than progressive recharge as most recharge to the spoil would tend to outflow to the pit and be discharged during mining.

Hydraulic parameters, specifically horizontal hydraulic conductivity, are based on measured values compiled from packer, laboratory core and slug tests including data within the Project area and surrounding region. In addition alluvial data was sourced from 59 measurements of the Hunter River basal sands and gravel, paleochannel values and those used in previous modelling studies. A total of 303 coal seam values and 151 values of interburden were employed in the modelling work (Section 5.2 AGE 2016 Figures 5-1, 5-2 and 5-3). AGE has applied both a regression equation exponential decrease of horizontal hydraulic conductivity of the coal seams and a regression equation power function decrease of that parameter for the interburden strata in the model.

Calibrated hydraulic conductivity parameters used in the model are provided in Table B-5 and comparison between field and model values Figure B-11 (AGE 2016), whilst storage properties are given in Table B-7. All values of hydraulic conductivity and storage appear plausible. A factor was used to determine vertical hydraulic conductivity from the horizontal value. The range of factor values appears reasonable but may not be precise for all values as they are not determined by any testing method but estimated and calibrated.

Model Calibration and Prediction

Calibration has been conducted under both steady-state and transient conditions from 1970 to 2015. Both manual (trial and error) and automated parameter estimation (PEST) software was used. Steady State calibration used 13 bores in the region considered to be unaffected by mining. Transient calibration utilized 301 monitoring points comprising monitoring points in the Wambo network, private bores and monitoring points in adjacent mines.
Calibration fit statistic for the transient case is 3.14% SRMS (scaled root mean square) which is well within the target maximum recommended of 10% in the modelling guidelines document (MDBC 2001). Comparison made between measured and modelled hydrographs are considered to be reasonable and acceptable given the very extensive and mixed mining activity in the region and uncertainty regarding mining operations in surrounding areas.

All data was used for calibration without verification which is normally the case depending on the duration of the water level record available. Verification can be conducted after an additional few years of mine project operation.

Total water balances have been presented in Tables B-8 and B-9 (AGE 2016) for steady state and transient cases. (HA 2016) have suggested that comparison of the steady state water balance differences between steady state and transient could be misinterpreted as due to mining. But differences are likely because only 13 bores were used in non-mine areas for the steady-state calibrated water balance, whilst 301 monitoring points and additional data were used in the transient calibration and water balance. In addition, different weather conditions during the calibration periods would have had an effect; in particular an annual average used for the steady state case. These reasons would suggest that the transient calibration water balance is likely to be a better estimate although ET rate and depth are considered by KA to be on the low side as discussed previously.

Post mining conditions were simulated by progressive removal of ‘drains’ followed by spoil fill using the TVM package to change hydraulic parameters during the simulation. This is the best method for achieving these changes without interrupting the simulation run. At the end of mining a recovery period was run over a period of 1000 years. As noted previously equilibrium was achieved in the United Open Cut remaining void after about 300 years.

Sensitivity and Uncertainty Analysis

Uncalibrated sensitivity analysis was conducted on horizontal and vertical hydraulic conductivity, specific yield, specific storage and rainfall recharge. While changes in recharge had minimum influence on drawdown extent, greatest influence depended significantly on changes in hydraulic conductivity of the geological units (plus and minus 0.2 to 10 times in the horizontal and plus and minus 10 times in the vertical) and also specific storage (plus and minus 0.1 to 10 times) of all geological units bar the overburden (Figure B-19 presents results for the Vaux seam). Sensitivity was also conducted on Permian to Alluvial flow change for both the Wollombi Brook and Hunter River alluvium that was most sensitive to hydraulic conductivity of the geological units. An increase in hydraulic conductivity increased Wollombi Brook alluvium groundwater capture to a peak of 211ML/year and the Hunter River alluvium capture to a peak of 124ML/year. Decreasing hydraulic conductivity increased baseflow from the Permian to the alluvium by 3 ML/year in comparison to the mine plan for both alluvial stream sediments (AGE 2016, Section B5.2). The sensitivity results are considered to be suitable as presented by AGE (2016).

Uncertainty analysis was conducted using statistical uncertainty of model predictions that in turn determined the likely range of influence due to uncertainty in model parameters. The analysis was conducted for both flow change to Wollombi Brook and Hunter River alluvium and Permian groundwater inflow to the Wambo and United open cut mines.

HA (2016) has suggested that because uncertainties of up to 50% are recognised it calls into question the precision expected of water licence estimation. Also that it would be better and more reasonable to licence an average rate over the duration of mining rather than the adoption of a maximum annual rate. HA indicates that commitments to licenced volumes should not extend after the first 5 years. KA agrees with these views and that such licenced average volume should be reviewed after the 5 year comparison between model predictions and measured bore data. The average rate would of course be obtained by the integration of the yearly rates calculated as a volume and divided by the time period adopted.

Groundwater Monitoring and Mitigation

A combined groundwater monitoring program (GWMP) operated by United Collieries and Wambo Coal comprises 27 bores and 11 VWP's with 55 sensors. In addition a bore census within 4kms of the proposed extraction area was also conducted in 2015 (Section 5.1 Appendix A, AGE 2016).

It is agreed that this network should be adequate for the most part but additional monitoring bores within the Hunter River unconsolidated sediments north of Wambo Open Cut at the Hunter River meander bend where drawdowns are predicted, would provide a better current and future assessment of water levels in this region. However, the bore/well data (Table A-3) indicates that bores/wells GW017644, GW017646, GW017648, GW017647[3] (see Figure A-2 AGE 2019 Appendix A and in Figure 2 below) encountered weathered Permian strata and not alluvium, or if alluvium is present then it is probably relatively thin with over-bank (i.e. flood laden) silts and clays with no *'high productive'* aquifers, but poor groundwater potential and EC in the range 3,000 to 10,000 µS/cm. It would seem only bore GW017648 (sunk in1954) much closer to the Hunter River and depth of 12.8m encountered alluvium sands and gravels (no lithological log is available) based on a yield reported at just exceeding 25 Litres/second of groundwater with salinity 3000 to 7000 µS/cm reported. Figure 1 therefore shows the more likely location of the southern boundary of the potential *'highly productive'* zone in the meander bend alluvium north of Wambo OC based on the currently available lithological bore/well data. However, the *'highly productive'* designation also depends on the salinity concentration of groundwater in this zone. The term is valid only for groundwater salinity less than 1500 mg/L (less than about 2400 µS/cm) and therefore this designation is unlikely to be applicable to the majority of this meander sediment and weathered strata.

In order to validate hydrogeological conditions and provide a suitable set of monitoring points for determining drawdown with distance in the unconsolidated sediments across the meander north of Wambo OC, three bores should be sunk as shown in Figure 2. Bores B1 and B2 should be sunk through the Permian weathered strata to solid rock and screened in the water bearing zone in each bore. Bore B3 would likely encounter sands and possibly gravels and should be screened within the most permeable section of the alluvial formation.

[3] Bore 017647 blue triangle in the original Figure A-2 has its label truncated RHS in Figure 2 below and also has a construction date of 1/01/2019 in the AGE Table A-3 when 1/01/2009 is likely.

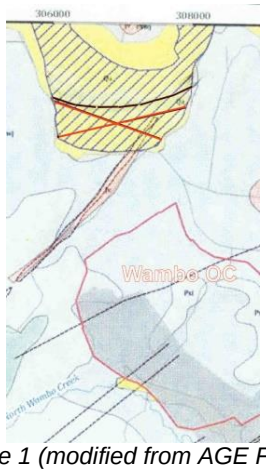

Figure 1 (modified from AGE Figure 4-3). Southern boundary (black line) of more likely 'highly productive' alluvium based on *bore/well data Figure A-2 and Table A3.*

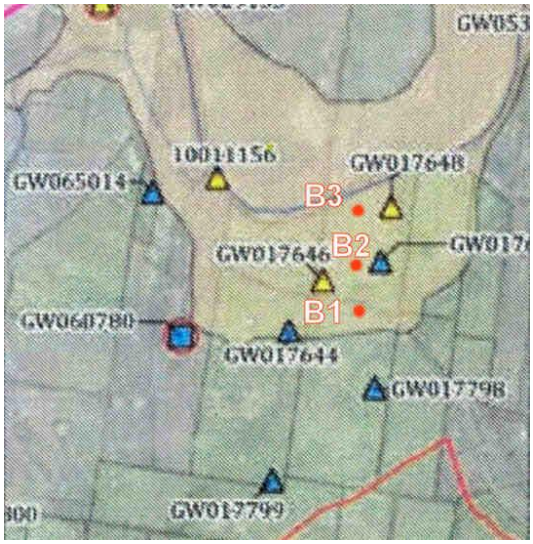

Figure 2. Red dots indicate 3 new suggested monitoring bore locations B1,B2 and B3. Note blue triangle with truncated label RHS is bore GW017647.

The bores should record the standing water level after construction. A short pumping test should be conducted on bore B3 over several hours if suitable alluvium is encountered and sufficient yield is evident to determine hydraulic aquifer parameters. At bores B1 and B2 suitable hydraulic tests should be conducted to determine hydraulic conductivity. Detailed groundwater quality should be determined for all bores and of course these bores should be included in the monitoring program over time. The bores should also be protected from flood inundation. The area is apparently on Wambo land and therefore the new additional monitoring bores could be sunk without requiring landholder permission.

KA is in agreement with the monitoring and management plan as outlined in Section 10 of the AGE (2016) report related to water levels; water quality; trigger levels; seepage monitoring; future model iterations; data management and reporting and mitigation strategies.

Review Issues

Umwelt Australia Pty Ltd, requested as part of this brief, for KA to focus and comment specifically on a number of items as listed below. KA response is provided below each item based on the review contents provided above and detailed examination of AGE (2016) report.

1. ***model selection and modelling approach (including set up)***
   KA response: The modelling selection of the USGS MODFLOW-USG code used for this project has been demonstrated in various verification and validation trials to yield equivalent results as the well-established, used over many years, of the MODFLOW-SURFACT code applied to model simulation of mining projects. Overall the modelling approach adopted is considered by KA to be valid and suitable although as noted in the review it would have been an advantage to display actual drawdown in the alluvial sediments and Permian weathered zone rather than 'drawdown', as reported, in the underlying model cells in the meander north of Wambo OC. AGE has indicated to KA the lack of specific water levels in the affected alluvial areas was the reason why this was not achievable with sufficient accuracy using the regional model. This is therefore one reason for additional monitoring bores suggested above in the *'Groundwater Monitoring and Mitigation'* section.

2. ***definition and mapping of alluvial areas and other features and users potentially affected***
   KA response: The definition and mapping of alluvial areas is based on the 1:25000 geological map of Singleton. AGE have indicated that (Section 2.4.1) that site information and geological mapping including previous investigations and exploration drilling has yielded a *"well understood"* distribution of alluvial sediments in the Wollombi Creek area that required AGE to adjust the DPI Water '*highly productive'* designated zone (Figure 2-1). Also, based on bore/well data (Table A-3 Figure A-2) examined by KA in the region of the 'alluvial' meander bend of the Hunter River immediately north of the Wambo current and proposed open cut shows a significant area underlain by weathered Permian. In addition the salinity in this area probably also disqualifies the shallow groundwater zone as *"highly productive"* given the likelihood of groundwater with a salinity that exceeds the 1500 mg/L limit. Hence the designation of the *'highly productive'* designation in at least two 'alluvial' zones described by AGE and herein is not as accurate as depicted by DPI Water shown in Figure 4-3 AGE (2016). It does put into question the accuracy of other alluvium zones depicted as *'highly productive'* along the Hunter River and Wollombi Brook in Figure 4-3 and in the broader region.

   AGE (2016) in Section 5.5 have indicated that the National Groundwater Information System (NGIS) was accessed to determine the registered bores in the region as well as two un-registered bores identified during the bore census. Therefore it would appear that all sub-surface works have been accounted for.

   AGE has also identified (Section 5.5.2) vegetation species *"in proximity to the Project Area having potential to be at least partially groundwater dependent".*

3. ***approach to cumulative effects***
   KA Response: The approach adopted for determination of currently approved and Project drawdown/depressurisation influence is considered to be suitable. The approach adopted is a standard methodology where mining is simulated in this case for existing open cut mines and underground operations using standard modelling

procedures. Underground operations were approximated due to limitations of precise mine plans but is considered to be suitable for cumulative assessment. AGE has also provided both uncertainty and sensitivity analysis that exceeds the usual accepted level of this kind of analysis. Any remaining uncertainty can only be determined by ongoing monitoring and comparisons made between model predictions and monitoring outcomes, and if necessary, a re-evaluation of the model based on those results. It is normal to recommend that such a review be conducted within a period of between 3 and 5 years after mining commences.

4. ***impact assessment criteria and analysis, including compliance with the NSW Aquifer Interference Policy and the likely requirements of the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development***

KA Response: The AGE report has clearly set out the compliance requirements in Sections 8 and 9 in their report. The AIP policy is only relevant to one privately identified bore where drawdown is likely to exceed the minimum harm of less than 2m drawdown. As noted in the AGE report Section 9.1.1 *"the proponent will 'make-good' any bores that have greater than 2m drawdown interference if it can be demonstrated that this interference is due to mining rather than to rainfall deficits".* Details of the *'make-good'* procedure are provided in Section 9.1.5 in the AGE (2016) report.

AGE make a valid interpretation of the Commonwealth guidelines by noting that *" It is important to note that coalmining will always impact the groundwater regime, as dewatering of the mine workings is essential to extract coal safely. However, we have interpreted the DoE guidelines to determine if the Project could have a significant impact on water resources. It also considers the potential for cumulative impacts with other developments".*

AGE (2016) in Appendix C has set out in detail the requirements together with relevant sections that deal with those requirements in the AGE report for the Department of Primary Industries Water (DPI); Department of Industries-Resources and Energy (DIRE); NSW Environmental Protection Agency (EPA); NSW Office of Environmental and Heritage (OEH); Singleton Council; Federal Government Department of Environment and the Independent Expert Scientific Committee (IESC). KA has examined the responses of AGE to all stated requirements in particular those by the IESC (Section C1.3.2, AGE 2016). It is considered that AGE has addressed all requirements including those listed by the IESC satisfactorily.

The impact and consequences of the current approved mining and the Project are clearly stated in the AGE report and summarised and referenced in the KA section herein *'Background and Key Issues Summary'.*

5. ***proposed mitigation and monitoring measures***

KA response: The report notes that *"Locating the mining outside the alluvial flood plain effectively mitigates the impact on the alluvial aquifer and connected streams. The groundwater seepage to the mining areas cannot be prevented, and must be removed to ensure safe operating conditions within the mining areas"*. Clearly on-going monitoring will ultimately determine whether any undue influence is being caused by the proposed Project and if so action would need to be taken to determine the reason for such groundwater system response and if necessary the mining plan modified to reduce such undesirable impact. The monitoring and management plan outlined in Section 10 of the AGE (2016) report should ensure that this objective can be achieved. It is also noted that the DPI Water (DPI 2016) has indicated the need

for a plan regarding maintenance or 'make-good' provision for surface water availability to any affected downstream water users in the Wollombi Brook region. This is considered to be a reasonable initiative provided that it can be established that loss of surface flow is due to mine influence rather than rainfall and consequent runoff deficit over and above previous pre-mine conditions.

6. ***presentation of results and interpretation.***
   KA Response: The hydrogeological description of the region, modelling work, presentation of results and interpretation described in the AGE (2016) report is detailed, comprehensive and has been conducted in a professional manner in my opinion.

Conclusions and Considerations

This peer review has assessed the adequacy of the hydrogeological data and the numerical model for predicting the drawdown influences of the proposed Project and currently approved mine operations. The hydrogeological description, conceptualisation, model design, simulations and reporting have been conducted overall in a thorough manner and described in detail. No fatal flaws have been detected in the description or modelling work conducted although improvements to alluvial drawdown predictions have been suggested. Overall drawdown/depressurisation predictions and effects of groundwater capture and influence on stream baseflow magnitudes are nevertheless considered plausible.

Non-uniqueness in modelling, despite sophisticated analysis, will always allow remaining uncertainty to exist and therefore ongoing monitoring is an important input into comparing predictions with actual measured water levels in the region. Some localised improvement of water level monitoring north of Wambo open cut with the addition of three observation bores is therefore suggested to validate the hydrogeological conditions and to determine more precisely the future drawdown influence in this region due to mining influence.

Monitoring bore data should be reviewed and compared with modelling results every 5 years as agreed by AGE in Section 10.5 of their report.

References

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). 2016. *Report on United Wambo Open-Cut Coal Mine Project – Groundwater Impact Assessment prepared for Umwelt Australia Pty Ltd. Project No G1733. July. Available on the internet as 'United Wambo – EIS_Appendix 12_Groundwater Impact Assessment_Part 1.'*
Field Results are given in Appendix A while and the detailed Numerical Modelling Report is given in Appendix B. Appendix D is the peer review report prepared by Dr N Merrick of HydroAlgorithmics (HA). Available on the internet as 'United Wambo – EIS_Appendix 12_Groundwater Impact Assessment_Part 2.

Department of Primary Industries 2016. *United Wambo Open Cut Coal Mine Project (SSD 7142, DA 305-7-2003 MOD 16 and DA 177-8-2004 MOD 3) Comment on the exhibited Environmental Impact Statement. Letter to Ms Dawson Resources Assessments Planning Services, NSW Department of Planning and Environment. Ref OUT16/35467 23/09/2016.*

HydroAlgorithmics Pty Ltd (HA) 2016 *United Project – Groundwater Assessment Final Peer Review. HA2016/4, May, Appendix D Attachment in AGE (2016) report. Available on the internet as 'United Wambo - EIS Appendix 12_Groundwater Impact Assessment _Part 2'*

Murray Darling Basin Commission (MDBC) 2001. *Groundwater Flow Modelling Guideline. Report prepared by Middlemis, H., Merrick, N., and Ross, J., Jan.*

National Water Commission (NWC) 2012 *Australian Groundwater Modelling Guidelines. Report prepared by Barnett, B., et. al. Waterlines Report Series No 82, June.*

APPENDIX

MODEL APPRAISAL

	ISSUES	Not applicable or Unknown					COMMENTS
1.0	**THE REPORT**						
1.1	Is there a clear statement of project objectives in the modelling report?		Missing	Deficient	Adequate	Very good	
1.2	Is the level of model complexity clear or acknowledged?		Missing	No	Yes		
1.3	Is a water or mass balance reported?		Missing	Deficient	Adequate	Very good	
1.4	Has the modelling study satisfied project objectives?		Missing	Deficient	Adequate	Very good	
1.5	Are the model results of any practical use?			No	Maybe	Yes	
2.0	**DATA ANALYSIS**						
2.1	Has hydrogeology data been collected and analysed?		Missing	Deficient	Adequate	Very good	
2.2	Are groundwater contours or flow directions presented?		Missing	Deficient	Adequate	Very good	
2.3	Has all relevant potential recharge data been collected and analysed?		Missing	Deficient	Adequate	Very good	
2.4	Has all relevant potential discharge data been collected and analysed?		Missing	Deficient	Adequate	Very good	
2.5	Have the recharge and discharge datasets been analysed for their groundwater response?		Missing	Deficient	Adequate	Very good	
2.6	Are groundwater hydrographs used for calibration?			No	Maybe	Yes	
2.7	Have consistent data and standard elevation units been used?			No	Yes		
3.0	**CONCEPTUALISATION**						
3.1	Is the conceptual model consistent with project objectives and the required model complexity?		Unknown	No	Maybe	Yes	
3.2	Is there a clear description of the conceptual model?		Missing	Deficient	Adequate	Very good	
3.3	Is there a graphical representation of the modeller's conceptualisation?		Missing	Deficient	Adequate	Very good	
3.4	Is the conceptual model unnecessarily simple or unnecessarily complex?			Yes	No		
4.0	**MODEL DESIGN**						
4.1	Is the spatial extent of the model appropriate?			No	Maybe	Yes	
4.2	Are the applied boundary conditions plausible and unrestrictive?		Missing	Deficient	Adequate	Very good	
4.3	Is the software appropriate for the objectives of the study?			No	Maybe	Yes	
5.0	**CALIBRATION**						
5.1	Is there sufficient evidence provided for model calibration?		Missing	Deficient	Adequate	Very good	
5.2	Is the model sufficiently calibrated against spatial observations?		Missing	Deficient	Adequate	Very good	

5.3	Is the model sufficiently calibrated against temporal observations?		Missing	Deficient	Adequate	Very good	
5.4	Are calibrated parameter distributions and ranges plausible?		Missing	No	Maybe	Yes	
5.5	Does the calibration statistic satisfy agreed performance criteria?		Missing	Deficient	Adequate	Very good	
5.6	Are there good reasons for not meeting agreed performance criteria?		Missing	Deficient	Adequate	Very good	Performance criteria have been met
6.0	**VERIFICATION**						
6.1	Is there sufficient evidence provided for model verification?		Missing	Deficient	Adequate	Very good	All data used for calibration Verification with ongoing monitoring
6.2	Does the reserved dataset include stresses consistent with the prediction scenarios?		Unknown	No	Maybe	Yes	
6.3	Are there good reasons for an unsatisfactory verification?		Missing	Deficient	Adequate	Very good	
7.0	**PREDICTION**						
7.1	Have multiple scenarios been run for climate variability?		Missing	Deficient	Adequate	Very good	Included in rainfall uncertainty analysis
7.2	Have multiple scenarios been run for operational management alternatives?		No	Deficient	Adequate	Very good	
7.3	Is the time period for prediction comparable with the duration of the calibration period?		Missing	Greater than	Similar to	Less than	46 years calibration 24 years prediction
7.4	Are the model predictions plausible?			No	Maybe	Yes	
8.0	**SENSITIVITY ANALYSIS**						
8.1	Is the sensitivity analysis sufficiently intensive for key parameters/		Missing	Deficient	Adequate	Very good	
8.2	Are sensitivity results used to qualify the reliability of model calibration?		Missing	Deficient	Adequate	Very good	
8.3	Are sensitivity results used to qualify the accuracy of model prediction?		Missing	Deficient	Adequate	Very good	
9.0	**UNCERTAINTY ANALYSIS**						
9.1	If required by the project brief, is uncertainty quantified in any way?		Missing	No	Adequate	Yes	
9.2	**Is the model 'fit-for-purpose'?**			No		Yes	

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Memorandum

Project number G1733D

To Umwelt

From AGE Consultants

Date 13/12/2016

RE **External Peer Review**

Umwelt was engaged by the United Collieries Pty Limited (United Collieries) and Wambo Coal Pty Limited (Wambo Coal) Joint Venture as the lead consultant for the preparation of the United Wambo Project Environmental Impact Statement (EIS). Umwelt then engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) as a sub-consultant to complete the groundwater impact assessment (GIA) as part of the EIS.

The EIS was submitted to the governing authority in September 2016, and received a series of submissions from agencies, organisations and members of the public. This included submissions from the Department of Primary Industries (DPI Water) and Department of Planning and Environment requestion a second external peer review.

In response to comments, a second external peer review was conducted by Dr Frans Kalf of Kalf and Associates in accordance with the Australian groundwater modelling guidelines (Barnett *et al* 2012)[1]. Dr Frans Kalf has over 47 years of experience in hydrogeological investigations and specialises in peer reviews.

The peer review by Dr Kalf found that the groundwater model is fit for purpose and *"addressed all requirements including those listed by the IESC satisfactorily".*

Dr Kalf did highlight two items to address that could improve data collection and understanding of the model results. The first is Review Issue 1, which refers to additional monitoring bores north-east of the proposed Wambo Open Cut. These recommendations have been incorporated into the proposed monitoring program.

[1] Barnett, B, Townley, LR, Post, V, Evans, RE, Hunt, RJ, Peeters, L Richardson, S, Werner, AD, Knapton, A, & Boronkay, A 2012, "*Australian groundwater modelling guidelines*", Waterlines report, National Water Commission, Canberra.

Review Issue 2 outlines the difficulty of applying the DPI Water mapped extent of highly productive alluvial zones, which is based on regional scale geological maps. As outlined in Section 2.4.1 of the GIA, the extent of highly productive alluvium was refined where reliable data and documented studies were available to support any amendments. No changes were made to the government mapped extent of highly productive alluvium north-west of the proposed Wambo Open Cut in order to be conservative. The installation of bores proposed within this area will assist in refining the extent of the highly productive alluvium in future.

Dr Kalf also identified the conservative nature of presenting groundwater level drawdown within the Quaternary alluvium based on total drawdown within each model cell. The drawdown in the model cells can exceed the saturated thickness of the unconfined Quaternary alluvium and was therefore considered by Dr Kalf to be overly conservative. To address this, the predicted maximum drawdown within the alluvium has been corrected to correspond with the interpolated saturated thickness presented in Figure 5-5 of the GIA. The maximum drawdown within the saturated alluvium due to the Project only (based on interpolated saturated thickness), is presented in Figure 1 below.

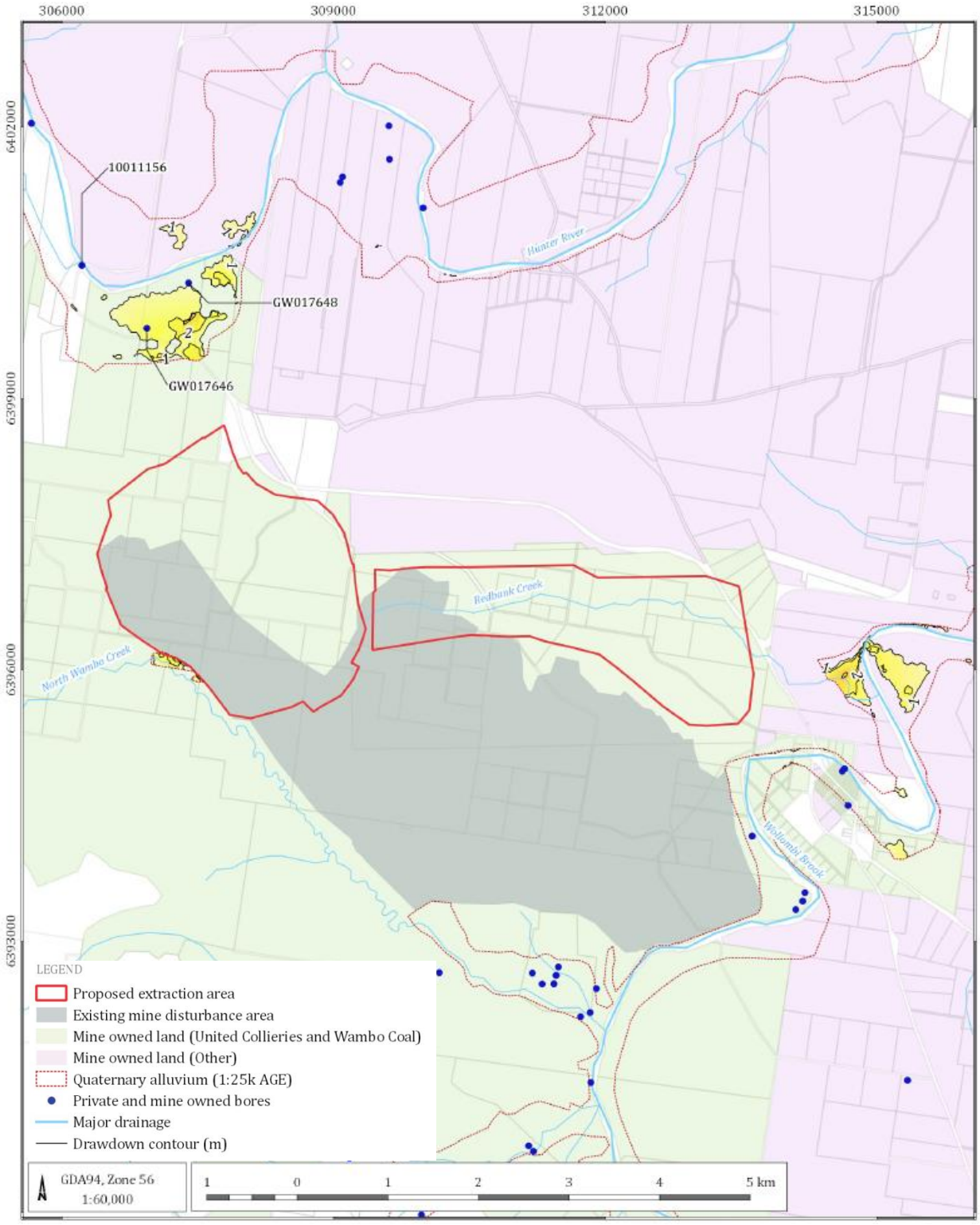
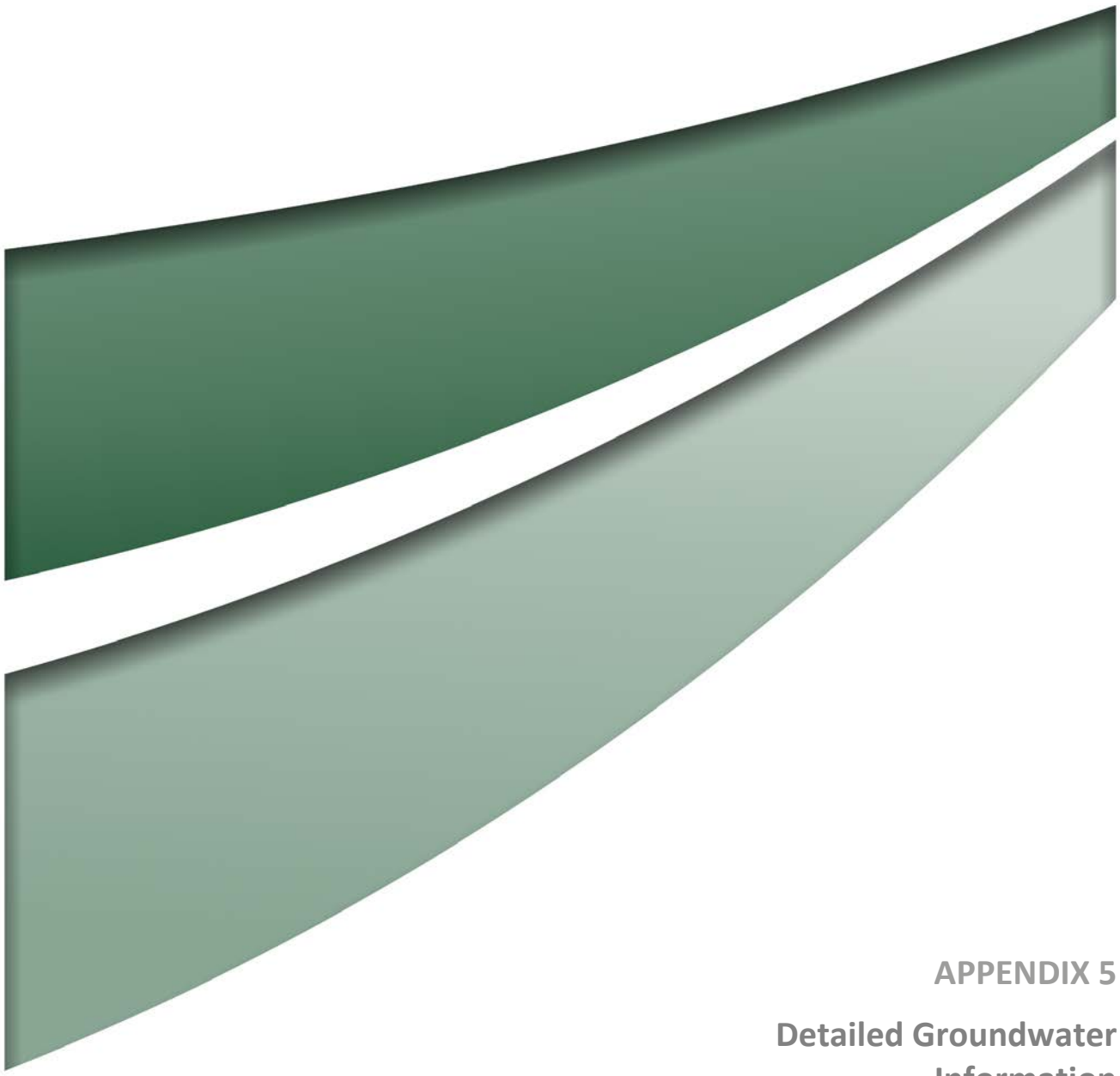


Figure 1 Maximum drawdown within saturated alluvium – due to the Project only



APPENDIX 5

Detailed Groundwater Information

Appendix 5 Water Quality Summary

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Hunter River†	Wollombi Brook‡	Less productive alluvium‡	Highly productive alluvium†	Interburden‡	Coal†	Spoil†
pH (Field)	Av.	pH unit	6.5 - 8.5[b]	6.5 – 8.5	6.0 - 8.5	6.0 - 8.5	-	8.1	7.7	7.3	7.2	7.2	7.2	7.1
	Med.							8.2	7.7	7.3	7.1	7.1	7.2	7.0
	Min.							5.5	6.4	5.8	6.3	5.9	6.1	6.1
	Max.							9.1	8.8	9.9	8.3	9.9	9.9	8.8
	Pop.							656	241	1021	483	855	2686	214
EC (Field)	Av.	µS/cm	-	120 - 300	-	-	-	693	1,084	4,609	1,019	7,487	7,041	6,915
	Med.							670	643	2315	780	7320	5740	7320
	Min.							70	105	13	21	17	500	1.189
	Max.							1,490	7,310	27,900	8,050	23,100	23,100	13,280
	Pop.							641	241	994	454	825	1757	214
TDS (Laboratory)	Av.	mg/L	600[b]	-	-	-	3,000 - 13,000*	506	311	2.068	569	5.873	6.405	5.242
	Med.							432	293	866	472	5277	3000	5110
	Min.							81	116	212	24	74	692	794
	Max.							3,800	898	8,894	2,600	15,200	15,200	10,790
	Pop.							327	115	214	49	120	255	38
TSS (Laboratory)	Av.	mg/L	-	-	-	-	-	37	16	81	162	80	290	50
	Med.							18	6	52	47	30	85	48
	Min.							1	1	16	1	2	290	12
	Max.							988	815	268	8,900	580	290	111
	Pop.							728	213	15	117	26	51	8
Silicon (t)	Av.	mg/L	-	-	-	-	-	14	9	30	23	23	23	11
	Med.							16	9	30	24	22	14	13

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Hunter River†	Wollombi Brook‡	Less productive alluvium‡	Highly productive alluvium†	Interburden‡	Coal†	Spoil†
	Min.							3	7	12	14	12	12	0
	Max.							19	13	75	30	56	56	16
	Pop.							24	12	80	34	39	195	24
Chloride (t)	Av.	mg/L	250[b]	-	-	-	-	212	-	1,019	147	2,513	2,899	1,634
	Med.							212	-	404	97	2185	1210	1390
	Min.							202	-	21	60	3	213	188
	Max.							222	-	3,510	574	7,740	7,740	3,830
	Pop.							2	-	113	14	64	47	14
Calcium (t)	Av.	mg/L	-	-	-	-	1,000	34	10	120	48	129	116	120
	Med.							31	10	61	43	99	55	104
	Min.							2.7	1.8	3.0	9.0	2.0	10.0	14.0
	Max.							66	19	2,877	196	2,172	288	232
	Pop.							47	23	231	58	119	302	85
Sodium (t)	Av.	mg/L	180[b]	-	-	-	-	62	74	498	98	1,606	1,729	1,125
	Med.							54	45	88	57	1380	956	1180
	Min.							14	11	16	36	13	140	258
	Max.							174	276	2,500	735	4,350	4,350	2,130
	Pop.							47	23	233	58	119	302	100
Magnesium (t)	Av.	mg/L	-	-	-	-	-	26	11	84	34	321	309	287
	Med.							23	8	43	32	312	110	281
	Min.							2.70	2.10	0.05	8.00	0.11	6.00	33.00
	Max.							50	36	386	111	2,590	726	592
	Pop.							47	23	232	58	118	302	93
Sulphate (t)	Av.	mg/L	500[a] / 250[b]	-	-	-	1,000 –	35	28	255	39	554	642	1,134

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Hunter River†	Wollombi Brook‡	Less productive alluvium‡	Highly productive alluvium†	Interburden‡	Coal†	Spoil†
	Med.						2,400 (pigs)	34	16	58	25	321	44	1195
	Min.							8.2	5.7	0.5	4.0	0.5	0.5	128.0
	Max.							80	129	1,930	364	7,470	7,470	2,560
	Pop.							54	19	213	53	108	284	98
Potassium (t)	Av.	mg/L	-	-	-	-	-	3.8	5.2	42.9	3.9	48.3	38.1	30.2
	Med.							3.6	5.0	5.0	2.0	31.0	15.0	27.0
	Min.							2.0	3.9	0.5	0.5	1.4	1.4	13.0
	Max.							7	7	1,874	28	1,586	390	58
	Pop.							45	23	230	58	118	276	100
Iron (d)	Av.	mg/L	-	-	-	-	-	0.3	1.0	1.4	0.4	0.5	0.5	4.7
	Med.							0.15	0.90	0.13	0.03	0.06	0.16	0.21
	Min.							0.003	0.15	0.01	0.01	0.01	0.01	0.02
	Max.							1.3	1.8	28.6	8.2	6.6	6.6	38.8
	Pop.							21	14	72	21	33	123	20
Aluminium (t)	Av.	mg/L	0.2[b c]	0.055	20	5	5	2.0	1.0	11.1	12.8	11.8	14.9	1.2
	Med.							0.9	0.5	0.9	0.4	0.7	0.3	0.2
	Min.							0.060	0.060	0.003	0.003	0.020	0.020	0.005
	Max.							12	5	410	260	255	255	20
	Pop.							43	23	135	48	84	201	38
Arsenic (t)	Av.	mg/L	0.01[a]	As (III) 0.024 As (V) 0.013	2	0.1	0.5	<0.001	0.001	0.002	0.001	0.2	0.2	0.04
	Med.							<0.001	0.001	0.001	0.001	0.002	0.001	0.011
	Min.							<0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Max.							<0.001	0.002	0.02	0.01	8.00	8.00	0.25
	Pop.							62	23	144	58	73	245	56

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Hunter River†	Wollombi Brook‡	Less productive alluvium‡	Highly productive alluvium†	Interburden‡	Coal†	Spoil†
Barium (t)	Av.	mg/L	2[a]	-	-	-	-	0.1	0.1	0.3	0.2	19.4	23.6	0.1
	Med.							0.03	0.04	0.06	0.04	0.14	0.16	0.06
	Min.							0.00	0.03	0.005	0.018	0.01	0.01	0.02
	Max.							0.6	0.1	6.1	1.5	660	660	0.4
	Pop.							59	20	107	34	51	149	28
Beryllium (t)	Av.	mg/L	0.06[a]	-	0.5	0.1	-	<0.001	-	<0.001	<0.001	-	<0.001	-
	Med.							<0.001	-	<0.001	<0.001	-	<0.001	-
	Min.							<0.001	-	<0.001	<0.001	-	<0.001	-
	Max.							<0.001	-	<0.001	<0.001	-	<0.001	-
	Pop.							2	-	9	2	-	9	-
Boron (t)	Av.	mg/L	4[a]	0.37	refer to guideline	0.5	7 (cattle)	0.04	0.03	0.06	0.04	0.2	0.2	0.1
	Med.							0.03	0.03	0.05	0.03	0.12	0.09	0.12
	Min.							0.00002	0.03	0.03	0.02	0.03	0.03	0.03
	Max.							0.2	0.1	0.5	0.2	0.8	0.8	0.2
	Pop.							66	23	105	43	48	171	41
Cadmium (t)	Av.	mg/L	0.002[a]	0.0002	0.05	0.01	0.01	<0.0001	-	<0.0001	-	<0.0001	-	-
	Med.							<0.0001	-	<0.0001	-	<0.0001	-	-
	Min.							<0.0001	-	<0.0001	-	<0.0001	-	-
	Max.							<0.0001	-	<0.0001	-	<0.0001	-	-
	Pop.							2	-	2	-	1	-	-
Chromium (t)	Av.	mg/L	0.05[a]	CrIII – ID Cr(VI) 0.001	1	0.1	1	0.0008	-	0.0008	0.0008	0.001	-	-
	Med.							0.0008		0.0008	0.0008	0.001	-	-
	Min.							0.0005	-	0.0005	0.0005	0.001	-	-
	Max.							0.001	-	0.0010	0.0010	0.001	-	-

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Hunter River†	Wollombi Brook‡	Less productive alluvium‡	Highly productive alluvium†	Interburden‡	Coal†	Spoil†
	Pop.							2	-	3	2	1	-	-
Cobalt (t)	Av.	mg/L	-	-	0.1	0.05	1	<0.001	-	<0.001	<0.001	0.001	-	-
	Med.							<0.001	-	<0.001	<0.001	0.001	-	-
	Min.							<0.001	-	<0.001	<0.001	<0.001	-	-
	Max.							<0.001	-	<0.001	<0.001	0.002	-	-
	Pop.							2	-	4	2	9	-	-
Copper (t)	Av.	mg/L	2[a] / 1[b]	0.0014	5	0.2	1 (cattle)	0.002	-	1.1	<0.001	1.0	-	-
	Med.							0.002	-	0.1	<0.001	0.017	-	-
	Min.							0.001	-	0.001	<0.001	0.001	-	-
	Max.							0.003	-	8.5	<0.001	4.3	-	-
	Pop.							2		21	2	25	-	-
Iron (t)	Av.	mg/L	0.3[b]	-	10	0.2	-	0.6	-	46.5	0.003	13.7	-	-
	Med.							0.6	-	4.7	0.003	4.9	-	-
	Min.							0.4	-	0.1	0.003	0.2	-	-
	Max.							0.8	-	397	0.003	123.0	-	-
	Pop.							2	-	20	2	27	-	-
Lead (t)	Av.	mg/L	0.01[a]	0.0034	5	2	0.1	<0.001	-	0.03	<0.001	0.04	-	-
	Med.							<0.001	-	0.015	<0.001	0.009	-	-
	Min.							<0.001	-	0.001	<0.001	0.001	-	-
	Max.							<0.001	-	0.1	<0.001	0.3	-	-
	Pop.							2	-	14	2	24	-	-
Lithium (t)	Av.	mg/L	-	-	2.5	2.5	-	<0.005	-	0.02	0.01	0.2	0.2	0.05
	Med.							<0.005	-	0.003	0.005	0.097	0.027	0.04
	Min.							<0.005	-	0.0005	0.0005	0.003	0.003	0.008

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Hunter River†	Wollombi Brook‡	Less productive alluvium‡	Highly productive alluvium†	Interburden‡	Coal†	Spoil†
	Max.							<0.005	-	0.6	0.1	1.0	1.0	0.1
	Pop.							37	-	99	40	42	150	24
Manganese (t)	Av.	mg/L	0.5[a] / 0.1[b]	1.9	10	0.2	-	0.1	0.3	2.6	0.7	1.9	2.9	0.7
	Med.							0.09	0.16	0.46	0.06	0.20	0.06	0.57
	Min.							0.02	0.07	0.0030	0.0005	0.006	0.006	0.03
	Max.							0.4	1.1	60	4	61	61	2
	Pop.							53	20	119	58	69	209	29
Mercury (t)	Av.	mg/L	-	0.0006	0.002	0.002	0.002	<0.0001	-	<0.0001	<0.0001	-	-	-
	Med.							<0.0001	-	<0.0001	<0.0001	-	-	
	Min.							<0.0001	-	<0.0001	<0.0001	-	-	-
	Max.							<0.0001	-	<0.0001	<0.0001	-	-	-
	Pop.							2	-	1	2	-	-	-
Molybdenum (t)	Av.	mg/L	0.05[a]	-	0.05	0.01	0.15	<0.001	-	0.003	0.004	-	-	-
	Med.							<0.001	-	0.003	0.004	-	-	-
	Min.							<0.001	-	0.003	0.001	-	-	-
	Max.							<0.001	-	0.003	0.01	-	-	-
	Pop.							2	-	1	2	-	-	-
Nickel (t)	Av.	mg/L	0.02[a]	0.011	2	0.2	1	0.002	-	0.018	0.001	0.02	-	-
	Med.							0.002	-	0.005	0.001	0.008	-	-
	Min.							0.002	-	0.003	0.001	0.002	-	-
	Max.							0.002	-	0.06	0.00	0.10	-	-
	Pop.							2	-	13	2	27	-	-
Selenium (t)	Av.	mg/L	0.01[a]	Total – 0.011 SeIIV - ID	0.05	0.02	0.02	0.03	0.004	0.004	0.004	0.06	0.06	0.006
	Med.							0.003	0.005	0.005	0.003	0.005	0.003	0.005

Analyte		Unit	NHMRC Drinking water	ANZECC (2000) Fresh Water Aquatic	ANZECC (2000) Short term irrigation	ANZECC (2000) Long term irrigation	ANZECC (2000) Stock Water	Hunter River†	Wollombi Brook‡	Less productive alluvium‡	Highly productive alluvium†	Interburden‡	Coal†	Spoil†
	Min.							0.0001	0.001	0.001	0.001	0.001	0.001	0.001
	Max.							0.5	0.01	0.02	0.02	0.5	0.50	0.05
	Pop.							67	23	117	48	57	202	41
Strontium (t)	Av.	mg/L	-	-	-	-	-	0.3	0.2	1.1	0.5	5.4	5.4	3.0
	Med.							0.3	0.1	0.6	0.5	4.1	1.2	2.8
	Min.							0.101	0.05	0.1	0.3	0.2	0.2	0.001
	Max.							1	0.5	13	2	14	14	6
	Pop.							38	20	99	40	42	150	24
Zinc (t)	Av.	mg/L	3[b]	0.008	2	2	20	0.009	0.02	0.2	0.3	0.1	0.1	0.1
	Med.							0.005	0.005	0.016	0.019	0.042	0.019	0.036
	Min.							0.002	0.003	0.003	0.003	0.003	0.003	0.003
	Max.							0.07	0.3	11	16	2	2	2
	Pop.							60	23	159	58	96	240	56

Notes: *Values below the limit of reporting were set at half of the limit for the calculations*

** Maximum concentration at which good condition might be expected, with 13,000 mg/L for sheep, 5,000 mg/L for beef cattle, 4,000 mg/L for dairy cattle, 6,000 mg/L for horses and 3,000 mg/L for pigs and poultry.*

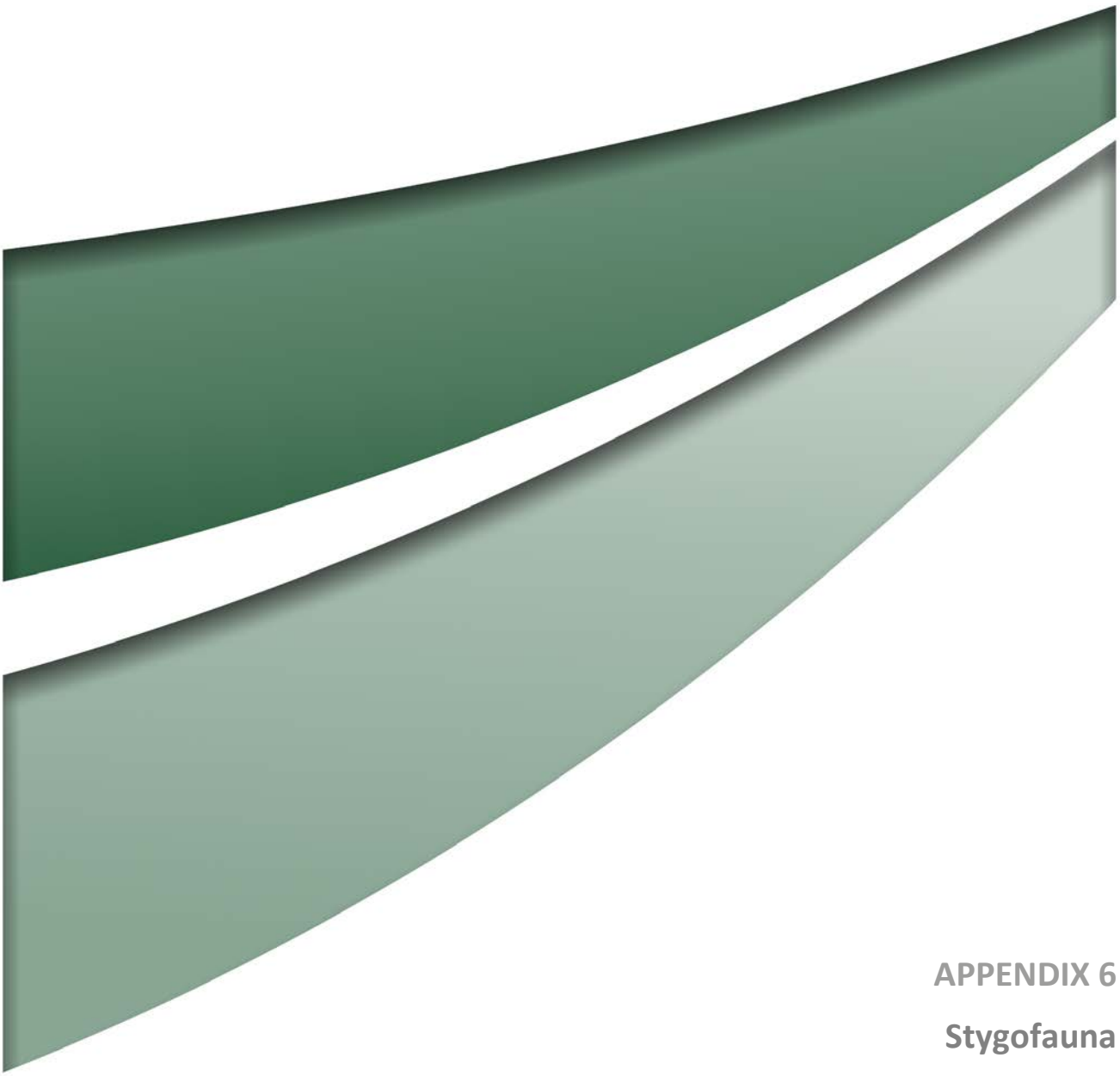
† Results derived from data from neighbouring mine, no site specific data

‡ Includes water quality data from Wambo, United and available water quality data collected from neighbouring mine

[a] NHMRC Health Guidelines for Drinking Water (2015)

[b] NHMRC Aesthetic Guidelines for Drinking Water (2015)

[c] NHMRC acid-soluble aluminium concentrations (2015)



APPENDIX 6

Stygofauna

United Wambo Open Cut Coal Mine Project
Baseline Stygofauna Assessment 2, November 2016.

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Document Control

Business Unit	Stygoecologia		
Project No.	**United Wambo Open Cut Coal Mine Project – Baseline Stygofauna Assessment 2.**		
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Supervising	**Name**	**Signed**	**Date**
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Executive Summary

The United mine (United) and Wambo mine (Wambo) are situated approximately 16 kilometres (km) west of Singleton in the Hunter Valley of New South Wales (NSW). The United and Wambo coal mining operations were established in 1989 and the late 1960's, respectively. There have been a range of underground and open cut coal mining operations at both of these adjoining coal mines since that time.

In November 2014, a 50:50 Joint Venture between United Collieries Pty Limited (United) and Wambo Coal Pty Limited (Wambo) was announced which combines the extraction and exploration rights for a number of mining tenements at United and Wambo. The Joint Venture will look to develop the United Wambo Open Cut Coal Mine Project (the Project) that combines the existing open cut operations at Wambo with a proposed new open cut coal mine at United. The joint venture is a State Significant Development as defined under the State Environmental Planning Policy (State and Regional Development) 2011 and therefore requires development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP & A Act).

As part of developing the Response to Submissions (RTS), Stygoecologia was commissioned by Umwelt (Australia) Pty Ltd on behalf of United to conduct an investigation to determine the presence of subterranean stygofauna communities within the areas of predicted maximum drawdown in the adjacent Wollombi Brook Alluvium and the Hunter River Alluvium. The object of the assessment is to assess the presence of stygofauna and to identify potential ecological risks to any subterranean stygofauna communities that may be present in the area of predicted drawdown from the proposed development.

Stygofauna are potentially threatened by activities that change the quality or quantity of groundwater, disrupt connectivity between the surface and aquifer, or remove living space. Subsidence and aquifer drawdown are identified as the main risks to stygofauna associated with both the current operations and the Project. The potential impacts include changes to:

- water table levels;
- loss of subterranean habitat
- aquifer flow paths;
- aquifer discharge volume to off-site GDEs;
- the frequency/timing of water table level fluctuations;
- river base flow;
- spring water pressure;
- natural groundwater chemistry; and
- groundwater salinity levels.

The stygofauna survey included one round of surveys in order to identify the presence of stygofauna within the predicted area of drawdown. The survey was conducted on the 14th of November 2016. The survey included 5 sites separated into 2 bores within the shallow alluvial aquifers of Wollombi Brook Alluvium and three wells within the Hunter River Alluvium. The groundwater situated in unconsolidated alluvial/colluvial sediments with most bores reaching approximately 9-14m. A total of four taxa of invertebrates were recorded within the Hunter River Alluvium which included two possible families of stygofauna. The other two taxa are surface water aquatic macroinvertebrates associated with the nearby streams and river.

The results show that stygofauna exist in very low diversity within the alluvial aquifer of the Hunter River but are absent at the sites surveyed within the Wollombi Brook Alluvium. Of the 5 sites sampled, 3 wells contained stygofauna species. The community composition included two orders of crustaceans, one order of aquatic worms and one order of insects. There were no listed threatened species collected, however, as is the case for most assessments in this emerging field, the stygofauna species are likely to be new to science. The biological and water quality data indicates that the fauna is associated with the Quaternary alluvial aquifers of the Hunter River. These aquifers are shallow aquifers, composed of coarse to fine sediments with moderate to high electrical conductivity and relatively neutral pH water quality. Although there is connectivity within the shallow alluvial aquifers and consistency in the environmental conditions of this aquatic ecosystem the very low diversity within the Hunter River wells and the absence of fauna within the Wollombi Brook bores is an indication the habitat structure and/or water chemistry are marginal or unsuitable for stygofauna. The fine grained nature of the alluvial sediments and the high electrical conductivity are the suggest reasons for the lack fauna within the Wollombi Alluvium and the significantly reduced biodiversity within the Hunter River Alluvium. For this reason the shallow alluvial aquifer was assessed as having a low ecological value for the purpose of this study.

The results of the current survey indicate that the subterranean ecosystem within the Wollombi Brook Alluvium downstream of the project area is unlikely to be impacted by the predicted drawdown levels due to the lack of fauna within the alluvium. The predicted drawdown of the Hunter alluvium is also predicted to have a minimal, local impact on the stygofauna community due to depauperate biodiversity, the large size of the alluvium and the connection with the Hunter River which will aid in long term recolonization of impacted zones. The limitation to this assessment is the small sample size both upstream, within and downstream of the predicted area of drawdown due to the very limited number of bores/wells available and the exclusion of the Hunter River hyporheic zone. The potential impact on the stygofauna community in the area of drawdown will be either a small loss of habitat associated with the dropping of water levels and a change in flow direction between the surface water and groundwater resulting in gaining sections of the Hunter River becoming loosing and a reduction in river levels.

A risk assessment ranked ecological risk to sites where stygofauna were present as Class G (low value/low risk). The remaining bores which did not record stygofauna were ranked as Class G (low value/low risk). The short term management actions relevant to these risk ratings include: continue the ongoing risk monitoring of physicochemical parameters such as water level and water chemistry; periodic biological survey monitoring for the identified hot spot sites; and the exploration of more appropriate monitoring locations. This is to be carried out within a long term adaptive management and monitoring program.

1. Introduction

The United and Wambo mines are neighbouring mining operations located approximately 16 kilometres (km) west of Singleton in the Hunter Valley of New South Wales (NSW) (Map 1). United Collieries Pty Limited (United) the operator of United mine and Wambo Coal Pty Limited (Wambo) the operator of Wambo mine, have formed a Joint Venture which includes the proposed development of the United Wambo Open Cut Coal Mine Project (the Project).

Map 1. Location the United Wambo Open Cut Coal Mine Project Area in a regional context within the Hunter Valley. (Umwelt, 2015. Overview of the Project. Fig 1.1)

The Project proposes open cut coal mining for a period of 23 years, with mining in a new open cut mine at United (the United Open Cut) combined with ongoing mining at the existing, approved Wambo Open Cut under a modified mine plan. The Project will optimise future mining operations across these two adjoining open cut mining areas, maximising coal recovery and the efficient use of existing mining infrastructure, while providing the operational flexibility required to actively manage the mine to minimise environmental impacts.

The Project is a State Significant Development as defined under State Environmental Planning Policy (State and Regional Development) 2011 and requires development consent under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The Project will also require a modification to the existing Wambo development consents under section 75W of the EP&A Act to harmonise these consents with the Project. An Environmental Impact Statement (EIS) has been prepared to accompany these applications.

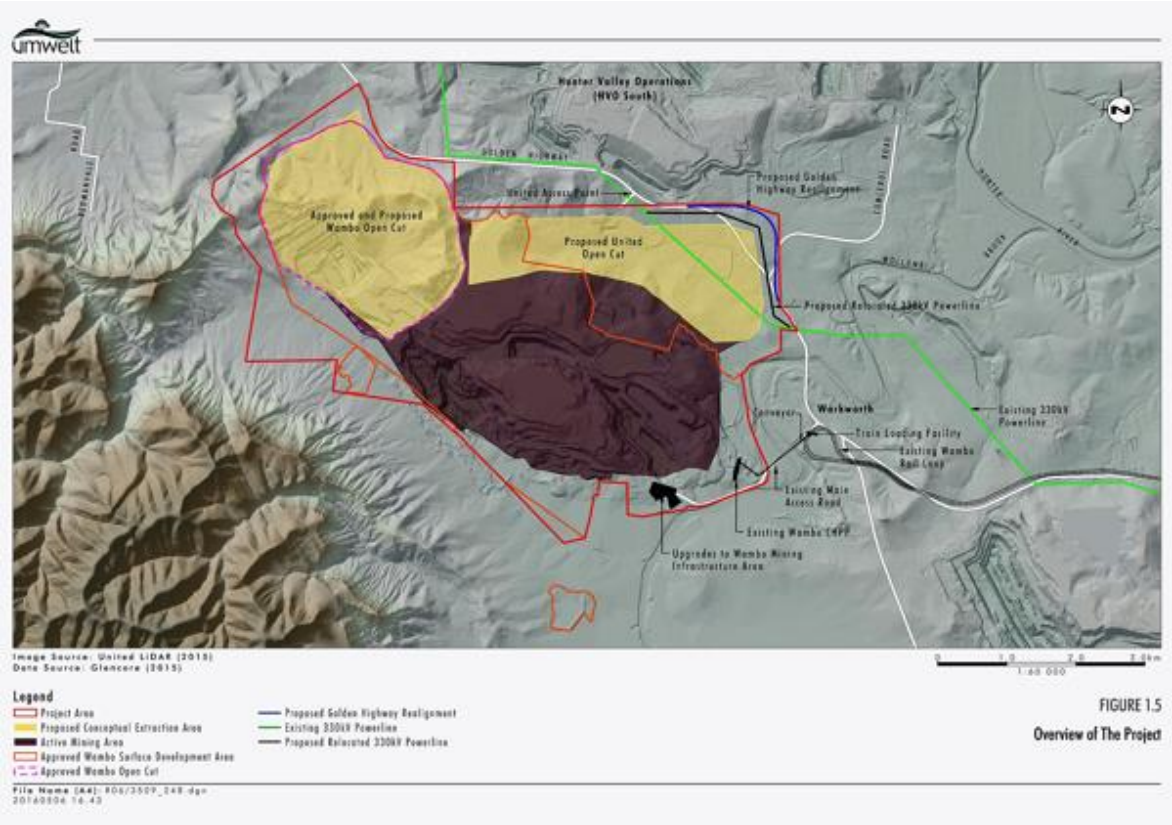
Mining has been occurring at Wambo since the late 1960's and at United since 1989, with both mines previously undertaking both open cut and underground mining operations. Over this time the two mines have regularly cooperated, including sharing access to coal resources where appropriate, to provide for more efficient recovery of the State's coal resources. The two mines have also shared some mining infrastructure, including the joint use of the Wambo train loading facility, and share water to minimise external water demand.

Building on this long history of cooperative operations, in November 2014 United and Wambo announced a 50:50 Joint Venture between the two companies. The Joint Venture agreement outlines how the two companies will work together to further develop open cut coal resources held by the two mines.

Whilst open cut coal mining has previously been undertaken at United, over the last two decades the focus has been on underground mining. Underground longwall mining operations were approved to provide up to 2.95 million tonnes per annum (Mtpa) of saleable coal. Mining operations were suspended at United in March 2010 with the mine entering a period of care and maintenance. At that time, exploration and pre-feasibility works were commenced to determine the potential for future mining activities within United's mining lease. Ongoing exploration has identified substantial reserves of coal suitable for open cut mining.

As discussed above, the Project includes open cut mining operations in two areas, the proposed United Open Cut and modified operations in the approved Wambo Open Cut for a period of approximately 23 years. The existing Wambo Open Cut has approval for continued open cut mining until March 2017 (with a modification lodged to extend this to 2020). Due to the progression of mining being slower than originally planned, there will be substantial coal resources remaining in this approved mining area at March 2017 and the Project proposes to continue mining in this approved area. The Project also seeks some minor extensions to the approved Wambo Open Cut surface mining area and will seek approval to mine deeper resources below the approved Wambo Open Cut area.

The key aspects of the Project are shown on (refer to Map 2). The survey sites are shown in Maps 3, 5 and 6 with the area of drawdown within the Quaternary Alluvials shown in Map.4.



Map 2. The boundaries and extent of the United Wambo Open Cut Coal Mine Project Area.
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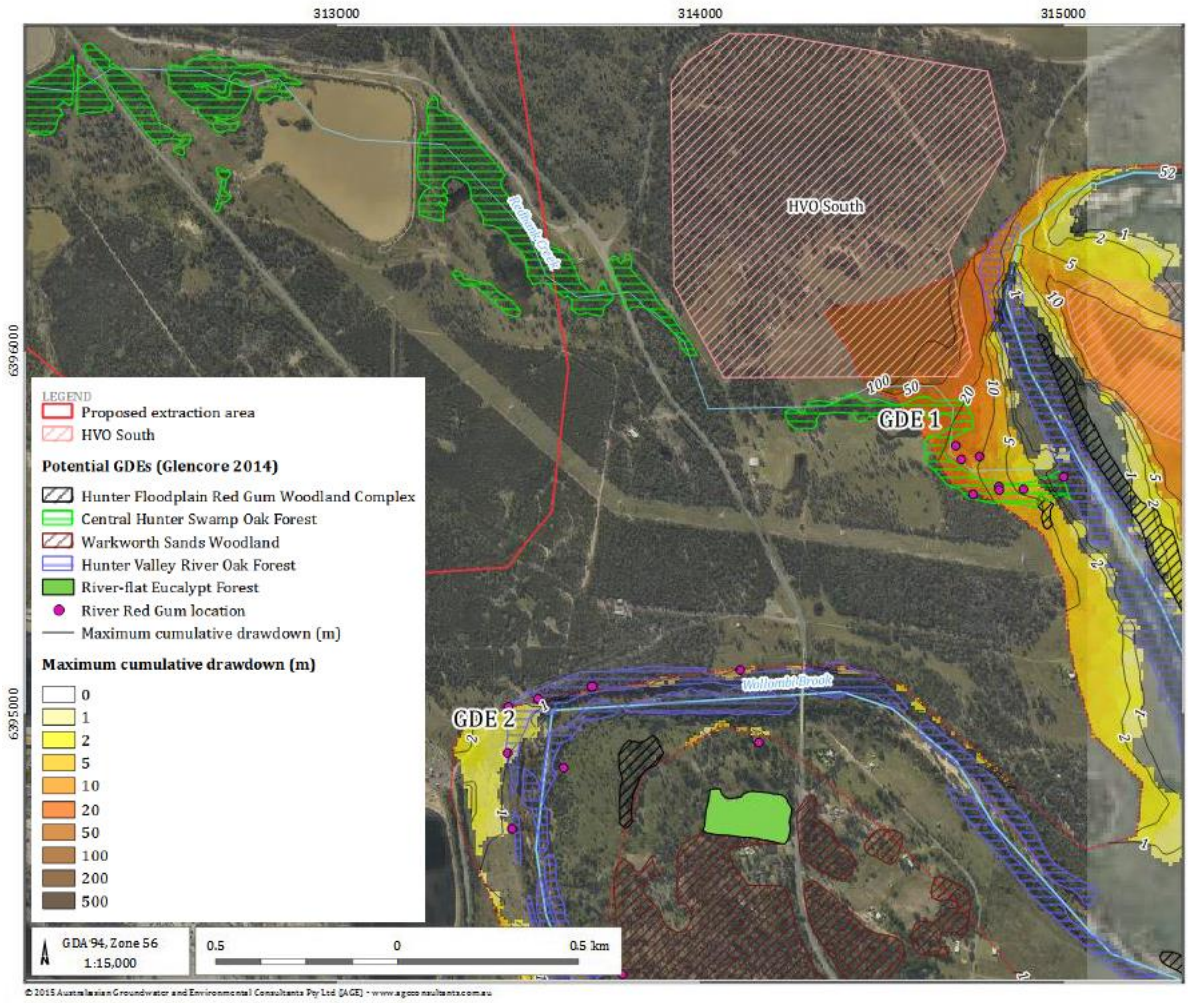
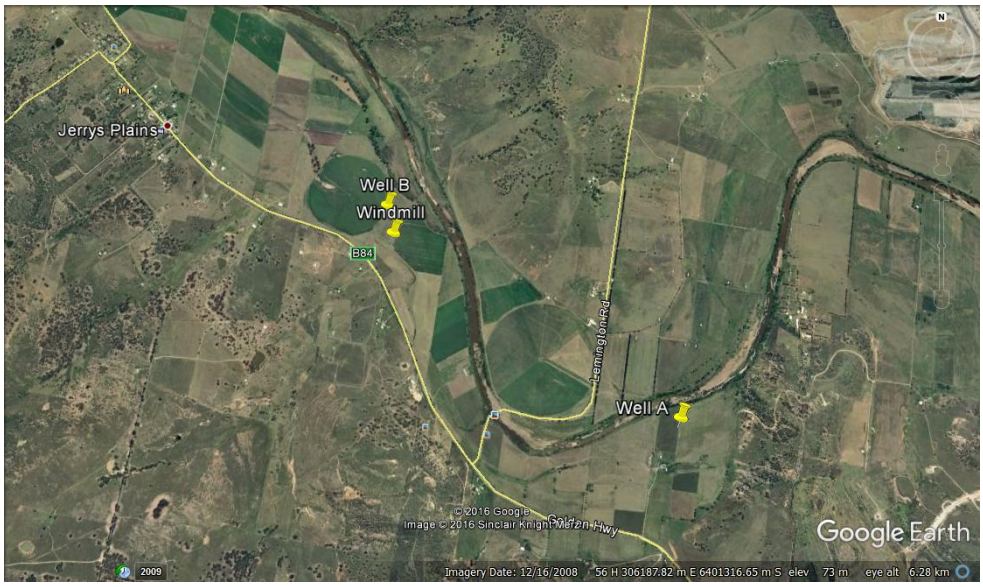
Map 3. Location of surveyed sites within and adjacent to the United Wambo Open Cut Coal Mine Project Area. The yellow pins represent sites that were positive for fauna and the white pins were negative to fauna.



Map 4. Drawdown zone within the Quaternary Alluvials of the Hunter River and Wollombi Brook. (AGE, 2016. United Wambo Project - Groundwater Impact Assessment (G1733). Fig 7.12).



Map 5. Location of surveyed sites within the Hunter River Alluvium. The yellow pins represent sites that were positive for fauna.

Map 6. Location of surveyed sites within the Wollombi Brook Alluvium. The white pins represent sites that were negative for fauna.

The Study Area examined in this investigation includes the Hunter River Alluvium (Map 3, 5) to the upstream of the confluence with Wollombi Brook and North West of the existing Wambo/United Open Cut, in the Wollombi Brook Alluvium. The Hunter River Alluvium is mostly cleared grazing or cropping land with patches of riparian vegetation along the river margins. The sediments in the Hunter River Alluvium consist of layers of fine clays with interbedded sand and gravel lenses. The sand and gravel beds and lenses are also the water bearing zones and stygofauna habitat. The bores sampled along Wollombi Brook are within the riparian zone which is vegetated with a mix of native

and introduced vegetation. The sediment within the alluvium consists of very fine sands with minor interspersed clays.

The object of this assessment is to determine if subterranean stygofauna communities may be present in the area of predicted drawdown as a result of the mining operation. This assessment is a baseline aquifer ecosystem evaluation for stygofauna across control areas and proposed future impact areas associated with the Project. There has been no previous published sampling for stygofauna conducted at these specific locations although stygofauna have previously been recorded from the Hunter River Alluvium and catchment although mainly within the hyporheic zone (subsurface river channel) of the River(Hancock, 2004, Hancock and Boulton, 2008).

1.1 Purpose of this Report

This Stygofauna Assessment Report has been prepared as part of the Response to Submissions report for the Project in response to submissions received on the Environmental Impact Statement (EIS) prepared for the Project. This report also serves to provide baseline information to inform future monitoring of impacts in the Project Area. The focus of this round of surveys in particular is the potential impact of drawdown on the stygofauna community within the Hunter and Wollombi Brook Alluviums.

1.2 Impact Assessment Objectives

The aim of the stygofauna baseline surveys and impact assessment is to determine the presence of stygofauna within the Project area and to assess the potential impacts of the Project on groundwater ecology including aquatic threatened species, populations, communities or their habitats that are dependent on groundwater. The assessment addresses the impacts of subsidence from underground coal mining.

The specific objectives were to:

- ❑ Describe the natural/pre-mine development characteristics of the groundwater ecology through quantitative and qualitative surveys of stygofauna;
- ❑ Identify or determine the likelihood of occurrence of threatened species, populations, habitat and/or communities within the Study Area;
- ❑ Assess whether these impacts will cause significant adverse effects to groundwater and baseflow stream ecology; and
- ❑ Determine whether these impacts will significantly impair any identified threatened species, populations, habitat or communities.

1.5 Terminology Used in This Report

Stygofauna is an all-encompassing term for animals that occur in subsurface waters (Ward et al. 2000). They are classified by the degree to which they are dependent on groundwater. Those that are completely dependent on groundwater are termed stygobites or phreatobites and consist predominantly of crustaceans. Those that rely on groundwater to a lesser extent and can live in mixed surface and groundwater are termed stygoxenes or stygophiles depending on their adaptation to the subterranean environment (Marmonier et al. 1993). The distinction is often ambiguous because it is difficult to know the degree of surface/groundwater mixing in an aquifer, and the classifications are regularly disputed (Sket 2010). However, classifications based on affiliation to groundwater can be

useful when assessing the conservation status of species and their vulnerability to potential impacts. In this report we adopt the following definitions:

Stygoxenes - organisms that have no affinities with groundwater systems but regularly occur by accident in caves and alluvial sediments. Some planktonic groups (e.g. Calanoida Copepoda) and a variety of benthic crustacean and insect species (e.g. Simullid larvae, Caenidae Mayflies) may passively infiltrate alluvial sediments (Gibert et al.1994).

Stygophiles - organisms that have greater affinities with the groundwater environment than stygoxenes because they appear to actively exploit resources in the groundwater system and/or actively seek protection from unfavourable surface water conditions. Stygophiles can be divided into occasional/temporary hyporheos and permanent hyporheos.

Stygobites - obligate subterranean species, restricted to subterranean environments and typically possessing specialised character traits related to a subterranean existence (troglomorphisms), such as reduced or absent eyes and pigmentation, and enhanced non-optic sensory structures.

1.6 Assumptions and Limitations

This report is a baseline assessment, which focuses on identifying the presence and biodiversity of stygofauna within the Study Area. The Study Area has been assessed using monitoring and insitu field information and will serve as a baseline for ongoing monitoring and impact assessment.

Groundwater bore sites sampled are assumed to be representative of the groundwater ecosystems present across the Study Areas, temporally and spatially. While every effort was given to maximize the representativeness of the system it does not cover the full extent of the bores and potential subterranean and groundwater dependent habitats in the Study Area. Temporal variations between autumn and spring also cannot be assessed at this stage as there has been no seasonal replication.

2. Study Area and Sampling Sites

The Study Area for the purposes of this report encompasses the Project Area (refer to Map 3) and adjacent alluvial lands to the North East and North West containing groundwater bores and wells.

2.1. General Description

The Study Area is for this Project is located within two alluvial aquifers. The Wollombi Brook and the Hunter River alluvium contain groundwater in thin Quaternary deposits adjacent to the mining area (AGE, 2016). These deposits consist of silt, sand and gravel in the alluvial floodplains of both the Wollombi Brook and the Hunter River Alluvium (AGE, 2016). The Wollombi Brook Alluvium includes the North Wambo Creek and Stony Creek. Wollombi Brook and its associated alluvial lands are located in the south and southeast of the mining area and flows in a north-easterly direction into the Hunter River approximately 5 kilometres east of the mining area.

The Hunter River alluvium flows in an easterly direction, while groundwater within the Wollombi Brook alluvium flows in a north to north-easterly direction towards the Hunter River. Recharge to the Quaternary alluvium occurs via ‘diffuse’ recharge from rainfall and ‘focussed’ recharge through the stream bed. The available data for the alluvium indicates that it is largely unsaturated within the more elevated tributaries, with the alluvial groundwater largely restricted to the thicker sequences of sand

and gravel (highly productive alluvium) along the Hunter River and Wollombi Brook. While the alluvium is an unconfined unit, the upper sequences of the alluvium (approximately upper 8m) are largely clay rich and less permeable than the basal sands and gravels. Groundwater levels within the Quaternary alluvium along Wollombi Brook and Hunter River are generally 4m and 10m below surface, respectively. The Quaternary deposits of the alluvium unconformably overlays the Permian aged Wittingham Coal Measures to the east of the project area which unconformably underlies the Triassic Narrabeen Group sediments to the west of the Project Area. The coal measures outcrop east of the Project Area, towards the Hunter River. (AGE, 2016)

2.2 Groundwater

The main aquifers in the area occur within the Permian Coal Measures and the Quaternary alluvial aquifers of Wollombi Brook and Hunter River. Groundwater is recharged by rainfall along the ridgelines and discharges as springs in the mid to lower slope areas, providing base flow to most of the small streams. The Quaternary alluvial aquifers are the widespread shallow aquifers and the sites range in water level depth from 6.72 to 10.15m (Figures 1-3). Graphs displaying the water levels and the thickness of the water column at each sample site, and therefore the available habitat, are presented below in Figures 1-3. Water column thickness is also presented in Figure 3-4. Most of the alluvial aquifer bores have only small water columns ranging from 5.17-7.09m of water within the Wollombi bores and 0.5-1.1m in the Hunter River wells. Whether this is a true measure of aquifer thickness or an artefact of the bore depths is not know at this time however it needs to be considered in terms of habitat availability. The bores /aquifers with a small water column thickness are vulnerable to impacts from drawdown and therefore will be more impacted via a loss of habitat if there are significant changes to aquifer levels.

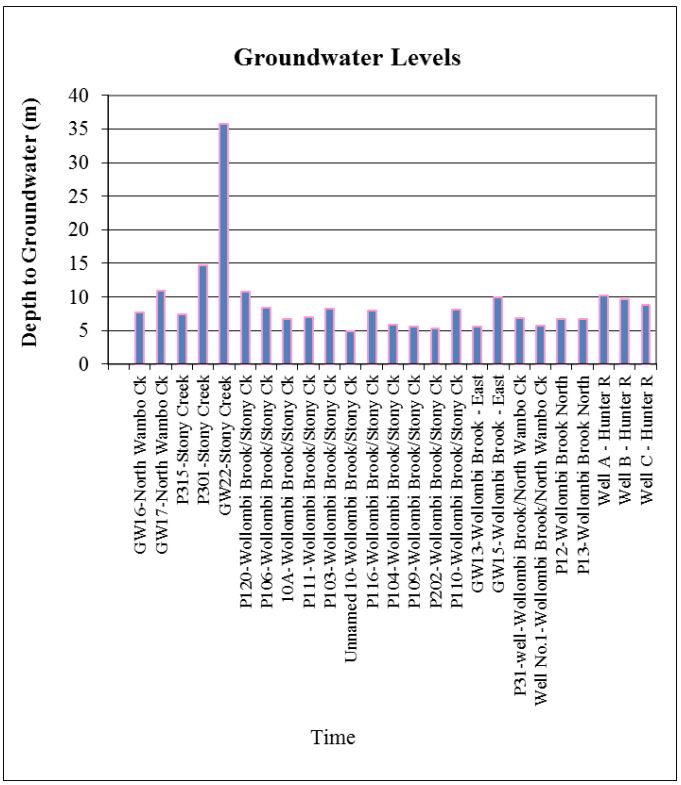


Figure 1. A comparison of field water levels of all bores sampled in Survey 1 & 2.

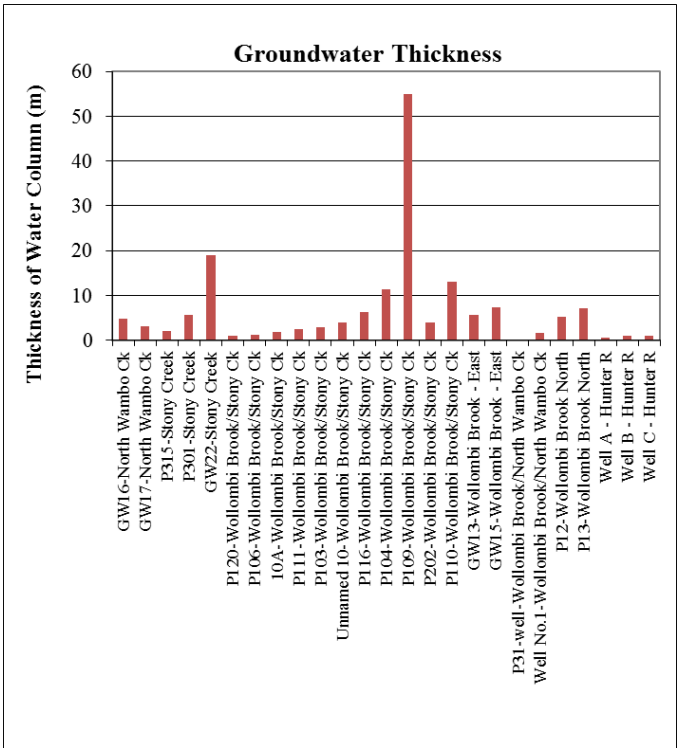


Figure 2. A comparison of field water levels of all bores sampled in Survey 1 & 2.

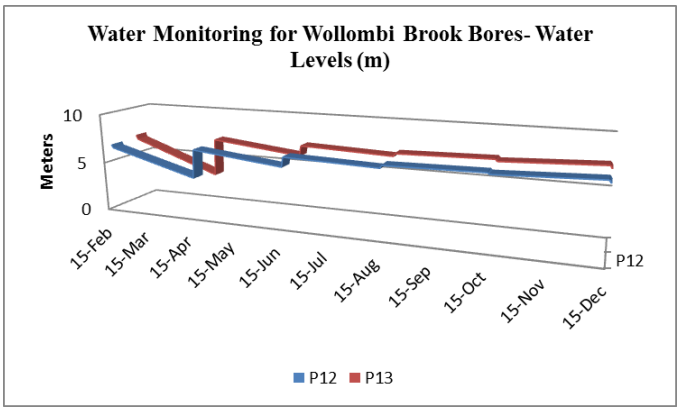


Figure 3. Annual groundwater level values for Bore No's P12 & P13 in Wollombi Brook from October 2014 to August 2016.

2.3 Study Sites

2.4 Bore Data

The bore and well data is presented in Table 1. Five sites were selected as representatives of each of the two alluvials (Table 1). Although there were a larger number of bores listed within the United area, most were deemed unsuitable for stygofauna for the following reasons: most of the bores were equipped with vibrating wire devices; the other monitoring bores had very high salinity or were dry or

more often were very old and could not be located. The bores rejected included 'Abandoned and destroyed bores' and all of the piezometers that were installed with Vibrating Wire Piezometers (VWP) surface water depth devises due to the difficulty of accessing the water. The bores surveyed were either shallow monitoring piezometers accessing groundwater situated in the unconsolidated alluvial sediments of the Wollombi Brook or shallow wells on farming land adjacent to the Hunter River. The bores were surveyed using two techniques on one occasion.

Of the 5 bores sampled, two bores are considered as potential impact sites as they are located on the alluvial land in the lower reaches of Wollombi Brook within the Project area (P12, P13). The remaining 3 wells are located to the north on the Hunter River alluvium with one well within the drawdown impact zone (Well C – windmill) while the other two to the north are outside of the area of modelled drawdown (See Figure 7.3, AGE 2016) and therefore classed as control sites

The piezometers or observation bores selected are typically constructed with a short steel casing extending from ground level to approximately 3-6m below the surface which surrounds a 50mm plastic casing extending the length of the bore with a terminal cap to prevent sediment entering from the bottom. The section of the casing that corresponds with the water bearing zone, that is required to be monitored, is equipped with slots to allow the water to enter. The three wells were constructed with reinforced concrete cylinders (Well B, Well C) or with timber beams (Well A). The survey sites are listed below in Table 1. Site images are presented in Appendix 2.

Bore No.	Name on Bore	Date	Easting	Northing	Potential Drawdown (m)	DTW (m)	DTB (m)	GW Thickness (m)	Monument Height (m)	Bore Diameter (mm)	Bore Material	Monument Material	pH	EC (uS/cm)	Use
Well A	Unnamed WellA	14/11/2016	307552	6400343	1	10.15	10.65	0.5	0	1500	Timber	Timber	7.6	7553	Irrigation/Stock
Well B	Unnamed Well B	14/11/2016	305358	6401898	0	9.72	10.7	0.98	0	1500	Concrete	Concrete	7.8	1872	Irrigation/Stock
Well C	Windmill	14/11/2016	305413	6401682	0	8.87	9.97	1.1	0	1500	Concrete	Concrete	7.7	3360	Irrigation/Stock
P12	P12	14/11/2016	313645	6394800	1	6.76	11.93	5.17	0.37	50	PVC	Steel	6.11	914	Monitoring
P13	P13	14/11/2016	313722	6394412	0	6.72	13.81	7.09	0.53	50	PVC	Steel	6.16	792	Monitoring

Table 1. Bore survey station list. DTW - depth to watertable; DTB – depth to bottom; GW – groundwater; EC – electrical conductivity.

3. Methodology

The "Risk Assessment Guidelines for Groundwater Dependent Ecosystems" (Serov et al. 2012) methods were structured to specifically reflect current relevant legislation, as well as to address the Secretary's Environmental Assessment Requirements for the Project. These methods include monitoring design and impact assessment criteria.

In preparing for each round of stygofauna sampling it is necessary to keep in mind the needs of a future monitoring program that will be required to determine if there has been any significant changes to either the water resource or the dependent ecosystems. This is best done by using a BACI (Before/After Control/Impact) experimental design i.e. before and after sampling at experimental and control (reference) sites. The development of any sampling protocol involves:

- ❒ Selecting sampling location points (bores, wells, piezometers, appropriate hyporheic habitat etc.);
- ❒ Deciding on an appropriate sampling method (pumps, bailers, plankton nets, Bou Rouche pump etc.);

❒ Determining sample handling procedures (such as filtration, transfer, preservation, etc.); and minimum disturbance to biological specimens.

3.1. Stygofauna Sampling

In order to sample a habitat effectively it is often necessary to use a combination of techniques to comprehensively collect all possible biota as the stygofauna community occupies a range of habitat niches. For routine surveying or monitoring of bores and wells, a submersible pump or hand pump, bailer and/or plankton nets (Mathieu et al. 1991) are the preferred devices. The sampling techniques used for the stygofauna surveys are described below.

The Phreatic/hypogean zone

The phreatic zone is the subsurface area within an aquifer where voids in the rock are completely filled with water. This is occupied by phreatobites. Phreatobites have adapted to tolerate suboxic conditions (dissolved oxygen concentration (DO) less than 3.0 milligrams per litre) or limited food supply (Malard and Hervant 1999; Hervant and Renault 200;, Datry et al. 2005) and even hypoxia (DO less than 0.01milligrams per litre) (Thomlinson & Boulton, 2008). Dissolved oxygen (DO) concentrations below 1.0 to 0.5 mg/l are the critical threshold for most groundwater fauna (metazoans) (Hahn 2006). The stygofauna community was sampled using two standardised methods and one non-standard method.

The first technique is the Phreatobiology Net. This is the standard technique that has been used successfully overseas and in Australia (Bou, 1974). This method involves using a weighted long haul or plankton net with a 150 µm mesh. Sampling consisted of dropping the net down to the bottom of the bore and taking at least three consecutive hauls from the entire water column at each bore. Upon removal from the bore the net is washed of sediment and animals and the contents of the sampling jar (the weighted container at the bottom of the net) are decanted through a 150 µm mesh sieve. The contents of the sieve are then transferred to a labelled sample jar and preserved with 100% ethanol.

The second standard method is the use of a groundwater bailer. A bailer is typically used by hydrogeologists to take water samples from bores for water quality/water chemistry analysis. The bailer used for this study is 1 meter long by 40mm clear plastic tube with a running ball valve at the bottom. The advantage of using a bailer is twofold. The main reason for using a bailer is that it is able to sample the bottom sediment of a bore that cannot be sampled by a haul net and therefore enables the collection of cryptic invertebrates that do not inhabit the water column or sides of the bore. The second advantage is that in shallow bores down to 5 meters in sediments with low transitivity porosity, a bailer is able to empty the entire contents of a bore and thereby confidently collect all animals within the bore. The contents of the bailer are emptied into a cleaned bucket from which the water is then decanted through a 150 µm mesh sieve. The contents of the sieve are transferred to a labelled sample jar and preserved with 100% ethanol. Following sampling and preservation of the sample and prior to the next sampling, all equipment including the bailer, net and sieves must be rinsed clean with clean water via a spray bottle to remove any sediment and animals that may have remained attached to the sampling devices. This is to reduce the possibility of cross contamination of organisms (stygofauna or bacteria) or pollutants from one aquifer or bore to another.

3.2. Laboratory Methods

3.2.1. Identification

All samples are preserved in the field with 100% ethanol and returned to the laboratory where each sample is sorted under a stereomicroscope and stored in 100% alcohol. All specimens are identified to the lowest possible taxonomic level, generally to genus, where possible. Specimens are identified under a compound microscope using a combination of current taxonomic works and keys such as Williams (1981) and the taxonomic identification series (Serov 2002) produced by the Murray Darling Freshwater Research Centre as well as the authors taxonomic expertise and experience.

3.2.2. Physico-Chemical Data

Physical and chemical parameter data was supplied by United and Wambo from their regular water quality monitoring program. Water quality parameters including, electrical conductivity and ph were collected in the field using a water quality multimeter. Bore depth was collected in the field during the initial survey and water level (SWL) data was collected at each site during each survey. There is previous monitoring data available for the two bores however no long term monitoring data available for the wells therefore only insitu field data is used in this report for these sites.

3.3 Data Analysis

3.3.1. Impact Assessment Methodology

The ecological valuation and risk assessment process used to assess the risk and potential impacts of the proposed development for the identified GDEs is the "Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Serov *et al*, 2012)".

In summary, GDEs are first identified and classified and the level of dependency on groundwater for individual GDEs inferred. Once the current ecological value of individual aquifers has been determined, the ecological value of the GDEs associated with that aquifer must then be assessed. The individual value of each GDE within the aquifer can also be assessed as a stand-alone unit. Following an assessment of the aquifer and associated GDEs current value, the potential future impact of a proposed activity on the aquifer and associated GDEs must then be determined. The magnitude of risk from that activity to the ecological value of the GDE(s) and aquifer is then determined. Finally, the Risk Matrix is applied to determine the most appropriate management response for a given environmental value. For more information on the process see "Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Serov *et al*, 2012)"

3.3.4. Comparative Indices (Number of Taxa)

Number of Taxa. All macroinvertebrate taxa are separated and counted. The number of families present generally decreases with decreasing water quality and is used as a comparative measure of community change over time.

4. Results

4.1 Environmental Physico-chemical Conditions

All physico-chemical parameters were remarkably consistent across each aquifer (Table 4). The groundwater chemistry for the sites that recorded stygofauna is well within the minimum requirements for pH as set out by the ANZECC and ARMCANZ guidelines (2000) however salinity/electrical conductivity was high to very high (1872-7553µS). At the time of sampling Wollombi Brook and Hunter River were experiencing low flow conditions. The data availability for a number of parameters is limited and patchy due to the short time period that monitoring has been

conducted for some bores. Therefore a limited data set including water levels, electrical conductivity and pH is presented here.

Survey 2	SWL (m)	GW Thickness (m)	Conductivity (mS)	pH (pH Units)
P12	6.76	5.17	914	6.11
P13	6.72	7.09	792	6.16
Well A	10.15	0.5	7553	7.6
Well B	9.72	0.98	1872	7.8
Well C	8.87	1.1	3360	7.7

Table 2. Physico-chemical data from each site collected on 14th November, 2016.

4.1.2 Electrical Conductivity

Figures 4-5 compares the salinities between over time within the bores at Wollombi Brook (Figure 4) and between all surveyed sites for the two surveys (Figure 5). The long-term levels in the Wollombi Brook bores were consistent between sites and stable throughout the year, The bores sampled during this survey illustrates that there were two salinity ranges i.e. bores with low salinities (312.8-863 µS/cm) within the Wollombi Brook alluvium and to bores with elevated salinities (1779-7775 µS/cm) within the Hunter River and Stony Brook alluvials. This distinct separation of the bores based on salinity represents the separation of the bores in the shallow fresh alluvium and those that are in contact with the saline coal measures. In the previous survey in 2015 this was particularly important in delineating the areas occupied by stygofauna from the areas devoid of fauna. Apart from the outlier, GW17, all stygofauna were present in bores with salinities below 860 µS/cm. It also separated out the two well sites both in terms of salinity (1155-1779 µS/cm) and fauna composition where the wells are dominated by Ostracoda or pea clams. This indicates that these groups of invertebrates favour these conditions whereas the other stygobite groups prefer a much lower salinity. This is also seen in the current round of survey where the well sites had similar salinities and fauna indicating that the fauna collected are naturally tolerant of disturbance and high salinities. The relatively low salinities in the Wollombi Brook bores is suggested not to be the limiting factor in the absence of the fauna but rather the fine grained nature of the sediments. This is consistent with the absence of fauna within the other bores in the lower Wollombi Brook alluvium, GW13 and GW15.

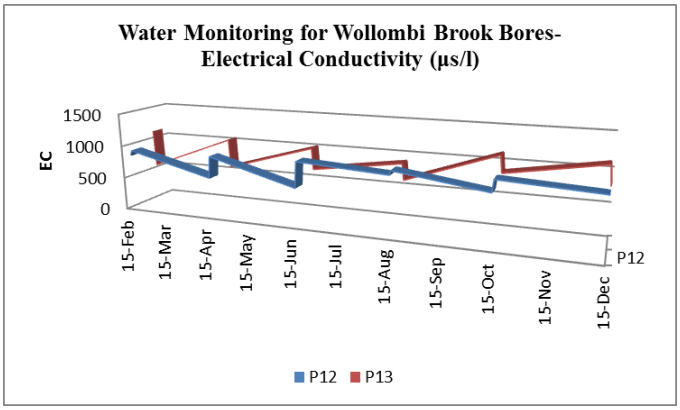


Figure 4. Annual groundwater level values for Bore No's P12 & P13 in Wollombi Brook from October 2014 to August 2016.

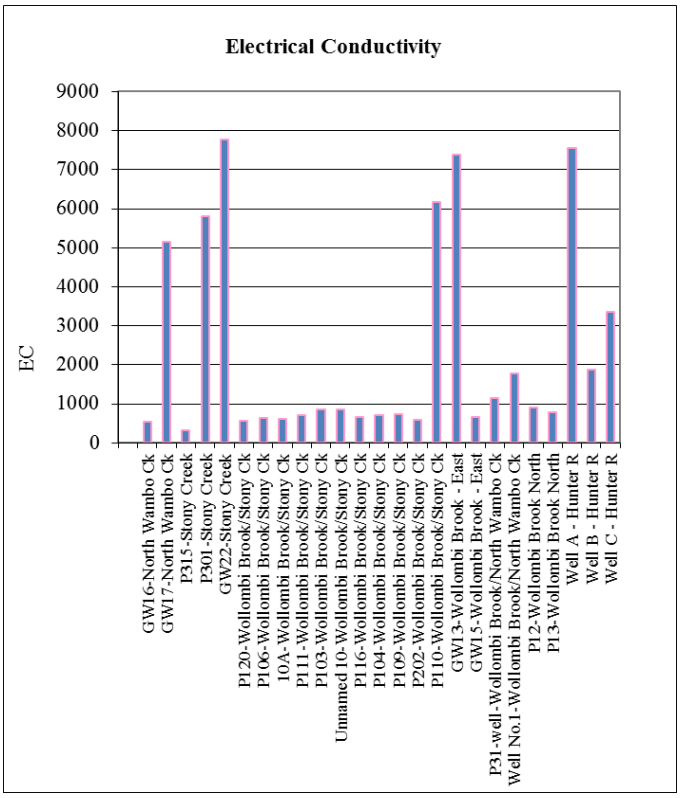


Figure 5. A comparison of field electrical conductivity levels for all bores sampled in Survey 1 & 2.

In terms of subcatchments the Hunter River Alluvium is characterised as having higher salinity levels exceeding 5000 µS/cm whereas Wollombi Brook has a low salinity profile of generally less than 1000 µS/cm.

4.1.3 pH

The range is pH sampled insitu (Figures 6-7) between the sites sampled is small varying from 6.11-6.16 at P12 and P13 respectively for the Wollombi Brook alluvium to 7.6 – 7.8 for Well A to Well respectively for the Hunter River Alluvium. As there has been very little fluctuation of pH throughout the system over time, it is therefore not considered to have any major impact on groundwater biodiversity. The long-term pH data recorded in the Wollombi Brook alluvial bores (Figure 6) as with the salinity data illustrates that there has been little change since early 2015.

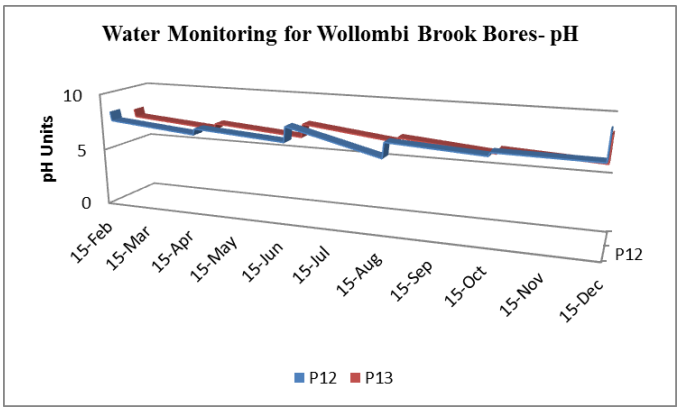


Figure 6. Annual pH values for Bore No's P12 & P13 in Wollombi Brook from October 2014 to August 2016.

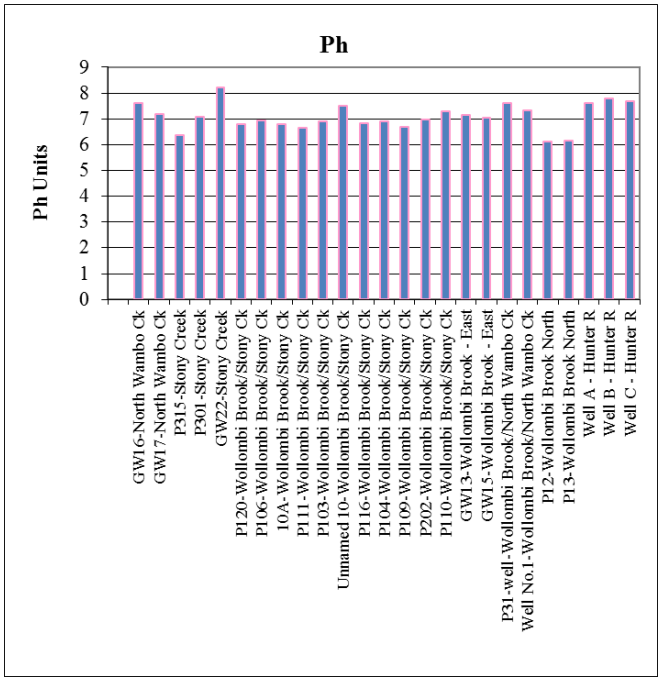


Figure 7. A comparison of field electrical conductivity levels for all bores sampled in Survey 1 & 2.

4.2 Ecological Response - Stygofauna Data

4.2.1 Community Structure

The survey sampled two bores and three wells across the Study area and recorded 3 sites that contained 4 stygofauna species. The species list and habitus for each site is listed in Table 3 below. The stygofauna were present within the shallow alluvial wells of the Hunter River Alluvial only and were not collected from the Wollombi Brook Alluvium. The most ecologically productive horizons within the alluvials appear to be in the depth range of 8.87-10.15m with the majority occurring at 9m

and at the lower salinities of approximately 1800 µS/cm. The community composition included two orders of crustaceans, one order of worms and one order of insects. There were no listed threatened species collected, however, as is the case with most assessments in this emerging field, most species are likely to be new to science and restricted in distribution due to the short range endemic nature of stygofauna species, in particularly the worms and crustaceans.

Most species collected are morphologically specialised, which includes total lack of eyes i.e. blind and unpigmented. Although the species have not been identified to species level as yet, the significant taxa include the second record of subterranean Oligochaete families Enchytraeidae as well as the microcrustaceans, the Ostracoda and Copepoda. Descriptions of the recorded families are presented below.

Phylum	Class	Order	Family	*Genus*	*Habitus*	Unnamed WellA	Unnamed Well B	Unnamed Well C	P12	P13
Annelida	Oligochaeta	Tubificida	Enchytraeidae		*Stygobite*	20	8			
Arthropoda	Maxillopoda	Cyclopoida	Cyclopidae	*Mesocyclops*	*Stygobite*		4	19		
Arthropoda	Ostracoda	Myodocopida	Candonidae	*Candonopsis cf.*	*Stygophile*			12		
Arthropoda	Insecta	Diptera	Culicidae	*Aedes*	*Stygoxene*	4	9	12		
				Total No. species		2	3	3	0	0
				Total No. of animals		24	21	43	0	0

Table 3. Habitus separation of stygobite, stygophile and stygoxene taxa. The white rows represent stygobites (stygofauna) whereas the orange are stygophiles and the blue rows represent stygoxene fauna.

Table 3 also separates the bore sites into ecotone types. The blue colour represents the bore site that registered positive to surface water fauna, the orange represents fauna that are likely stygophiles with the remaining white colour representing stygofauna. The bores that contained no fauna were not included.

The majority of fauna recorded during the survey were crustaceans and worms. The low number of taxa and numbers of specimens collected at each site indicates a depauperate fauna within the alluvial aquifers at the well sites and a low to moderate level of hydrological connectivity within the aquifer, possibly due to the substrate consisting of unconsolidated sands. This alluvial aquifer has a low to moderate degree of connectivity between the sample sites as indicated by the similarity of fauna across the Study Area. This may also indicate that there is a series of palaeochannels present with the alluvium.

The relative consistency of the faunal composition across the wells sampled suggests that the subterranean community diversity is naturally low compared with other regions in NSW such as the Peel River in NW NSW and certainly comparable with the fauna found in the wells sampled in the upper Wollombi Brook alluvium. The fauna composition indicates a shallow groundwater system which is directly connected to the river system. The fact that sections of Hunter River Alluvium contain water while other sections are dry indicates a variable gaining/loosing flow situation whereby the groundwater is partly feeding into the river. The variability of the porosity of the aquifer substrate appears to be one of the significant factors in determining the fauna composition as well as the presence or absence of fauna from bores. The porosity varies from low porosity in the clays and finer

alluvial sediment zones and high porosity in the courser unconsolidated sands sediments close to the river. The relative small size of the phreatic fauna collected is also an indication that the sediments are generally fine in nature.

The fauna is separated into two major ecotone groups and one minor ecotone group. The major separations is into the Stygobites groundwater fauna that contained the Oligochaeta, Ostracoda and Copepoda and the incidental surface macroinvertebrate stygoxene fauna represented by the Insect Order, the Culicidae (Mosquitoes). The minor ecotone separation is between the well sites that contained a predominance of Candonidae Ostracoda and the sites to the south that was dominated by the Copepoda and Oligochaetes. These ecotones are described below in more detail.

Ecotone 1 - Stygobites – Sites: Well A, Well B.

Two sites recorded the presence of stygofauna located entirely within the alluvial aquifers. This first ecotone is characterised by the community of obligate groundwater fauna represented by the Oligochaeta (Family Enchytraeidae) and the Crustaceans including the Copepoda and Ostracoda. This faunal assemblage can be found in both the shallow hypogean (true groundwater) ecosystem as well as the temporary and permanent hyporheic zone ecosystems of stream and rivers within the Hunter River.

Although other aquifer ecosystems have been identified within the region, there are none so far identified within the area of the Hunter River Alluvium. The community appears to be restricted to an area encompassing the floodplains of the river however separated into discreet pockets.

Oligochaeta

In Australasia, the Oligochaeta are represented in freshwaters by the families Haplotaxidae, Aeolosomatidae, Lumbriculidae, Phreodrilidae, Naididae, and Tubificidae (Brinkhurst 1971). Of these families, the Haplotaxidae has a Gondwana, South East Australia and New Zealand distribution but is poorly represented in Australia, (Pinder 2001) although increasingly prominent in groundwaters.

The obligate groundwater fauna is characterised by the Family Enchytraeidae. The Enchytraeidae are a small family of aquatic worms that are poorly known although they have been found in freshwater environments in Victoria, NSW and recently in groundwaters in Queensland. They are a poorly known group that requires further taxonomic work (Pinder & Brinkhurst, 1994. In terms of their use within current environmental sensitivity indices such as the SIGNAL Index ranking, they can only be assessed at the Order level of Oligochaeta which has a ranking of 2. This equates to a family which is quite tolerant of environmental disturbance. This, however, is misleading as the family is usually associated with high water quality environments.

In a review of the stygobitic oligochaete fauna of the world, Juget & Dumnicka (1986) noted 66 species in seven families (Aeolosomatidae, Potamodrilidae, Haplotaxidae, Lumbriculidae, Dorydrilidae, Tubificidae, and Enchytraeidae). More recently, Giani et al. (2001) reported 57 species that can be classified as stygobites in southern Europe alone, suggesting the global diversity far exceeds initial estimates (e.g., Juget & Dumnicka 1936). Indeed, Giani et al. (2001) estimated that, when records from other areas of the world (e.g., North America, Africa, Europe) are added, a total of 96 stygobitic freshwater oligochaetes are known in the world (they excluded Australasia from their estimate for some reason). It should be noted that it is often difficult to make a clear separation between stygobitic and stygophilic oligochaetes. For example, the features that distinguish stygobitic crustaceans from epigean forms, such as absence of eyes, lack of pigmentation, and elongation of

body, do not distinguish between stygobitic and epigean oligochaetes. Giani et al. (2001) noted that very few species of Naididae are stygobites. However, a clear indication that an aquatic worm is stygobitic is its presence in a bore or well that has no aquatic connection with surface water bodies.

The presence of Oligochaete worms in wells A and B indicates that the water quality is characterised by elevated organic carbon, and possibly high levels of dissolved iron. The relatively small size (1-30mm) of the Oligochaete (worm) species present indicates a low to moderate hydraulic connectivity within the river/aquifer environment. The shallow water table levels within the alluvial phreatic zone and the presence of this family of worms suggests a direct association/connectivity with a slow base flow river system with a shallow alluvial aquifer. There is very little known about the diversity and distribution of freshwater Oligochaeta, therefore the identification can only be given to the family level. Subterranean Oligochaetes are an increasingly important component of Australia's groundwater fauna that contain a large number of short range endemic species with large faunas along the continental marginal areas, particular in the southwest and eastern seaboards.

Ostracoda

Ostracods are present in all groundwater habitats from fractured rock aquifers, to karst and alluvial aquifer systems, as well as in hyporheic and parafluvial habitats within rivers.

Research indicates that species have quite distinct distributions and, apparently, habitat preferences, with highest biodiversity adjacent to rivers and lower diversity in alluvial aquifers more distant from surface rivers (Ward et al. 1994). Other studies indicate that proximity to running water rich in organic matter is important (Rouche & Danielopol 1997). Their distributions are more complicated than simple proximity to rivers or concentration of organic content. There appear to be few meaningful correlations between ostracod abundances and individual physical factors (organic content, alkalinity, calcium, oxygen concentration). Instead, differences in habitat stability in terms of complexes of physico-chemical factors (e.g., water temperature and organic content) and the upwelling or downwelling nature of interstitial flows seem important, with some taxa more common in variable habitats and others more abundant where conditions are more constant (Ward & Palmer 1994).

The one well site Well C is characterised by the presence of the Candonidae Ostracoda (Seed Shrimp) indicates connectivity between these sites as these fauna can only disperse via hydrological connectivity. Further examination of these taxa is necessary to determine if these represent one species or more separate, short range endemic species.

Plate 3. Ostracoda, Candonidae. (©P.Serov 2015)

Copepoda

The Copepoda are a subclass of Crustacea comprising over 10,000 known species (Williamson and Read 2001). Copepoda are predominantly marine, although 3 of the 10 orders are widespread and abundant in freshwater habitats. These are the Calanoida, Cyclopoida and Harpacticoida. The first order occurs in the water column as plankton only, whereas the latter two are common in benthic habitats of surface waters and are important components of many groundwater communities.

The Copepoda Cyclopidae is normally associated with fine to course sandy substrates of still water environments of rivers, wetlands, the hyporheic zone and shallow groundwaters. Although they are a ubiquitous component of these habitats, their small size means that they are often overlooked and undercounted. In terms of management, therefore, they are potentially very useful bioindicators, particular of base flow fed streams or alluvial aquifers or flow through wetlands, as they are sensitive to changes in the environment (Tomlinson & Boulton, 2008). The Cyclopidae were collected at two sites Well B and Well C which are all located within the shallow alluvials on the outer flood plain of Hunter River. These two sites are characterised as being shallow (8-10m), occurring within the alluvium and having neutral to slightly alkaline pH. The conductivity levels however vary considerably from moderate to high suggesting that the fauna is either very tolerant of salinity changes.

5.0 Ecological Value and Risk Assessment

The assessment of the ecological value and risk value the stygofauna community at each of the sites surveyed as well as an overall assessment of the shallow aquifers that supply the water to the identified GDEs is presented below.

Locality Name	Habitat	Survey Result	Ecological Value	Ecological Risk	Matrix Ranking
Overal Aquifer Values			Low	Low	G
P12	Interstitial	Negative	Low	Low	G
P13	Interstitial	Negative	Low	Low	G
Well A	Interstitial	Positive	Low	Low	G
Well B	Interstitial	Positive	Low	Low	G
Well C	Interstitial	Positive	Low	Low	G

Table 4. Study Area Ecological Value and Risk Assessment Table.

The ecological value and risk value assessment undertaken for the Project was based on current data which is a snapshot of the current condition of the subterranean environments as of mid to late-2016 and modelled hydrogeological data as presented in the Groundwater Impact Assessment by AGE (2016). The AGE (2016) modelled data on the hydrogeological impacts of the Project on the Quaternary alluvial aquifers of North Wambo Creek and Wollombi Brook are summarised below.

- The most significant modelled drawdown within the Quaternary alluvium is predicted to occur east of United Open Cut along Wollombi Brook and Redbank Creek, as well as north along the closest edge of the Hunter River alluvium to the Project.

- The drawdown for all sites that recorded stygofauna is expected to be negligible as they are either in areas of minor (1m) drawdown or outside of the area of predicted drawdown, therefore the stygofauna community is unlikely to be adversely impacted by drawdown.

- The Hunter River stays saturated. Predicted impacts are in relation to changes in flux between Permian aquifer and alluvium which will be addressed by licences within requirements of Water Sharing Plan (which provides for sustainable flows).

- As the Permian strata become depressurised, flow from the Permian to the alluvium within the zone of depressurisation will progressively decrease. This can be considered beneficial as it reduces the inflow rate of higher salinity groundwater from the Permian to the overlying alluvium. The Project is therefore not predicted to adversely affect groundwater quality within alluvial aquifers.

- Within Wollombi Brook there are two areas predicted to be impacted, labeled as GDE 1 and GDE 2 in the groundwater assessment. At GDE2, around 1m in groundwater level decline is predicted due to cumulative impacts from mining (approved mining and the Project). The alluvium stays saturated and impacts are associated with change in flux between Permian aquifer and alluvium to be addressed by licences within requirements of WSP (which provides for sustainable flows). GDE1 is predicted to become largely desaturated as a result of the cumulative impacts of mining in the surrounding area – this desaturation will occur anyway without the Project.

An overall value and risk assessment was conducted focusing on the shallow aquifers of the Study Area as a whole in order to place the sites into a landscape perspective and to demonstrate the condition and ecosystem function performed by these aquifers. The results of this assessment

demonstrated that currently the aquifers in general are in very good condition in regards to water levels, water quality, as well as supporting a range of GDE types.

As shown in Table 4, the sites that registered stygofauna were assessed as having low ecological value due to absence or small number of salinity tolerant fauna and the marginal water quality within the Hunter River aquifer. Those bores that did not contain fauna typically had good water quality (low salinity) but very fine sediments and were assessed as having low ecological value in terms of subterranean ecosystems.

The Study Area recorded an overall low risk value for the ecological risk assessment for those sites that recorded stygofauna, as there was low potential for impact from the Project as a result of the modelled drawdown levels outlined by AGE (2016) in the groundwater impact assessment (refer to Map 7.3, AGE, 2016). This risk value also recognizes that as the populations were still intact after a long period of mining activity prior to the survey indicates that there has not been sufficient change over time to impact them.

In summary, in terms of the stygofauna community across the Study Area, the following points are noted:

- Limited and localised subterranean ecosystems exist in the shallow, unconfined alluvial aquifers of the Hunter River Alluvium. None of these species are currently listed as endemic, relictual, rare, or endangered biota (fauna or flora) populations or communities as listed under the TSC Act, FM Act or the Commonwealth EPBC Act. They do have a high potential to be short range endemic species, relictual and rare.

- The ecological values of the sites that contain stygofauna were low due to the absent or depauperate fauna as well as the ecological condition of the aquifers.

- The presence of the same or similar species in the wells indicate a direct connectivity between the shallow alluvial aquifers and the river.

- The risk of the proposed development to these subterranean ecosystems was rated as low based on the modelled drawdown particularly to the Quaternary alluvial aquifers and the highly connected nature of the alluvials with the underlying coal seams.

- There was very limited number of available sites and the insufficient long term data for the well sites sampled to determine whether past land use practices have impacted aquifers and associated GDEs. As a result, the confidence of the overall risk assessment is low to moderate. It is likely that the subterranean GDE community is in a low to moderate condition given the biodiversity and water quality in the area however, the consistency of the stygofauna occurrence across both control and potential impact sites indicated that the community is stable.

6.0 Management

This stygofauna assessment has identified the presence of subterranean fauna within the shallow alluvial of the Hunter River aquifer in the Study Area. Since the numbers of animals and diversity was low they indicate low to moderate water quality and a low to moderate connectivity between the river and groundwater system (Serov et al. 2012.). The restricted distribution of the stygobitic fauna recorded would strongly suggest that there is moderate connectivity within and between the alluvial aquifers and the associated streams. The fauna should be considered as short range endemics (SREs) species that are associated with this area. From a management perspective stygobites (phreatobites) usually face a higher risk of extinction than other invertebrate communities as they live only in small geographical areas and typically have narrow physiological tolerance ranges.

The risk assessment presented in Section 5 identified the overall Study Area to have a Class G risk ranking for the current ecological conditions and the risk from the current and proposed development. This indicates that the ecological values of the aquifers and the stygofauna community where present in the Study Area are low, however the potential for detrimental impacts from the current and proposed developments is also low. The two sites that did not record the presence of stygofauna were also ranked as Class G, indicating a low ecological value for the aquifer in terms of its stygofauna community and a low risk from the current and proposed development.

The current controls to manage GDEs are largely vested in the legislative controls of the *Water Management Act 2000*. A requirement of Water Sharing Plans (WSPs) is to monitor plan performance using a standard set of performance indicators as set out by the *Water Management Act 2000*. There are five main types of relevant rules which operate to protect GDEs in NSW WSPs, which are summarised as follows:

Distance Rules

- Rules for water supply works located near sensitive environmental areas. This rule specifies the distance restriction for new bores from high priority GDEs, karsts (Karst Rule), escarpments (Scarp Rule) and rivers. This rule is designed to minimise the impacts of extraction on these environments.
- Rules for the use of water supply works located within restricted distances. This rule specifies the maximum amount of water that may be taken on a yearly basis from existing water supply works that are located within the restricted distance from a high priority GDE, karst, escarpment or river. This rule is designed to minimise the impacts of extraction on these systems.

Drawdown Rule:

- Drawdown rules apply to minimise the negative effects of extraction on water levels. No drawdown is permitted to occur at the outside edge of the perimeter of any high priority GDE listed in the WSP. This rule is designed to minimise the impacts of extraction on high priority GDEs.

Cease to Pump Rule:

- Base flows in streams are protected by cease to pump rules. Most licensed users are required to cease pumping when there are no visible flows in the river or when flows are less than the 95th percentile.

Dealing (trading) Rules:

- Dealing (trading) rules are intended to promote trade of entitlement, including for new development, while minimising environmental impacts. Ideally, dealing arrangements result in environmental improvement rather than harm, for example, by avoiding the

concentration of extraction in a particular area. In most groundwater sources covered by macro plans, trade is allowed within a groundwater source but not into or out of the groundwater source. This recognises that groundwater sources as defined in WSPs represent discrete aquifer systems.

Local Impact Rules:

- All macro groundwater sharing plans include local impact management rules. These rules are intended to ensure that water levels in a groundwater source are not depleted detrimentally, beyond seasonal variations. Water quality can also decline as a resulting of excessive extraction. All the macro groundwater sharing plans include local impact management rules to manage water quality across a groundwater source. Water quality changes resulting from extraction are to be managed consistently with the designated category.

6.2. Cumulative Impacts

Cumulative effects may result from a number of activities interacting with the environment. The nature and scale of these effects can vary depending on factors such as the type of activity performed, the proximity of activities to each other and the characteristics of the surrounding natural, social and economic environments. They may also be caused by the synergistic and antagonistic effects of different individual activities, as well as the temporal or spatial characteristics of the activities. Importantly, cumulative effects are not necessarily just additive. The implication of multiple mining actives in one region, as exhibited within the Study Area, is that impacts may overlap and result in larger impacts than would be expected for a single mining operation (cumulative effects).

Due to the long history of mining within the region, the cumulative drawdown was determined by comparing predicted changes to 2015 groundwater levels. The cumulative drawdown within the Quaternary alluvium extends along Wollombi Brook and Hunter River, adjacent to mining operations (i.e. Wambo, HVO South, HVO North, Ravensworth and Mount Thorley Warkworth). It should be noted that the model predicted drawdown in certain areas exceeds the saturated thickness of the alluvium. The most significant modelled drawdowns within the Quaternary alluvium are visible east of United Open Cut, along Wollombi Brook and Redbank Creek (AGE, 2016)

6.3. Suggested Management Actions

Further work suggested for future stygofauna monitoring includes:

- ❑ Identify stygofauna to species (particularly those listed as phreatobites) to determine levels of endemicity of the stygofauna community, particularly between the community within Wollombi Brook, North Wambo Creek and the Hunter River. The determination of whether these populations contain the same species or are isolated, separate species is an important consideration particularly as stygofauna are known to be highly localised and endemic with several species often occurring in the same aquifer.
- ❑ Conduct annual biodiversity surveys in line with the water quality monitoring program to monitor potential changes/impacts to the stygofauna community;
- ❑ Continue ongoing monitoring of water levels, and water chemistry, with the addition of water temperature.

7.0. Conclusions

This round of sampling and assessment of the groundwater ecosystems that exist in the Study Area has demonstrated that:

- Stygofauna were present within the Hunter River alluvial aquifer;
- The biodiversity of the stygofauna community across the shallow alluvial aquifers is low with hotspots of biodiversity which will potentially have a high degree of endemism.
- Stygofauna were present within the groundwater drawdown zone of the Project (i.e. the impact zone) and outside the impact zone of the Project i.e. the control sites;
- There is a connectivity within and along the alluvial aquifers;
- Stygofauna were not surveyed from within the deep aquifer of the lower Wollombi Brook Alluvium, although they are considered unlikely to be present due to the fine nature of the sediments, or if so, to have high values for the reasons discussed earlier in this report;
- The similarity in fauna between the Hunter River Alluvium and the upper Wollombi Brook sites and Tributaries indicate that there has been and may still be a connectivity the between the aquifers however as it would appear that this is not through the lower Wollombi Brook alluvium it is likely that a high diversity and connectivity occurs in the shallow hyporheic zones of the river systems. If there is no connection through the hyporheic zone then the high stygofauna biodiversity of the mid to upper sections of the Wollombi Brook and tributaries must be regarded as isolated and endemic and of high ecological and conservation value.

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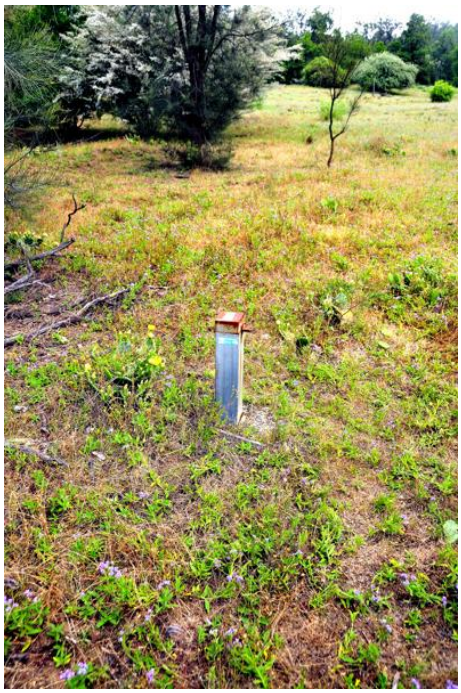
Appendix 1 - Site Images

Northeast Wollombi Brook

4.  5.

Plates 2. Bore No. P12. Plate 3. Bore No. P13

Hunter River Wells

6. 7.

Plates 4. Well A. 5. Well A close-up.

6. 7.

Plates 6. Well B. 7. Well B close-up.

8. 9.

Plates 8. Well C. 9. Well C close-up.

Appendix 2 - Risk Assessment Tables

Locality	**Hunter River Alluvial Aquifers**		
GDE ENVIRONMENT	**High**	**Moderate**	**Low**
GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc.			No
Presence of exotic flora or fauna within GDE	None exist		
Removal or alteration of GDE type or subtype		Minor change or alteration in physical structure, species composition, or size resulting in a temporary change in GDE type or subtype.	
AQUIFER			
Water quantity parameters	**High**	**Moderate**	**Low**
Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations.		Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type.*	
Alteration to direction of hydraulic gradients	No detectable change from natural seasonal variation.		
Alteration of base flow conditions	No detectable change from natural seasonal variation.		
Water quality parameters	**High**	**Moderate**	**Low**
Degree of acid runoff or acidification of groundwater source.	No detectable change from natural seasonal variation.		
Degree of nutrient load.	No detectable change from natural seasonal variation.		
Degree of groundwater salinity.	No detectable change from natural seasonal variation.		
Degree of bioaccumulation i.e. heavy metal contamination	No detectable change from natural seasonal variation.		
Aquifer structure	**High**	**Moderate**	**Low**

Degree of alteration of aquifer structure (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc.).	No detectable change in aquifer structure		
BIODIVERSITY			
Rarity within catchment/groundwater source	**High**	**Moderate**	**Low**
Presence of Threatened, Rare, Vulnerable or Endangered species, population or ecological community within GDE.			No
Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE ***			No
Patch size % of GDE relative to original/historic extent	>50%		
Diversity within catchment/groundwater source	**High**	**Moderate**	**Low**
Diversity of groundwater dependent native flora and fauna species within a GDE.			Presence of one species or less than 50% of species relative to reference sites
SPECIAL FEATURES WITHIN CATCHMENT/GROUNDWATER SOURCE	**High**	**Moderate**	**Low**
Provides drought refuge for terrestrial or aquatic species			Access to multiple water sources.
Presence of rare physical/physico-chemical features or environments (e.g. karsts, mound springs, natural saline wetlands, peat swamps etc.)			Occurs only within the State

Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation through aquifer connectivity	Unconfined aquifer with connection to terrestrial and aquatic ecosystems.		
Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification/denitrification, biodegradation relating to aquifer structure and porosity	Unconsolidated aquifer with connection to terrestrial and aquatic ecosystems.		
TOTAL NUMBER OF ATTRIBUTES	**11**	2	6
OVERALL VALUE	high		
COMMENTS	The alluvial aquifer that contains the stygofauna community recorded in this round of survey has remained stable in terms of water levels, pH and salinity over the period of monitoring for this mine. The presence of similar fauna in the Hunter River Alluvium upstream pf the confluence with Wollombi Brook is a strong indication that the aquifer environment has been stable and is in good ecological condition over time. The depauperate fauna in the Hunter River Alluvium and the absence of stygofauna in the downstream section of Wollombi Brook is however is an indicator that the habitat or water chemistry is not suitable to contain a diverse stygofauna community. Therefore the high ecological value is justified in terms of habitat stability however as there is little or no fauna the due to unsuitable habitat and or water chemistry - high EC) the ecological value for stygofauna of both the Hunter Alluvium and the lower Wollombi Brook is low.		

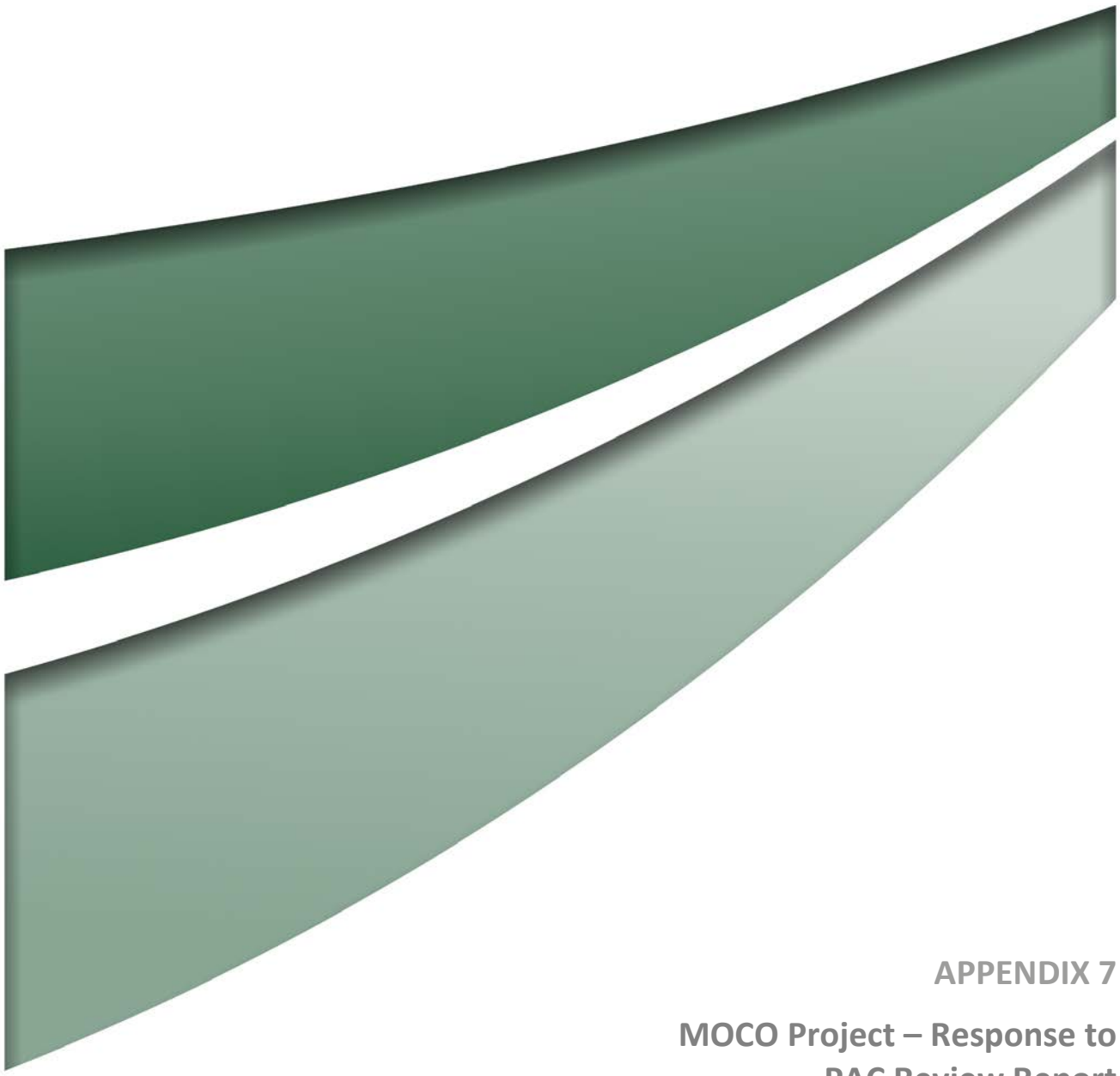
Table 5. Overall ecological value assessment for Study Area.

Locality	**Hunter River and Wollombi Brook Alluvial Aquifers (Well A, Well B, Well C: Bores: P12, P13)**			
Water Quantity Asset	**High**	**Moderate**	**Low**	**Insufficient data or unknown**
What will be the risk of a change in groundwater levels/pressure on GDEs?			No change to aquifer water levels or pressure beyond seasonal variation.	
What will be the risk of a change in the timing or magnitude of groundwater level fluctuations on GDEs?			No change in timing of water level fluctuations.	

What will be the risk of changing base flow conditions on GDEs?			No change in direction of flow.	
Water Quality Asset	**High**	**Moderate**	**Low**	**Insufficient data or unknown**
What is the risk of changing the chemical conditions of the groundwater source?			Negligible change (<5%)	
What is the risk on the groundwater source by a change in the freshwater/salt water interface?			No change or not applicable	
What is the likelihood of a change in beneficial use (BU) of the groundwater source?			Negligible change for identified triggers (<5%)	
Aquifer Integrity Asset	**High**	**Moderate**	**Low**	**Insufficient data or unknown**
What is the risk of damage to the geologic structure?			No change	
Biological Integrity Asset	**High**	**Moderate**	**Low**	**Insufficient data or unknown**
What is the risk of alterations to the number of native species within the groundwater dependent communities (fauna and flora)?			No reduction in No. of species.	
What is the risk of alterations to the species composition of the groundwater dependent communities (fauna and flora)?			No change in species composition.	
What is the risk of increasing the presence of exotic flora or fauna?				Unknown
What is the risk of removing or altering a GDE subtype habitat (e.g. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction)?		10-20% removal or alteration of habitat.		

Risk Valuation		1	9	
Risk	**The risk associated with the proposed development poses a low risk of impact to the stygofauna communities identified within the Quaternary alluvial aquifers of Hunter River. The risk to the community is minimal as the small modelled drawdown for the Hunter River Alluvium would only reduce the habitat marginally and locally. Therefore the risk to the stygofauna community is low.**			

Table 6. Overall risk assessment for the Study Area.



APPENDIX 7

MOCO Project – Response to PAC Review Report

Appendix 3 - Rehabilitation Research Undertaken at Mount Owen by CSER Research/University of Newcastle

Research Synopsis 1996 - 2016

Research into rehabilitation techniques and processes has been undertaken at Mount Owen Mine since 1996, initially through The University of Newcastle and now *CSER RESEARCH*. Four key themes are present in this research that relate to sustainable rehabilitation issues important for the mine to achieve its consent conditions and relinquishment, some of these results have been made available to others in the industry through the "Establishment of Native Vegetation" document (Nussbaumer, Castor & Cole, 2012) available at (http://hdl.handle.net/1959.13/937756). The four themes are:

- Sustainable Plant Nutrition
- Topsoil Substitutes
- Reconstructing Soil Function
- Diversification and Success of Rehabilitation Areas

Theme 1: Sustainable Plant Nutrition (1996 to date)

Historically, mine rehabilitation practices followed those used by forestry and agriculture, not those that occur in nature. Thus, there was previously complete reliance on the use of fertilizer with the consequent downstream pollution of watercourses. This is understandable in that the soil had been heavily damaged through erosion following vegetation clearing and running hoofed animals over it. A key research theme has, therefore, been to minimize the use of fertilizer and encourage the use, and reintroduction, of natural nutrient acquisition and cycling processes. These require appropriate microbial life to be present in the topsoil or soil substitute, or that it be reintroduced.

Objectives:

- To reduce the dependency on fertilizer for plant growth
- To determine the capacity of topsoil (including stockpiles) to form root-microbe associations
- To determine if mycorrhizae and rhizobia can be reintroduced into rehabilitation areas

Synopsis of Key Outcomes:

- The capacity to form root-microbe associations in pasture and forest topsoil, including in stockpiles was very low or almost absent (Newman, 1996).
- Nitrogen was the most limiting nutrient (thus the need for nitrogen fixing rhizobia) and phosphorus the second most limiting nutrient (the need for mycorrhizal fungi), (Nussbaumer *et al.* 2016, Nussbaumer, 2005).
- The spoil amelioration experiment showed that we could grow forest on spoil with some amendments including gypsum and fertilizer as well as using forest soil (Nussbaumer, 2005).
- In Ravensworth State Forest (RSF) topsoil, in the mine path, it was found that 8% of locations contained endomycorrhizae. On the rehabilitation area where RSF topsoil had been used (in the monitoring transects) 67% of roots contained endomycorrhizal associations and when trap plants were used the soil had the capacity to infect all roots. Trapping on top of the spoil placement area showed that 78% of roots had these associations. In an old growth forest almost all feeding roots would be expected to be mycorrhizal. Soil decompaction appears to have allowed spores to germinate and infect roots. Nodulation capacity (with rhizobia) varied across the rehabilitation area but was present in all locations sampled (Nussbaumer *et al.* 2011, Cole *et al.* 2009).
- Early practices of using fertilizer on rehabilitated areas, where forest topsoil was used, ceased and natural plant nutrition replaced the use of fertilizer (recommendation adopted by mine operator).

- Mycorrhizal specificity was suggested when endomycorrhizal roots collected from *Themeda australis* were used to inoculate *Corymbia maculata* and *Angophora floribunda*, the latter failing to be infected (O'Keeffe, 1998). This was followed by apparent specificity of soil inoculum used in a field experiment containing *Acacia parvipinnula* (where all of the plants died) and *Acacia filicifolia* (where plants grew and reproduced) (Nussbaumer, 2005).

- An initial focus on microbial specificity was for rhizobia bacteria that fix nitrogen, because it is the most limiting nutrient for plant growth, and the presence of specificity was shown using DNA technology (Targett, 2001). This was further developed indicating a level of group specificity and demonstrated changes in growth efficiency for a range of species (Fisher, 2010).

- *Dodonaea viscosa* has been found to be an obligate endomycorrhizal species (Newman, unpublished) and can now act as an indicator species for the presence, and dispersal, of endomycorrhizae in rehabilitation sites. It has been one of the most successful species in the rehabilitation areas even during drought where its numbers continued to increase and it dispersed into the surrounds (Nussbaumer *et al.* 2011).

- RSF soils contain residual microbial capacity that will successfully establish natural root-microbe associations as noted above, however, most other soils or substitutes, following forestry and grazing practices will require that microbes will have to be reintroduced. This has been achieved through inoculation for mycorrhizae (O'Keeffe, 1998) rhizobia (Nussbaumber, 2005) specific native strains of rhizobia (Fisher, 2010) and mycorrhizae, rhizobia and endophytic fungi Newman (current PhD candidate).

Theme 2: Topsoil Substitutes (2005 - to date)

Most mines know that they will have a topsoil deficit during the life of the mine due to soil erosion whilst being used for forestry and grazing. Thus, we have been challenged by Mount Owen to conduct research linked to whether or not we can ameliorate spoil or use other topsoil substitute media. This included assessing residual microbial capacity and whether inoculation would succeed.

Objectives:

- To use readily available bulk materials to replace topsoil to construct woodland and forest.

- To trial the reintroduction of root-microbe associations depleted by past land uses.

Synopsis of Key Outcomes:

- The use of readily available bulk materials (ACARP C12033) showed success in constructing vegetation communities on a number of different media (Cole *et al.* 2006).

- After 10 years the soil chemistry in most of the treatments in ACARP Site 1 were very similar to those of the northern remnant of RSF. In addition, the carbon content of soil substitutes had increased showing carbon sequestration into the soil (Nussbaumer *et al.*, 2014).

- The different treatments in Site 2 were successfully inoculated with rhizobia (Fisher, 2010) although residual capacity was present in the subsoil used.

- It has been shown that all strata from canopy to grass can be grown in tailings, with or without organic matter added, as a potential soil substitute (Nussbaumer & Cole, unpublished).

Theme 3: Reconstructing Soil Function (2007 to date)

Plant root-microbe associations noted above are critical to the sustainability of plant growth and function, however, it is important that other components of soil function are present if these are to be maintained. These include the ability of soil to breathe and allow aerobic organisms, including the microbes and plant roots to gain oxygen supply. Thus soil structure is needed which would also assist with water penetration. A natural progression from reconstructing root-microbe associations was to begin to reconstruct other components of soil function by combining microbial mixes with organic matter and plants to sustain their establishment and growth.

Objectives:

- To demonstrate the role of plants, mycorrhizal fungi and organic matter in the formation of aggregates with spoil fines in the laboratory.

- To demonstrate the ability of a complement of microbes to assist with plant establishment and growth as well as aggregation of spoil in the field.

Synopsis of Key Outcomes:

- It was found the presence of plant roots, mycorrhizal fungi and organic matter was needed to achieve aggregation of spoil fines (Daynes *et al.* 2013, Daynes *et al.* 2010)

- The presence of a compliment of microbes with compost has increased survival and growth of four plant species in spoil (Newman, unpublished).

- Spoil aggregates are also being formed in the field experiment at Mount Owen (Newman, unpublished).

Theme 4: Diversification and Success of Rehabilitation Areas (1996 to date)

In rehabilitation areas the species that grow are generally very hardy, early succession species that can cope with poor physical and chemical soil conditions. Other species often fail. In forest topsoil many other species germinate and grow but some disappear, these may be incompatible with the soil or other conditions, or disappear into the seed bank; some species are absent and others fail to germinate. One of our key research questions has been why species fail to germinate, fail to establish and disperse, or disappear. As part of this the reintroduction of a number of species has occurred including those from the dry rainforest.

Objectives:

- To characterize dormancy mechanisms of species difficult to establish in mine rehabilitation areas.

- To evaluate dormancy breaking mechanisms, and methods of seeding with a particular focus on herbaceous, shrub, and rainforest species

- To trial the introduction of herbaceous and subshrub species using seed or seedlings.

- To determine if species of low abundance, or missing, could be reintroduced into the rehabilitation area and if soil amendments assist in doing so.

- To trial the introduction of dry rainforest species into the rehabilitation area.

Synopsis of Key Outcomes:

- Dormancy was characterized for a number of species and mechanisms for dormancy breaking investigated. The results (Milgate, 1996) were incorporated into the ACARP C7010 (Gillespie *et al*., 2001).

- Continued trials of dormancy breaking have been undertaken for species difficult to incorporate into the rehabilitation area and to improve methods used for seed preparation for use in the rehabilitation area. These include the use of Coopex at an appropriate concentration to deter, but not kill, ants that used to harvest well over 90% of the seed sown (Nussbaumer *et al.,* 2011). Contractors at the Mount Owen Complex now use the method that was selected.

- Herbaceous species have been experimentally introduced using seed or seedlings and a number of species have established well and are dispersing. Others are less obvious or cryptic. Thus, with good seed stocks for the hardy species the mine is now targeting less common species to develop (by seed or planting) sources that could be used for dispersal into other areas, or, as seed sources (Nussbaumer *et al.*, 2015).

- An addition to this is the experimental introduction of herbaceous species with the intent to begin to characterize their niche requirements and determine if soil ameliorants such as compost assist with their survival, recruitment and growth (Scanlon 2015, conducted at the neighbouring Ravensworth Operations).

- An objective of the dry rainforest experiment on the top of the spoil placement area at Mount Owen was not only to further diversify vegetation species but to also introduce more fruitivorous plant species. By increasing these species it is expected that birds and mammals would increasingly use fruit on the rehabilitation area rather than using fruit from weedy species such as *Lantana* and exotic olives. A byproduct is that support species such as *Melaleuca stypheloides,* are providing additional habitat opportunities as birds are nesting in them. Thus, this has been a successful diversification effort so far.

Relevant Publications:

2016: Nussbaumer, Y., Cole, M.A., Offler, C.E., & Patrick, J.W., "Identifying and ameliorating nutrient limitations to reconstructing a forest ecosystem on mined land", *Restoration Ecology*, **24:2**, 202-211

2015 Scanlon, R., "Barriers to life cycling of Herbaceous Perennials on Restoration Sites", Honours Thesis, The University of Newcastle

2014: Nussbaumer, Y., Castor, C., Newman, K., & Cole, M.A., "Establishing Native Vegetation" RSFVC Supplement: 2014 Edition

2013: Daynes, C.N., Field, D.J., Saleeba, J.A., Cole, M. A., and McGee, P. A., February 2013, "Development and stabilization of soil structure via interactions between organic matter, arbuscular mycorrhizal fungi and plant roots", *Soil Biology and Biochemistry*, **57:** 683-694.

2012: Nussbaumer, Y., Castor, C., & Cole, M., "Establishing Native Vegetation, Principles and Interim Guidelines for Spoil Placement Areas and Restoration Lands", Xstrata Coal and The University of Newcastle.

2011: Nussbaumer, Y., Castor, C., Cole, M., Fisher, N., Dyer, L., Kovacs, A., Schulz, S., Parsons, R., & Rainsford, F., "Ravensworth State Forest Vegetation Complex Research Program Report", The University of Newcastle.

2010 Daynes, C.N., Field, D.J., Saleeba, J.A., Cole, M.A., McGee, P.A., "Restoration of soil function requires plants, arbuscular mycorrhizal fungi and organic matter" 2010 19th World Congress of Soil Science, Soil Solutions for a Changing World 41 1 – 6 August 2010, Brisbane, Australia. Published on DVD.

2010 Fisher, N., "Sustainable Reintroduction of the Nitrogen Cycle Post Coal Mining Utilizing the Legume-Rhizobia Symbiosis", PhD Thesis, The University of Newcastle.

2009: Cole, M., Nussbaumer, Y., Castor, C., Fisher, N., Dyer, L., Kovacs, A., Schulz, S., Parsons, R., & Rainsford, F., "Ravensworth State Forest Vegetation Complex Research Program Report", The University of Newcastle.

2006: Cole, M., Nussbaumer, Castor, C., & Fisher, N., "Topsoil Substitutes and Sustainability of Reconstructed Native Forest in the Hunter Valley", (ACARP C12033), Australian Coal Research Program, Brisbane.

2005: Nussbaumer Y., "Rebuilding Biodiversity and Microbial Associations in Native Forest Rehabilitation Following Open-Cut Coal Mining", PhD Thesis, The University of Newcastle.

2001: Targett, K., "The Native Legume – Rhizobia Symbiosis in Sustainable Mine Rehabilitation, Honours Thesis, The University of Newcastle

2001: Gillespie, M., Baker, K.S., & Mulligan, D.R., "Native Understorey Species Regeneration at New South Wales Coalmines", (ACARP C7010), Australian Coal Research Program, Brisbane.

1998: O'Keeffe, A., "Plant and Soil Nutrient Dynamics and Coal Mine Rehabilitation, Honours Thesis, The University of Newcastle

1996: Newman, K., "Mycorrhiza and Rhizobium in the Rehabilitation of Open-Cut Coal Mines in the Hunter Valley", Honours Thesis, The University of Newcastle

1996: Milgate, A. W., 1996, "Aspects of Seed Dormancy in a Selection of Australian Native Flora, Honours Thesis, The University of Newcastle

Presentations and Posters by Kate Newman linked to her PhD Candidature:

2016: "Soil Biology in Rehabilitation: Mount Owen Case Study" in *Best Practice Ecological Rehabilitation of Mined Lands Conference 2016"*presented by the Tom Farrell Institute for the Environment. 7-8 April.

2015: "Organic Matter and Inoculum Amendment of Mine Spoil for Rehabilitation" in *School of Environmental and Life Sciences Research Higher Degree Candidates Conference 2015."*4 Dec.

2015: Poster "Effects of Compost and Microbes on Rehabilitation of Bare Spoil" in *Best Practice Ecological Rehabilitation of Mined Lands Conference 2015"*presented by the Tom Farrell Institute for the Environment. 26-27 March 2015.

2014 "Can Inoculation with fungi improve mine rehabilitation?" Australian Mycological Society Meeting April 22-24.

2013: "Combining Compost and Microbes to Improve Spoil Rehabilitation" in special meeting of NSW, Office of Environment and Heritage Hunter Region. December.

2013: "The Importance of Functional Soil in Land Rehabilitation" in *Best Practice Ecological Rehabilitation of Mined Lands Conference 2013"*presented by the Tom Farrell Institute for the Environment. 12-13 September.

2013: "Mine Land Rehabilitation in the Hunter Valley, NSW." in ordinary meeting of the Royal Mt George Yacht squadron.6 Dec.

2013: "Combining Compost and Microbes to Improve Spoil Rehabilitation" in special meeting of NSW, Department of Resources and Energy Hunter Region. July.

2012: "Investigation of Compost and Plant Associating Microbes for use in Mine Spoil rehabilitation" in *Best Practice Ecological Rehabilitation of Mined Lands Conference 2012"*presented by the Tom Farrell Institute for the Environment. 5 Sept.

2012: Poster "Investigation of Compost and Plant Associating Microbes for use in Mine Spoil rehabilitation" *Soil Solutions for Diverse Landscapes Conference 2012* conducted jointly by the Australian and New Zealand Soil Science Societies.

2012: Poster "Review of NSW Soil Policy" *Soil Solutions for Diverse Landscapes Conference 2012* conducted jointly by the Australian and New Zealand Soil Science Societies.

APPENDIX 8

Economic Assessment Peer Review Response

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25/01/2017

Kirsty Davies
Senior Environmental Scientist
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Dear Kirsty

Submissions and Peer Review of Economic Assessment – United and Wambo Open Cut Mine Project

Thank you for requesting us to respond to the submissions and peer review of our cost benefit analysis and economic impact analysis of the United and Wambo Open Cut Coal Mine Project.

We appreciate the thorough peer review that has been undertaken by the Centre for International Economics (CIE) and acknowledge their overall finding that the economic assessment has been undertaken in a manner that is broadly consistent with the 2015 NSW Government Guidelines (the guidelines). Additionally, the CIE report supports the overall conclusion of our analysis that the economic benefits of the Project are likely to exceed the economic costs of the project.

The attachment to this letter contains a response to the key points raised by the CIE in their review dated 11 October 2016. In addition, we respond to a number of submissions received by the Department of Planning and Environment (DPE) during Public Exhibition in September 2016 that identified areas for clarification or of concern in the economic assessment. This letter and the attachment should be read in the context of these documents.

Yours sincerely

Kathryn Matthews
Partner

Deloitte Access Economics Pty Ltd

Attachment: Response to submissions on the Economic Assessment

This attachment sets out our responses to the peer review by the CIE, comments from the Department of Planning and Environment (DPE) and other submissions received by DPE that contain comments relevant to the Economic Assessment of the United and Wambo Open Cut Coal Mine Project.

In total we have reviewed and had regard to nine submissions from the following:

- Department of Planning and Environment (DPE)
- The CIE
- The Australia Institute (AI)
- Lock the Gate Alliance (LtGA)
- Hunter Communities Network (HCN)
- National Parks Association of NSW (NPA)
- Davis, B.
- Van Der Kallen, J.
- Leslie, J.

As some issues are raised in multiple submissions, our responses are grouped by issue. In total we have identified 22 separate issues raised across the submissions. Table 1 summarises how the submissions relate to the issues identified and addressed in this response.

The sections below respond to items specified by DPE for response, including the recommendations of the CIE peer review, and also responds to other items raised in various submissions received following Public Exhibition of the project in September 2016. This includes further explanation of our approach and additional information as appropriate.

This attachment should be read in the context of the submissions received. Further, both the submissions and our responses should be read in conjunction with our original economic assessment of the United and Wambo Open Cut Coal Mine Project. The original economic assessment contains information that is important for understanding the context of these responses.

Table 1: Summary of issues raised and submissions

Issue		DPE	CIE	AI	LtGA	HCN	NPA	B.D.	J.V.D.K.	J.L
1	Pacific Environment Report	X	X							
2	Year on year data	X								
3	Supplier surplus effects	X								
4	Local effects analysis detail	X								
5	Employment numbers	X								
6	Approval of Modification-12		X	X						
7	Groundwater assessment		X	X	X	X	X			
8	Noise assessment		X							
9	Biodiversity assessment		X	X		X	X			
10	Project alternatives		X							
11	Greenhouse gas assessment		X							
12	Sensitivity analysis parameters		X							
13	Transcription error in some tables		X							
14	Coal prices					X				X
15	Health impacts							X	X	X
16	Scope 3 emissions			X	X		X	X	X	X
17	Corporate taxation			X						
18	Discount rate						X			
19	Time frame of analysis			X						
20	Consistency between CBA and LEA				X					
21	Qualitative treatment of Water and biodiversity			X	X	X	X			
22	Sensitivity analysis ranges		X							

Issue 1. Reference to Pacific Environment (2016) report

Issue: The Pacific Environment (2016) report referenced in the economic assessment should be included in the response to submissions.

Submitters: DPE (8.b); CIE (p. 20)

Response: This report has been provided as an appendix to the Response to Submissions.

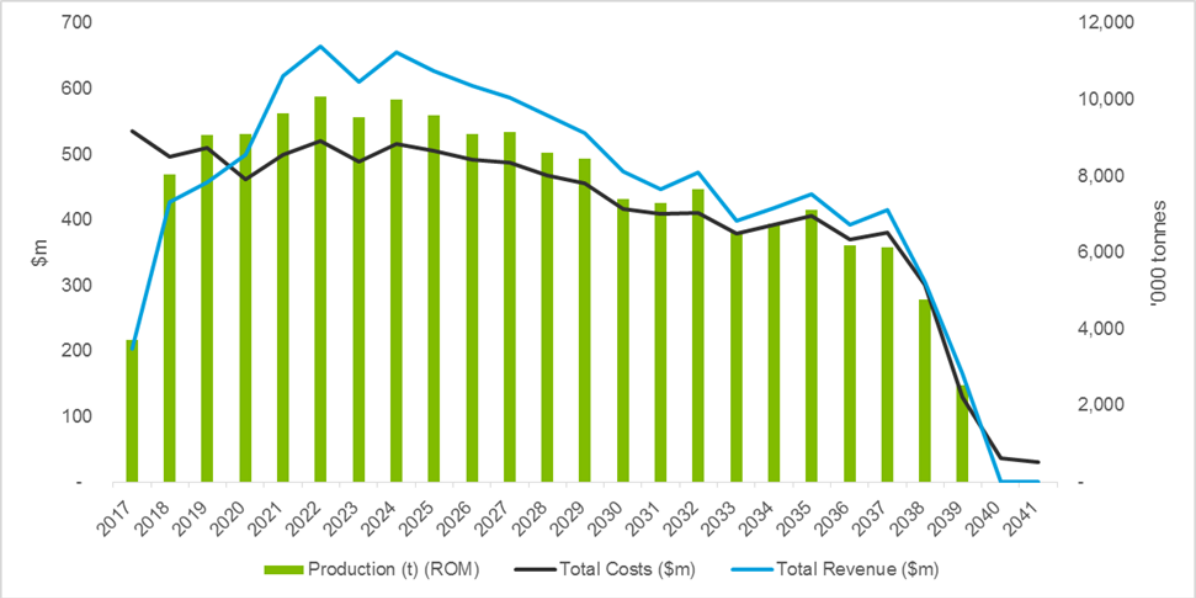
Issue 2. Level and timing of activity, cost and revenue streams

Issue: While headline numbers (NPVs and 25 year totals) are presented, year-on-year numbers are not reported and are required for the Department's review of the economic assessment.

Submitters: DPE (8.c)

Response: A year-on-year breakdown of projected activity, cost and revenue streams for the Project are presented in Figure 1. The data for this figure can be found in Appendix A.

Figure 1: Year-on-year activity, revenue and costs of the Project



Issue 3. Further information requested on supplier surpluses

Issue: Further information in the discussion of supplier surplus is required (pp14, 24, 60). The assessment considers upstream 'winners' but does not identify if there are any 'losers' from the mine expansion.

Submitters: DPE (8.d)

Response: The economic assessment considered that there were no net benefits to suppliers (in terms of producer surplus) relative to what they otherwise receive in the base case. The assessment acknowledges that these outcomes are difficult to measure and it conservatively assumed that suppliers earn similar margins relative to what they could have received from other sources under the base case.

The assessment acknowledged that a decline in mining activity in the region could have flow on impacts for suppliers which could be partially offset by the Project, such that the Project delivers additional benefits for suppliers relative to the base case.

There is not expected to be any significant loss of producer surplus for existing industries. The local effects analysis notes that "the Project is not expected to have any material effects on tourism and business travel. The Project involves the continued use of existing mining areas and does not affect any local accommodation providers. Overall the Project is not expected to result in a change in either the supply or demand of tourism or business travel services in the locality."

There may be some local industries affected by wage pressure in the project. The Computable General Equilibrium (CGE) model suggests an increase annual growth in real wages in the locality, incremental to the base case, ranging from roughly 0.75% to 3.5% per year over the life of the project (see Chart 5.5 of the assessment report). An increase in real wages could create losses for suppliers if they are unable to pass this cost through to prices. As this increase in wages is common to all suppliers it is highly unlikely that such an increase in cost cannot be passed through to consumers. Further, it is important to note that an increase in real wages represents a reallocation of resources between owners of capital and labour and does not represent a cost to the economy or society overall.

Issue 4. Local effects analysis lacks detail

Issue: The local effects analysis lacks detail and it is somewhat difficult to assess where the numbers come from. The analysis requires more discussion about the costs and benefits to the local area in accordance with the guidelines.

Submitters: DPE (8.e)

Response: The local effects analysis (LEA) has been presented to consider the likely impact of the development on the locality. The LEA translates the CBA results to determine the scale of changes that will occur at the SA3 level. The three priority local affects determined in the guidelines are:

- Effects relating to local employment;
- Effects related to non-labour project expenditure; and
- Environmental and social impacts on the local community

The LEA analysed each of these effects.

The direct figures regarding employment numbers and non-labour project expenditure were sourced from United. Wage figures in the LEA are based on Lower Hunter wage data by occupation sourced from the ABS census data. On the advice of the proponent we assumed the project wages will equal the average mining wage for the local area. This conservatively assumes no wage surplus. In the NSW Guidelines (2015), LEA reportable values such as net income increases per employee are given as averages. Therefore, unlike the cost benefit analysis (CBA) results, the results are provided as a yearly average rather than a net present value. LEAs are intended, in part, to help inform local communities; in this context, yearly averages have an advantage of being more easily interpreted by individuals with a non-technical background.

The LEA guidelines sensibly state that "in quantitatively and qualitatively analysing [local] effects, an LEA starts with information from the CBA and identifies the relevant local components." The quantitative environmental and social effects are therefore based on the CBA results. Each cost is attributed as either 'in' or 'outside' the locality. For example, air quality, noise and traffic cost are expected to fully accrue to locals while the cost of greenhouse gas emissions are spread across Australia's population.

The second-round effects such as indirect employment and wages growth are based on the CGE modelling. An acknowledged limitation of CGE modelling is that it is generally complex. However, DAE considers that CGE modelling is the preferred approach to estimating the consequences of major projects such as establishing or expanding a coal mine, since – as noted in the guidelines – IO analysis can overstate impacts.

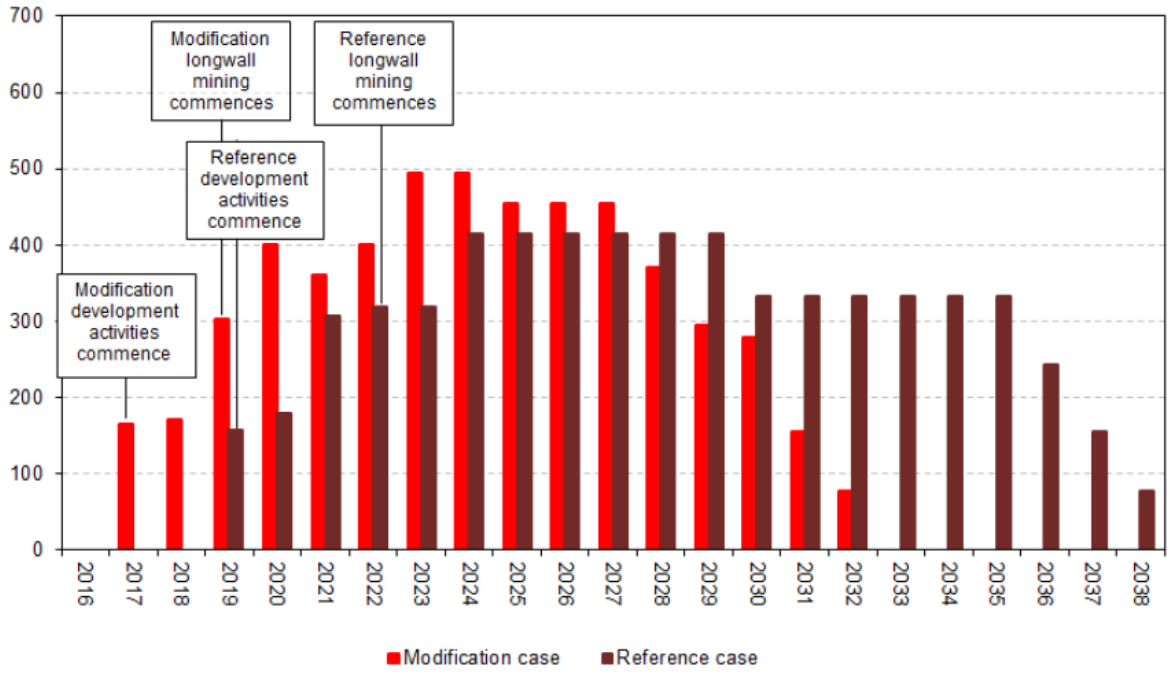
Issue 5. Employment numbers from the existing Wambo mine and Modification 12

Issue: Clarify the relationship between the employment numbers from the existing Wambo mine and Modification 12[1]

Submitters: DPE (8.f)

Response: DA 305-7-2003 Modification 12 (Mod12) was approved by the Planning Assessment Commission on 12 December 2016. Under Mod12, employment is expected to increase earlier than under the existing Wambo mine plan. Employment will reach a peak of 500 FTE (in 2023-2024 compared to a peak of 410 (in 2024-2029) under the reference case. The employment profile under Mod12 is compared with the existing Wambo mine (the reference case) in Figure 2 below. This figure shows the relationship between the employment numbers from the existing Wambo mine and Modification 12.

Figure 2: Employment under modification case versus the reference case (no approval)



Source: AnalytEcon (2016) South Wambo Underground Mine Modification Environmental Assessment, Appendix K, Socio-economic Assessment, AnalytEcon

Issue 6. Inclusion of Modification 12 in the base case

Issue: The base case assumes Modification 12 is approved and economic benefits are assessed under Modification 12. This assumption is not appropriate under the NSW Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals.

Submitters: CIE (pp. 9-10), The Australia Institute

[1] Modification 12 is a medication to the South Wambo Underground Mine involving the realignment and extension of the approved South Wambo Underground Mine longwall panels and mining the Woodlands Hill Seam rather than the Bowfield Seam. Modification 12 was approved by the Planning Assessment Commission on 12 December 2016.

Response: The NSW Guidelines state that:

> "The base case should include existing and already approved (but not yet operational) projects that will interact with the mining or coal seam gas project…. The base case should not include projects that may be potentially approved in the future."

We acknowledge that, a direct application of the NSW Guidelines would mean that DA 305-7-2003 Modification 12 (Mod12) should have been excluded from the economic assessment.

The economic assessment considered the impact of including Mod12 on the results for NSW. Specifically, the assessment acknowledges that:

> "The inclusion of the Wambo Mod 12 as part of the base case has led to a conservative assessment of the economic benefits. That is, if Mod 12 is not approved, the estimated net benefits of the Project to NSW would be higher than those reported in this assessment.
>
> It should be noted that the environmental impact assessments completed as part of the broader Environmental Impact Statement assume that Wambo mine operations end in 2017 and that the DA 305-7-2003 Mod 12 proposal is not approved. The findings of these assessments have been used to quantify the environmental impacts of the Project as part of this Cost Benefit Analysis. Again, this suggests that the incremental environmental costs of the Project are conservatively estimated in this assessment. That is, if Mod 12 were approved, the environmental costs of the Project to NSW would be lower than those reported in this assessment."

That is, we included Mod 12 in the baseline to help ensure that our analysis provided a conservative estimate of the potential benefits of the Project. This is recognised by the CIE who note that "that estimating the impact in this manner will provide conservative benefits".

The exclusion of Mod12 from the baseline would require an assumption that Wambo Open Cut production ends in 2017. If this was assumed then the incremental net benefits of the Project would be greater. The increase in net benefits would be largely driven by an increase in royalties (that is, royalties in the base case would be lower). Further, we note that the environmental costs would not change given that the environmental assessments already assumes Mod12 is not approved.

The CIE raise the concern that some cumulative impacts would occur if the base case (including Mod12) and the project run simultaneously. However, Mod12 and the United and Wambo joint venture represent two alternative options for Wambo Open Cut and do not warrant consideration together.

We note that Mod12 was approved by the Planning Assessment Commission on 12 December 2016.

Issue 7. Groundwater impacts

Issue: A number of submissions raised concerns with the environmental assessment of groundwater. This has implications for the CBA which has qualitatively considered groundwater impacts.

Submitters: CIE (pp. 22-23), The Australia Institute (p. 5), Lock the Gate Alliance (p. 3), National Parks Association (p. 2), Hunter Communities Network (p. 6).

Response: The Department of Primary Industries (DPI) raise concern about the impact of groundwater drawdown on groundwater dependent vegetation communities as a result of the project and this is noted by the CIE. The Australia Institute and the Hunter Communities Network

raise concern that the groundwater impacts associated with two final voids have not been assessed. Lock the Gate and the National Parks Association raise concern that a quantitative estimate of water loss has not been included in the economic assessment.

Because the environmental assessment concluded that groundwater impacts are unlikely to be significant, it is not considered that quantifying these impacts would have a significant impact on the economic analysis. The qualitative assessment reflects these conclusions.

We agree with the principle of CIE's recommendation that any changes to the groundwater assessment in response to issues raised by DPI, where relevant, should be included in the CBA. We have been advised by Umwelt that the submissions on groundwater have been addressed in the response to submissions report and do not result in any changes to the groundwater assessment findings that would affect the CBA.

Issue 8. Noise impacts

Issue: There were concerns raised about the environmental assessment of noise, primarily raised by the NSW Environmental Protection Agency (EPA). This has implications for the CBA which has quantified noise impacts.

Submitters: CIE (pp. 23-24)

Response:

The CIE note that the EPA were concerned that the "the EIS does not allow them to assess and determine noise criteria and associated conditions for the separate United Wambo Open Cut Coal Mine and Wambo Coal Mine."

We agree with the principle of CIE's recommendation that the "value of noise pollution impacts should be updated where changes to the noise modelling is required to address the NSW EPA's concerns." We have been advised by Umwelt that the submissions on noise have been addressed in the response to submissions report and do not result in any changes to the modelled noise levels that would affect the outcomes of the CBA.

Further, The CIE note that the "noise estimate (around $0.3 million present value) is an indication of the scale of noise related to the external costs, and applies to traffic noise rather than the noise of mining". This cost estimate is based on the upper limit of the range recommended to the European Commission DG Environment by Navrud (2002) (32 euros per dB per household per year) converted to 2016 Australian dollars using exchange rate and Consumer Price Index data. This should be interpreted as an indication of the scale of noise related externality costs and not a precise valuation, particularly as the unit cost estimates applied relate to traffic noise rather than the noise impacts of mining.

Issue 9. Biodiversity impacts

Issue: A number of submissions raised concerns with the environmental assessment of biodiversity. This has implications for the CBA which has qualitatively assessed biodiversity impacts.

Submitters: CIE (p. 22), The Australia Institute (p. 5), Natural Parks Association (p. 2), Hunter Communities Network (p. 3)

Response: The CIE note that the "NSW Office of Environment and Heritage (OEH) has highlighted a number of gaps in the Biodiversity Assessment Report provided as part of the EIS. OEH has not been able to fully assess the adequacy of the proposed biodiversity management approach." The Australia Institute and the Hunter Communities Network propose that the biodiversity assessment is insufficient, particularly with regards to the offset policy proposed. The National Parks Association and the Hunter Communities Network raise concern that a quantitative estimate of biodiversity impacts has not been included in the economic assessment.

Major biodiversity impacts have been avoided, where possible, through Project design and unavoidable impacts will be offset under the Upper Hunter Offsets Scheme. The biodiversity assessment also concluded that there are not expected to be any substantial indirect impacts on biodiversity values.

Under NSW Government policy, the impacts of the Project on biodiversity are required to be quantified and offset. DAE understands that the Proponent is currently liaising with OEH regarding the offset requirements for the Project and resolving OEHs queries. The CBA has been prepared on the basis that an appropriate offset strategy that meets government requirements will be implemented for the Project. On this basis, it is considered that biodiversity has been appropriately considered in the CBA.

Given these considerations and the findings of the biodiversity assessment, it is not considered that quantifying these impacts would have a significant impact on the economic analysis.

We note that an estimate of offset costs has been included in the operational costs of the CBA.

Issue 10. Consideration of other alternative projects

Issue: While the EIS presents a single option (the Project), from the perspective of the NSW community, it is possible that there are alternative options that have not been presented here that may deliver greater net benefits to the community.

Submitters: CIE (p. 9)

Response: The Economic Assessment is required to consider the Project defined by the proponent. As such, a full quantitative consideration of alternative options is beyond the scope of these requirements. As noted by the CIE, the EIS provides a qualitative discussion on the alternatives considered by the proponent in the design of the Project.

Issue 11. Attribution of greenhouse gas emissions to NSW

Issue: The approach to allocating only a portion of (greenhouse gas emission) costs to NSW is inconsistent with the 2015 draft Guidelines which require the attribution of the full global cost.

Submitters: CIE (p. 21)

Response: The Economic Assessment considered the social cost of greenhouse gas emissions under the project to be $35m (in present value terms), of which $11m (32%) were attributed to NSW.

The 2015 Guidelines state that:

"In general the total net environmental, social and transport costs will be attributable to NSW. The proponent should include the total net environmental, social and transport costs in the NSW CBA, unless there are cases where these costs are not entirely attributable to the NSW community."

As acknowledged by the CIE, there is a debate regarding the extent to which the global social cost of carbon are appropriate for the use in the benefit cost analysis of domestic policy options and how these costs should be allocated. As the cost of carbon emissions are experienced across the earth, we considered that it is reasonable to assume that the costs of greenhouse gas emissions are not entirely attributable to NSW. More broadly, we consider that this issue is not clear in the NSW Guidelines and would appreciate further clarity on the preferred approach.

Acknowledging that it is unclear exactly how to allocate the costs of carbon emissions to geographic areas, we have considered a comparison example in which the full cost of GHG emissions are assigned to NSW (as opposed to 32% in the Economic Assessment) If the full costs of greenhouse gas emissions were assigned to NSW, the net benefit of the Project for NSW would be reduced from $413.5 million to $390.1 million (Table 2).

Table 2: Net benefit of the project to NSW

Summary item	Economic Assessment Results	Comparison example
	($m, NPV)	($m, NPV)
Incremental benefits to NSW	437.3	437.3
Incremental costs to NSW	23.8	47.2*
Overall net benefit of Project for NSW community	413.5	390.1

* 100% of GHG emission costs attributed to NSW.

As acknowledged by the CIE "irrespective of whether the costs associated with greenhouse gas emissions (under all price scenarios) are allocated in full to NSW or only 32 per cent of this is allocated to NSW this does not change the conclusions".

Issue 12. Sensitivity analysis implicitly assumes parameters are uncorrelated.

Issue: The sensitivity analysis used in the evaluation changed individual parameters keeping all else equal. This implicitly assumes that the parameters are uncorrelated.

Submitters: CIE (p. 28)

Response: The CIE is correct in its interpretation that the sensitivity analysis performed alters one variable at a time and so implicitly assumes parameters are uncorrelated. This is a standard approach when undertaking sensitivity analysis and highlights how responsive the results of the model, and the conclusions based on those results, are to certain assumptions. We agree that varying one input parameter at a time is somewhat of a simplification as some variables may be correlated.

The CIE notes that a more complete methodology would use a risk analysis that accounts for correlation in parameters. However, The CIE make no recommendation for further sensitivity testing and there is no precedent for undertaking a full risk analysis for the Project under the NSW Guidelines. This is an acknowledged weakness of sensitivity analysis and to our knowledge there is no established methodology for reasonably estimating the correlations between the various parameters tested in the model.

Regardless of the discussion above, the approach to sensitivity analysis used in the economic assessment and submitted as part of the EIS satisfies the requirements of the NSW Guidelines and is therefore considered appropriate to provide for assessment of the Project.

Issue 13. Figures in Table 5.8 and 5.9 are incorrect

Issue: There is a transcription error in Table 5.8 of the economic assessment. The rows of dollar values duplicate the percentage value in the last two rows with a column lag. There are rounding errors in Table 5.9 of the economic assessment.

Submitters: CIE (p. 32)

Response: We acknowledge that there has been a transcription error in Table 5.8 and 5.9. The correct tables are provided below in Table 1.3 and Table 1.4.

It should be noted that the revised figures have minimal consequences for the interpretation of results. An exception is incremental employment in 2017, which was previously underestimated by 33 FTE for the rest of NSW. The incremental employment impacts of the Project are therefore higher than suggested in the economic impact assessment.

Table 3: Economic impacts (2016 $m)

	NPV	2017	2019	2024	2029	2034	2039
GRP/ GSP ($m 2016)							
Locality	2,001	65	133	260	219	181	100
Rest of NSW	826	19	40	108	105	88	54
Total NSW		84	173	368	324	269	154
Deviation from the reference case (%)							
Locality		0.65	1.27	2.29	1.77	1.35	0.69
Rest of NSW		0.00	0.01	0.02	0.02	0.01	0.01

Note: All values are in real 2016 terms. The NPV discount rate is 7%.
Source: Deloitte Access Economics

Table 4: Incremental employment impacts, 2016 – 2039

	2017	2019	2024	2029	2034	2039
Employment FTE						
Locality	36	63	125	96	71	28
Rest of NSW	36	45	99	83	66	36
Total NSW	72	108	223	178	137	64
Deviation from the reference case (%)						
Locality	0.10	0.16	0.32	0.24	0.17	0.07
Rest of NSW	0.00	0.00	0.00	0.00	0.00	0.00

Source: Deloitte Access Economics

Issue 14. Coal prices could decline further

Issue: There is potential for further decline in the price of coal.

Submitters: Leslie, J (p. 2); Hunter Communities Network (p. 13)

Response: The Hunter Communities Network claimed that there is "no public benefit (of the project) due to costly increase in greenhouse gas emissions and likely drop in price of thermal coal due to over-supply." Leslie, J. also raised concern about coal price reductions.

The CIE conclude that "While there is uncertainty regarding how the future production profile from the mine will be affected by changes in the international market, it is expected that there will be a sustained demand for the product over the timeframe of the Project."

The economic assessment considered the sensitivity of the results to further declines in coal prices. This analysis found that if coal prices fall to 9th percentile of historical prices since 1995, the project would deliver net benefit to NSW of $264.3 million.

We consider that the potential for future reductions in coal prices have been appropriately considered in the economic assessment.

Issue 15. Health impacts are not adequately addressed

Issue: The economic impact assessment does not adequately address health costs associated with the mining coal.

Submitters: Van der Kallan J. (p. 4); Leslie, J (p. 2); Davis, B (p. 4)

Response: The NSW guidelines reasonably incorporate health impacts of mining activity through assessment of particulate matter emissions and water quality impacts. Coal mines may possibly have other health impacts; however, it is difficult to separate out the specific cost of other pathways since they frequently occur simultaneously with air pollution (Hendryx & Ahern, 2008).

The impacts of the project on air quality (via particulate matter emissions) have been quantified and water quality impact qualitatively assessed as part of the CBA.

Issue 16. Exclusion of Scope 3 emissions and other downstream effects

Issue: The CBA does not adequately address downstream health and environmental costs associated with the electricity generation from coal. Scope 3 emission were not counted.

Submitters: Van der Kallan J. (p.4); Leslie, J (p.2); Davis, B, (p.4); National Parks Association (p.2), Australia Institute (p.7); Lock the gate (p. 16)

Response: The NSW Guidelines set out that the CBA of the Project should only consider the first round (primary) cost and benefits of the project itself (that is, mining the coal). While the downstream combustion of the mined coal will certainly incur additional social and economic costs and benefits, these are from sources not owned or controlled by the Project and so are secondary impacts. These secondary impacts from Scope 3 emissions were not quantified in the economic assessment, in accordance with the NSW Guidelines.

We consider that it would be misleading for decision-makers to include secondary impacts in the economic assessment as it would result in double-counting of costs and benefits. For example, if Scope 3 emissions were considered, their cost would be counted once when considering developing a mine and again when considering developing a power plant.

Issue 17. Exclusion of tax position from corporate tax estimates

Issue: The cost benefit analysis does not consider the tax position of the companies involved.

Submitters: Australia Institute (p. 4)

Response: The cost benefit analysis takes into account some complexities of the taxation system (such as accumulated depreciation). However, the overall tax position of proponents is beyond the scope of the CBA. The CBA focuses on the first round (primary) impacts of the Project. Nevertheless, a sensitivity analysis considered potential changes in company tax paid. The results found that if the company tax rate was decreased by 50%, the project would still deliver net benefits to NSW of $357.6 million assuming a 7% discount rate.

Issue 18. Inclusion of a fixed discount rate

Issue: The analysis uses a fixed, time-invariant discount rate which may overestimate the economic benefits

Submitters: National Parks Association (p. 2)

Response: There is widespread academic debate surrounding the appropriate discount rate to use when evaluating projects (especially those with potential climate impacts). There is some behavioural evidence suggesting that individuals' discount rates are not time-invariant but the implications of this evidence are not clear (Rubinstein 2003).

However, as National Parks Association acknowledge, the economic assessment has met the requirements of the NSW Guidelines (2015).

Issue 19. Time frame for considering unquantified impacts

Issue: The environmental impacts of the project may be permanent. It is misleading for Deloitte to claim that these impacts would need to be: "equivalent to undiscounted costs of $902 million over the period and is considered to be unlikely given the evidence regarding these impacts".

Submitters: Australia Institute (p.6)

Response: The guidelines state that 'the evaluation period should be long enough to capture all costs and benefits attributable to the project'. Biodiversity and water cost were treated qualitatively as the relevant environmental assessment did not expect there to be significant long term costs in these areas for the Project.

With respect to the treatment of permanent impacts, the nature of time-invariant discounting means that distant future costs begin to approach very small values. To match the overall estimated net benefit of the Project of $413.5 million, any permanent environmental cost would need to be amount to around $29 million per year in perpetuity (which has a present value of $414 million using a 7% discount rate).

Issue 20. Consistency between CBA and LEA employment estimates

Issue: The employment figures differ between CBA and LEA

Submitters: Lock the gate (p. 14)

Response: The CBA and LEA use a different methodology as they aim to consider employment from different perspectives.

The employment figures used in the CBA are the direct number of full time equivalent employees that United and Wambo expect to employ to work on the Project. This counts workers from both within the Project's locality as well as workers from other parts of NSW. The Project will employ a combined operational and construction workforce of 363 FTE employees in 2017 before peaking at 605 FTE employees in 2018, during the primary establishment phase. Over the following years, the operational workforce is expected to number 500 FTE employees out to 2023, subsequently declining to 450 FTE employees for the remaining life of the Project to the year 2039.

The employment figures used in the LEA considers only the expected number of employees hired from within the Lower Hunter locality. This results in a lower figure than found in the CBA. The Project is expected to employ 132 FTE workers annually from within the locality during the establishment phase and 230 FTE workers annually from within the locality during the operations phase.

Issue 21. Water and biodiversity impacts are not quantified

Issue: A number of impacts are not quantified, including biodiversity and water impacts and PM_{10}. The project will leave behind two final voids that will permanently impact on groundwater. Furthermore, it will impact the Central Hunter Valley Eucalypt Forest and Woodland, a state and federally listed endangered ecological community.

Submitters: Australia Institute (p. 5), Lock the gate (p. 1-2), National Parks Association (p. 1), Hunter Communities Network (p. 2-3)

Response: As noted in the guidelines "in practice, valuation of some factors is, at least partly subjective or not possible". As acknowledged in the economic impact report, a number of costs including impacts on biodiversity, visual amenity, Aboriginal and non-Aboriginal heritage and water could not be accurately valued.

Biodiversity costs were treated qualitatively based on the Biodiversity Impact Assessment which found that the risks of the Project to biodiversity will be appropriately counterbalanced given the proposal to implement an appropriate biodiversity offset strategy. Likewise water was treated qualitatively based on the Water Impact Assessments that found that the Project would likely not have a significant impact on water users or the environment in terms of groundwater. Aboriginal and non-Aboriginal heritage cost and visual amenity costs were also treated qualitatively due to the inherit difficulty in quantifying these costs.

The cost of air quality lost was provided by Pacific Environment (2016). The unit damage cost values were derived from work undertaken by PAEHolmes which provides unit damage cost values in A$ per tonne of $PM_{2.5}$. Costs were based on $PM_{2.5}$ rather than PM_{10} because, as noted by PAEHolmes (2013), "there is increasing evidence that the adverse health effects - particularly mortality - are more closely associated with $PM_{2.5}$. As PAEHolmes acknowledge, a UK report by COMEAP (2009) states that $PM_{2.5}$ is considered to be the best index of PM for quantitative assessments of the effects of policy interventions".

Issue 22. Sensitivity analyses

Issue: There was no explanation provided around the adjustment to royalties and company tax in the sensitivity analysis and it is unclear why these parameters are tested.

Submitters: CIE (p. 26)

Response: The sensitivity analysis considered variation in "company income tax from project (50 per cent lower or higher than the primary case)" and "royalties derived from project as a result of lower gross mining revenue (25 per cent lower or higher than primary case)" in line with the NSW Guidelines (2015). These items and ranges are specifically identified on page 18 of the NSW Guidelines; they provide reasonable ranges which capture uncertainty around the actual amount of royalties or company tax which will be collected.

That is, the sensitivity analysis multiplied the final results of the royalties' calculation in the project case (discussed in 4.3.2 of the economic impact assessment) by 125% for the high case and 75% for the low case. Likewise the corporate tax sensitivity analysis multiplied the final results of the corporate tax calculation (discussed in 4.3.3 of the economic impact assessment) by 150% for the high case and 50% for the low case.

The approach to sensitivity analysis used in the economic assessment and submitted as part of the EIS satisfies the requirements of the NSW Guidelines and is therefore considered appropriate to provide for assessment of the Project.

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PAEHolmes (2013), Methodology for Valuing the Health Impacts of Changes in Particle Emissions – Final Report

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Appendix A: Year-on-year data: Project case

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Production ('000t) (ROM)	3,715	8,047	9,077	9,101	9,642	10,080	9,548	10,002	9,597	9,111	9,152	8,604	8,458
Total Revenue ($m)	203	427	457	499	619	665	610	655	627	605	586	560	533
Total Costs ($m)	536	496	509	462	499	521	489	515	506	491	488	467	455

	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Production ('000t) (ROM)	7,399	7,289	7,648	6,526	6,761	7,116	6,198	6,124	4,780	2,531	-	-
Total Revenue ($m)	473	446	473	398	418	439	392	415	305	166	-	-
Total Costs ($m)	416	409	410	379	393	406	370	380	300	130	36	30

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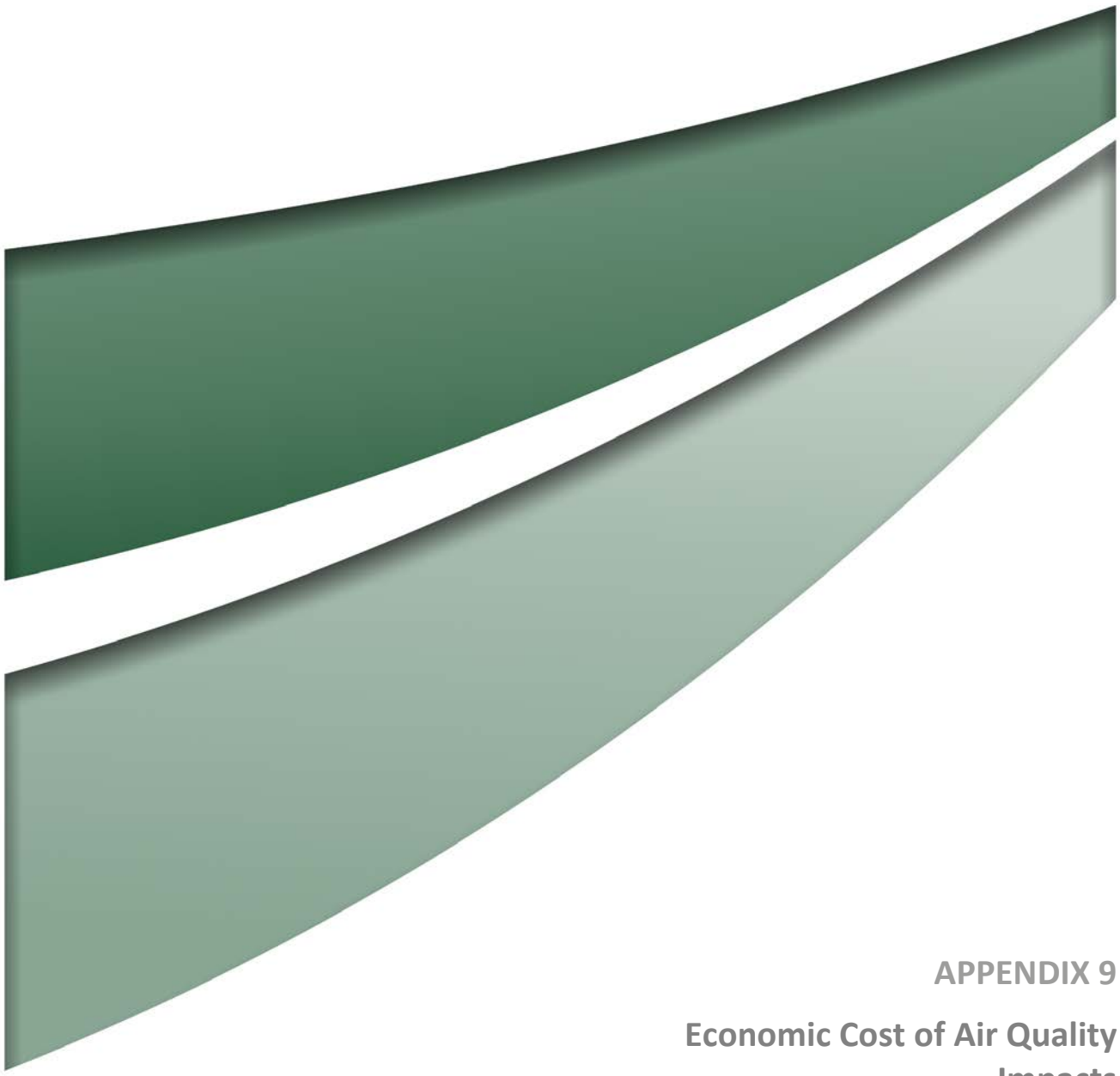

APPENDIX 9

Economic Cost of Air Quality Impacts

Pacific Environment Limited

Consulting • Technologies • Monitoring • Toxicology

Report

Economic Cost of Air Quality Impacts – United Wambo Open Cut Coal Mine Project

Umwelt (Australia) on behalf of United Collieries

Job ID. 21116C

18 July 2016

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EXECUTIVE SUMMARY

Pacific Environment has been engaged by Umwelt (Australia) Pty Ltd to estimate the economic costs of air quality impacts from the United Wambo Open Cut Coal Mine Project (the Project). The Project is a 50:50 joint venture between United Collieries Pty Ltd (United) and Wambo Coal Pty Ltd (Wambo). The Project will involve new open cut operations at United (the United Open Cut) and extended mine operations at the Wambo Open Cut under a modified mine plan.

The analysis of economic costs of air quality impacts (economic analysis) will be an input into the cost benefit analysis (CBA) being undertaken for the Project. The CBA will compare all quantifiable benefits and costs, including air quality impacts, attributable to the Project.

Methodology to assess the economic costs of air quality impacts

The economic analysis estimates the economic costs of air quality impacts associated with the Project (i.e. the costs associated with changes to air quality impacts due to the Project) using two methods. The costs are first estimated using the unit damage costs approach outlined in economic assessment guidelines released by the NSW Department of Planning and Environment. A second method, which approximates an impact pathway approach (by considering the pathway from emissions to economic costs), is also adopted. Method 2 is considered more robust, adopts conservative assumptions (leading to a high estimate of economic costs) and has been undertaken because the damage cost approach is likely to lead to an inaccurate estimate of the economic costs of air quality impacts.

Air Quality Impact Assessment

This economic analysis utilises and builds on an Air Quality Impact Assessment (AQIA) for the Project, undertaken by Jacobs. The purpose of the AQIA was to predict emissions of selected air pollutants from the Project, and predict concentrations of those air pollutants at residences and monitors proximate to the Project. The economic analysis used AQIA model results to estimate the cost of air quality impacts associated with the Project.

Overview of Results

Using the approximated impact pathway approach, the economic costs of air quality impacts are estimated to be **$5.8 million** in Present Value (PV) terms (2016 prices using a 7 per cent real discount rate), or **$7.5 million** or **$4.6 million** (using a 4 per cent or 10 per cent discount rate respectively). These estimates are based on broadly conservative assumptions (leading to an upward bias).

The estimated costs using a damage cost approach vary according to which unit damage costs are used. Using a strict application of the economic assessment guidelines (and associated Excel workbooks), emissions from the Project would be assigned a unit damage cost corresponding to 'Not in any Significant Urban Area (NSW)'. This results in no estimated economic impacts (the workbook assigns a nil economic cost to emissions assigned to 'Not in any significant urban area (NSW)').

While not considered appropriate, if the unit damage costs for Singleton (the nearest significant urban area to the Project) are used, the economic costs of air quality impacts are estimated to be **$98.5 million**, **$127.0 million** or **$78.7 million** (using a 7 per cent, 4 per cent or 10 per cent discount rate respectively). Given the Project's location and likely surrounding population's exposure to incremental pollutant concentrations, the approximated impact pathway approach, which adopts broadly conservative assumptions, provides a much more accurate estimate of the economic costs than the damage cost approach.

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1 INTRODUCTION

This report has been prepared by Pacific Environment for Umwelt (Australia) Pty Ltd (Umwelt) on behalf of United Collieries Pty Ltd (United). United is 95 per cent owned by Abelsore Pty Ltd, a wholly-owned subsidiary of Glencore Coal Pty Limited. The report includes an assessment of the economic costs of the likely air quality impacts of the proposed United Wambo Open Cut Coal Mine Project (the Project), which is a 50:50 joint venture mining project between United and Wambo Coal Pty Ltd, located in the Upper Hunter Valley, New South Wales (NSW).

Pacific Environment was engaged by Umwelt to:

- estimate the economic costs of particulate matter (PM) emissions using the draft and final[a] Guidelines for the Economic Assessment of Mining and Coal Seam Gas Projects released by the NSW Department of Planning and Environment (the Guidelines) (**NSW Department of Planning and Environment, 2015a**; **NSW Department of Planning and Environment, 2015b**);
- provide advice on the appropriateness of, and limitations associated with, using the approach outlined in the Guidelines and the associated Air Quality Valuation Workbook (AQVW);
- estimate the economic costs of PM emissions using an alternative approach that provides a more appropriate assessment of the economic costs; and
- provide a comparison and discussion of estimates using the Guidelines and the alternative method.

The Project will involve new open cut operations at United (the United Open Cut) and extended mine operations at the Wambo Open Cut (Wambo) under a modified mine plan. The economic analysis involves estimating the incremental economic costs of air quality impacts associated with the Project, that is, the economic costs of air quality impacts from the Project, less the economic costs of air quality impacts that would occur under the 'base case' (what would occur if the Project did not proceed).

The economic analysis utilises and builds on Air Quality Impact Assessment (AQIA) analysis undertaken by Jacobs for the Project (**Jacobs, 2016**). The purpose of the AQIA was to estimate emissions of selected air pollutants from the Project, and predict concentrations of those air pollutants at residences proximate to the mine. This report refers to, and should be read in conjunction with, the AQIA.

The remainder of the report includes:

- an outline of the methodologies used to estimate the economic costs of air quality impacts (Chapter 2 – Methodology);
- a comparison of results from using the different methodologies (Chapter 3 – Results);
- concluding remarks (Chapter 4 – Conclusion); and
- references (Chapter 5 – References).

[a] Although the final guidelines take precedence over the draft, the draft guidelines are still likely to be relevant for project proponents as they provided much more detail on economic assessment approaches than the final guidelines.

2 METHODOLOGY

2.1 Overview

Pacific Environment has assessed the economic costs of air quality to provide inputs into the cost-benefit analysis (CBA). The assessment was conducted using the following two approaches:

- **Method 1:** Using the 'unit damage cost approach' and associated AQVW, as outlined in the Draft Guidelines (**NSW Department of Planning and Environment, 2015a**)
- **Method 2:** An alternative method that approximates an 'impact pathway' approach.

Both methods estimate the health impact from fine particulate matter of less than 2.5 micrometres in diameter ($PM_{2.5}$), as the economic costs of health impacts from air pollution are dominated by mortality and morbidity impacts resulting from $PM_{2.5}$ (**NSW Department of Planning and Environment, 2015a**). The economic costs estimated in this analysis are the full economic costs of health impacts and should be interpreted as the full cost to society (inclusive of lost income, value of lost community involvement, health system costs and other values captured in the estimate of a VSL).

This chapter outlines:

- assumptions relating to the Project's incremental emissions (used in both methods);
- an outline of Method 1 including a discussion on the appropriateness and applicability of Method 1 for estimating the economic costs of air quality impacts of the Project; and
- the assumptions and approach for Method 2, and an explanation for why the assumptions lead to a conservative estimate.

2.2 Incremental emissions attributable to the Project

A CBA compares the incremental costs and benefits of a project relative to an assumed baseline scenario/base case (i.e. relative to what would occur if the project did not proceed). The Project relates to new open cut operations at United from 2017 to 2039 (i.e. over a period of 23 years) and extended mine operations at Wambo under a modified mine plan. The projected incremental emissions for the Project were based on projected incremental production and an assumed ratio of emissions to production.

The incremental production for the Project includes both the new production from United and incremental production (i.e. production that is additional from the base case) at Wambo. All projected production from United between 2017 and 2039 was considered to be incremental. For Wambo, the incremental production between 2017 and 2039 was calculated as the difference between projected production from the Project (based on estimates provided by the proponent), and projected production in the base case (assumed to be 1.9 Mtpa of product coal between 2017 and 2020 and no production thereafter, consistent with assumptions in the CBA).

The ratio of emissions to production was based on assumptions presented in the AQIA relating to run of mine (ROM) production from the Project **(Table 13, Jacobs, 2016)** and estimated $PM_{2.5}$ emissions due to the Project **(Table 16, Jacobs, 2016)**. The ratio was estimated as 0.03 kg $PM_{2.5}$ per tonne of ROM.

The resulting projections for incremental production and emissions are shown in **Figure 2.1** on the next page.

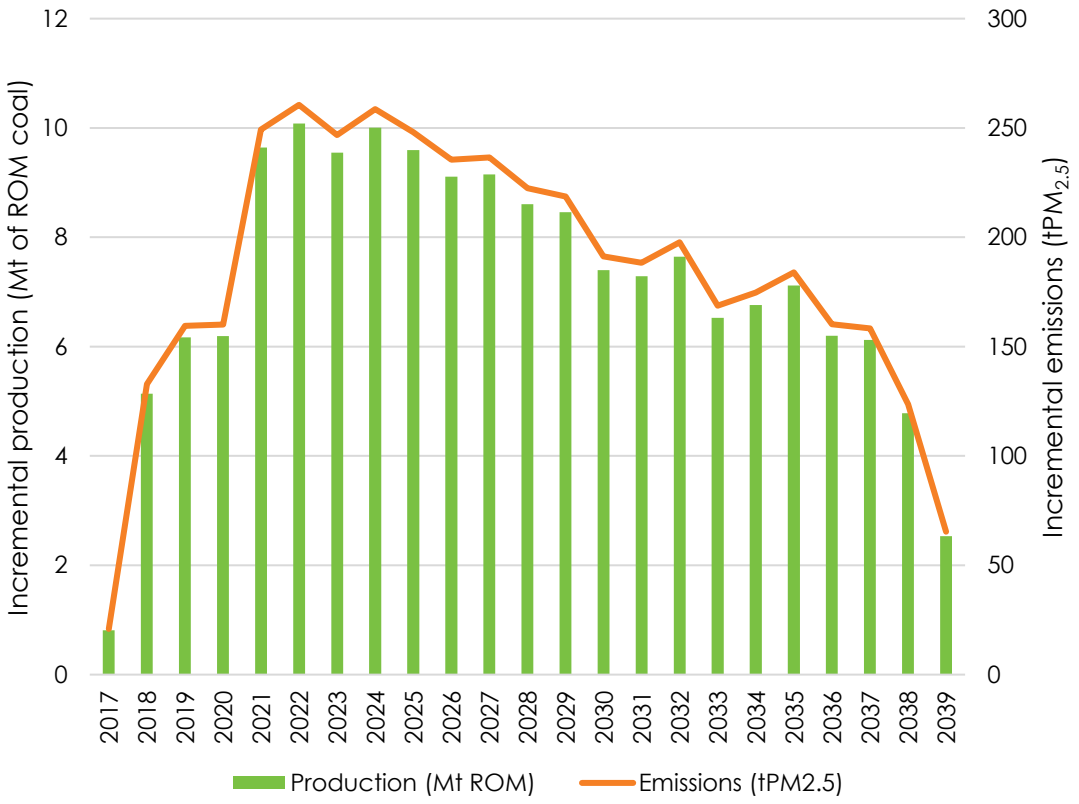

Figure 2.1: Emissions projections used in economic analysis

2.3 Damage cost approach (Method 1)

2.3.1 Overview of approach

The unit damage cost approach (Method 1) adopts the approach for the appraisal of air quality impacts as outlined in the Draft Guidelines for the economic assessment of mining and coal seam gas proposals (**NSW Department of Planning and Environment, 2015a,** pp. 43-48). This approach involves assigning a project's emissions sources to a Significant Urban Area (SUA) in NSW, and applying the unit damage costs (i.e. $ of economic impact per unit of emissions) for that SUA to estimate economic costs. NSW contains 35 SUAs, which represent regions with clusters of related urban centres with a core population of over 10,000 (**PAEHolmes, 2013**). A unit damage cost is also available for emissions not located within any of the 35 SUAs.

The Project's emissions sources are located outside of the 35 SUAs in NSW, therefore, the unit damage cost representing 'Not in any Significant Urban (NSW)' in the AQVW has been applied. The economic costs have then been estimated following Tasks 1 – 5 for using the AQVW as outlined in the Draft Guidelines (**NSW Department of Planning and Environment, 2015,** pp.47-48). Note that Task 6 (sensitivity analysis of the quantity of $PM_{2.5}$ emissions) was not undertaken given that a sensitivity range of emissions quantities have not been estimated for the AQIA.

The nearest major town (Singleton) is in the Singleton SUA. The eastern boundary of this SUA is approximately 8 km from the emitting activities of the Project. To provide a point of comparison, the estimated economic costs based on application of the unit damage costs for Singleton have also been applied. However, these are not considered an accurate estimate of economic costs of the Project's air quality impacts for the reasons set out below.

2.3.2 Limitations of the damage cost approach

The unit damage cost values have been derived from work undertaken by PAEHolmes (**PAEHolmes, 2013**). The PAEHolmes report presents unit damage cost values (A$ per tonne of $PM_{2.5}$ emitted, at 2011 prices) for 'significant urban areas' (SUAs) in Australia. The method is fundamentally based upon damage cost values from the UK (Defra), with a conversion to reflect differences in the valuation of health outcomes and currency between the UK and Australia.

The differentiation between the unit damage costs for SUAs in Australia is a function of population density alone. In other words, one tonne of $PM_{2.5}$ emissions occurring in a more densely populated area is associated with higher economic costs compared with one tonne of $PM_{2.5}$ emissions occurring in a less densely populated area. This allows the location of emissions to be linked to an approximate population-weighted exposure to $PM_{2.5}$ (see Table 1 below for example damage costs).

Table 1: Selected $PM_{2.5}$ unit damage costs from PAEHolmes (2013) (2011 A$ per tonne)

SUA name	Area (km^2)	Population ¤	Population density (people/km^2)	Damage cost (A$ per tonne of $PM_{2.5}$)
Sydney	4,064	4,028,525	991	$280,000
Newcastle – Maitland	1,019	398,770	391	$110,000
Singleton	127	16,133	127	$36,000
Muswellbrook	262	11,791	45	$13,000
Not in any Significant Urban Area (NSW)	788,116	999,873	1.3	$360

¤ Based on ABS 2011 datasets

Source: p. vi, PAEHolmes (2013).

The intent of the PAEHolmes 2013 study was to provide unit damage costs that may be used for economic appraisals in NSW and Australia where a full 'impact pathway' approach is not possible or practical. Nevertheless, the report noted the limitations of the damage cost method under certain conditions, as it is based on the assumption that emissions are spatially proximate to the exposed population within the SUA (as discussed in the next subsections).

Use of Not in any Significant Urban Area (NSW) unit damage cost

The use of the Not in any Significant Urban Area (NSW) unit damage cost is likely to significantly understate the economic cost of the Project's air quality impacts. The value is derived from the population density for the large area of NSW that is not within SUA boundaries (788,166 km^2). An application of the Not in any Significant Urban Area (NSW) would only be appropriate if the Project was located in a remote area far from any significant population centres, whereas, the Project is in fact located within less than 15 km of towns and villages.

Use of Singleton Significant Urban Area unit damage cost

Conversely, the use of the Singleton SUA unit damage cost is likely to significantly overstate the economic cost of the Project's air quality impacts and would also be inappropriate. Firstly, the Project's emissions are located outside of the SUA boundaries. Secondly, even if the Project's emissions sources were located within SUA boundaries, PAEHolmes note that the damage cost method is likely to over-estimate population weighted exposure for localised sources (such as coal mines), given that the damage cost values were derived from analysis of road transport emissions in the United Kingdom (UK) (**PAEHolmes, 2013**, pp. 41-42):

> *'Emissions from non-transport sources will lead to a different population-weighted exposure compared with road transport. This is reflected in the Defra[b] damage costs, which assign much lower levels to industry and electricity generation (as these are mostly emitted from tall stacks in rural areas). Population-weighted exposure from industrial stack emissions is not analysed separately in the UK for different areas. Further modelling work would be needed to address this issue accurately (both in the UK and Australia). It is therefore highlighted that the application of the new damage costs to industrial stack emissions will over-estimate population-weighted exposure, and it is recommended that industrial emissions are considered separately where industry dominates an area'.*

These limitations would apply when applying the damage cost method to other large but localised industrial emission sources in areas with small pockets of population. This is particularly the case for most open cut coal mining developments in NSW where the residences are located some distance from the source of emissions, and the underlying assumption that emissions are spatially proximate to the population is not accurate as most of the particulate material has settled out before it reaches the nearest residences.

While the unit damage costs account for population density differences across SUAs (by assigning lower values to emissions occurring in less densely populated SUAs), they do not account for differences in the proximity of emissions sources to those population centres within the SUA. Therefore, in the case of an emitter such as a coal mine that is located away from population centres, the approach will most likely over-estimate impacts and costs.

2.4 Approximated impact pathway approach (Method 2)

2.4.1 Overview of approach

Method 2 approximates an impact pathway approach. An impact pathway approach *'is the most robust valuation approach following the pathway from emissions to cost via ambient air quality concentrations, population exposure, and morbidity and mortality health impacts'* (**NSW Department of Planning and Environment, 2015a, p.46**). Whilst this method does not adopt a full impact pathway, it approximates the costs of the Project's $PM_{2.5}$ emissions by:

- making use of predicted $PM_{2.5}$ concentrations at points near the main population centres within proximity of the Project (based on modelling from the AQIA);
- projecting the incremental premature mortalities associated with the incremental increase in annual average $PM_{2.5}$ concentrations;
- monetising the incremental projected premature mortalities; and
- applying an uplift to account for morbidity impacts.

Five main population centres were considered in the economic analysis. These included Jerrys Plains (approximately 8 km northwest of the Project), Warkworth (approximately 1 km east of the Project), Bulga (approximately 7 km south of the Project), Maison Dieu (approximately 10 km east of the Project) and Singleton (approximately 15 km east of the Project).

The predicted $PM_{2.5}$ concentrations at population locations was based on Year 6 of the AQIA modelling. Mining and dumping activities are assumed to be closest to Warkworth and Singleton in that year out of the four Project years modelled in the AQIA (years 2, 6, 11 and 16). Year 6 was therefore used to arrive at a conservative estimate for overall population exposure (given that most of the

[b] The Department for Environment, Food and Rural Affairs (DEFRA) in the UK is the government Department responsible for policies related to safeguarding the natural environment, supporting the food and farming industry, and sustaining the rural economy. DEFRA provides guidance on the economic impacts of air quality in the UK.

population exposure is expected at Singleton). The predicted exposure in Year 6 was then applied pro-rata to projected incremental emissions (see **Figure 2.1**) in each of the years 2017 to 2039, to estimate exposure in each of those years.

Note that the analysis does not include a detailed Health Risk Assessment (HRA) but rather, provides a more accurate and appropriate estimate of the economic cost of $PM_{2.5}$ emissions from the Project, relative to Method 1. While morbidity impacts are included in the estimate (through the application of an uplift), Method 2 does not include an analysis of current hospital rates and projected incremental cases of health outcomes related to morbidity (which would normally be the subject of a full HRA). This simplification is not expected to have a material impact on the estimate given that overall economic impacts are dominated by mortality (**PAEHolmes, 2013**).

2.4.2 Predicted $PM_{2.5}$ concentrations near main population centres

The economic analysis makes use of predicted incremental annual average $PM_{2.5}$ concentrations from Year 6 of the modelling undertaken for the AQIA. The modelled area was approximately 20 km x 20 km in size, and included predictions for locations within approximately 10 – 15 km from the mine.

The modelled area fully encompassed only one of the discrete population centres (Warkworth Village) likely to experience material changes in air quality concentrations. Jerrys Plains and Maison Dieu are partly within the modelled area, whereas Singleton (where the greatest health impacts from the Project's emissions are expected) is wholly outside of the modelled area.

Exposure at the main population centres was based on corresponding predictions from the AQIA, using predictions from locations within the population centre (for Warkworth) or predictions for locations close to, but not in[c], the population centre (for Jerrys Plains, Maison Dieu and Singleton). The following locations (highlighted in **Figure 2.2** on the next page) were used to estimate exposure:

- The location of monitor AQ01 for Warkworth.
- The location of the meteorological station at Maison Dieu operated by the NSW Office of Environment and Heritage (OEH) for Maison Dieu.
- The location of monitor D17 for Jerrys Plains.
- The location of monitor D11 for Bulga.
- A location[d] near the eastern edge of the modelled area for Singleton.

[c] For population centres that were wholly or partly outside of the modelled area, estimated exposure was based on locations closer to the mine than actual population (to provide a conservative estimate of exposure).

[d] Universal Transverse Mercator (UTM) coordinates 56 H 319608 m East and 6396700 m North

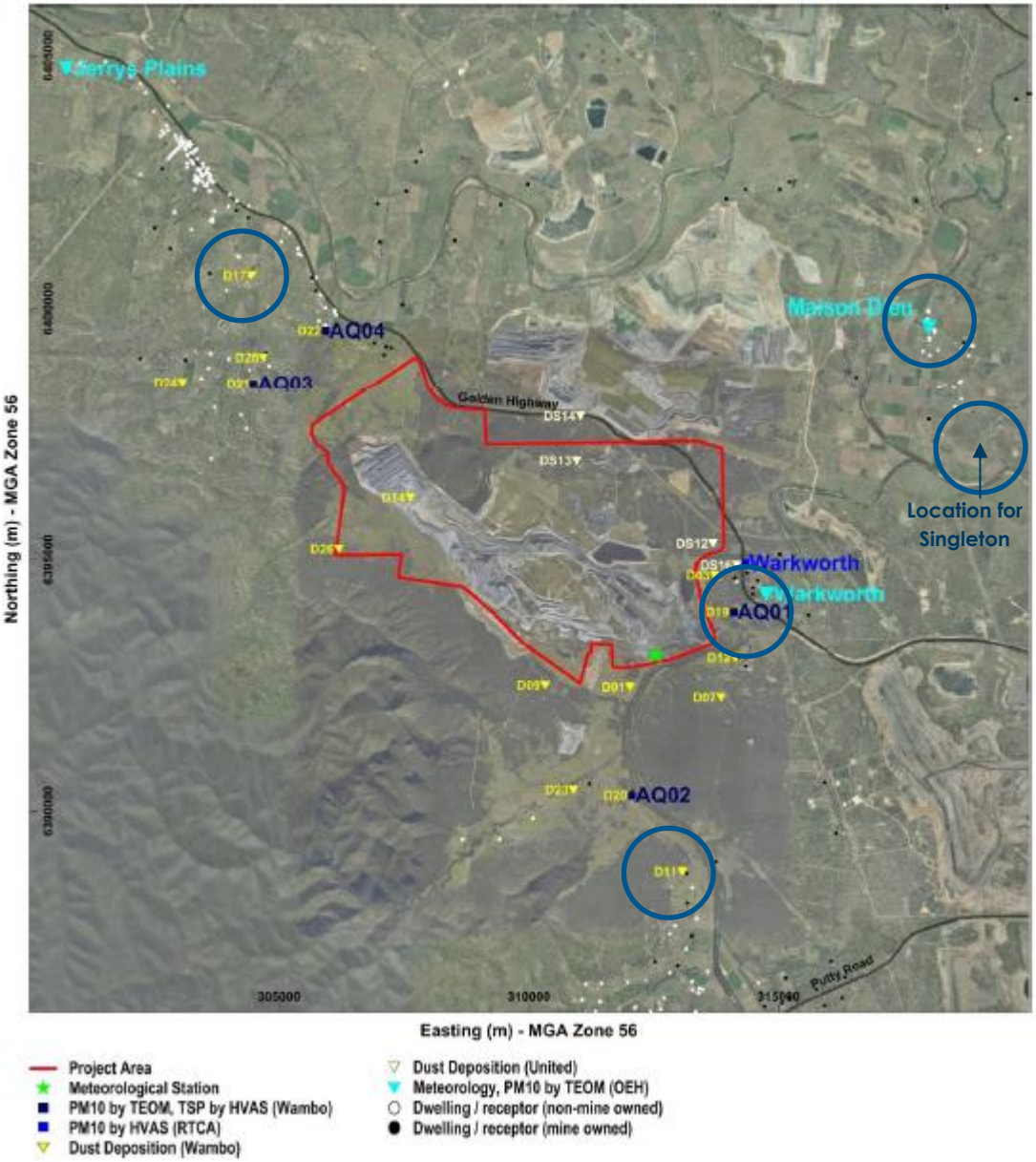

Figure 2.2: Predictions used to estimate exposure (Figure 4, Jacobs, 2016)

The resulting assumed predicted incremental concentrations at the population centres, used for the corresponding year (2023) in the economic analysis, are shown in **Table 2.1** below.

Table 2.1: Incremental concentrations of $PM_{2.5}$ (annual average) used to estimate exposure

Population centre	Concentration in year 6 (µg/m³)
Jerrys Plains	0.30
Warkworth	4.09
Singleton	0.12
Maison Dieu	0.17
Bulga	0.12

2.4.3 Monetisation of incremental premature mortalities and uplift for morbidity impacts

Incremental premature mortalities associated with the change in exposure to $PM_{2.5}$ concentrations were projected using the method described in Section 4.1 of **Golder Associates** (**2013**). The method involves calculating the change in mortality rate based on existing mortality rates, change in pollutant concentrates and a 'Beta (β)' coefficient, which represents the sensitivity of health outcome incidence rates to changes in pollutant concentrations, known as a concentration response function (CRF). The changes in mortality rate are then applied to the number of persons in the exposed population to estimate an absolute number of additional premature mortalities.

The CRF used for this study was the CRF used by Golder Associates to characterise the health risks of changes in annual average $PM_{2.5}$ concentrations, which in turn was based on recommendations by **Jalaludin and Cowie (2012)** *'as the most current and robust CRF for use in Australia'* (**Golder Associates, 2013**). This same approach has also been used in the report 'Economic Analysis to Inform a National Plan for Clean Air (Particulates)' (**Boulter and Kulkarni, 2013**).

The steps in projecting premature mortalities were:

- estimating the baseline incidence of all cause mortalities for the 30+ years age group (based on analysis of statistics for NSW and the Hunter New England Local Health District from HealthStats NSW[e]);
- applying a CRF, using a 'Beta Co-efficient' from **Jalaludin and Cowie (2012)** and population estimates for the exposed population centres (ABS 2011 Census[f] and AQIA modelling[g]);
- monetising the incremental projected premature mortalities using a Value of Statistical Life (VSL), based on **Boulter and Kulkarni (2013)**; and
- applying an uplift to account for morbidity impacts based on analysis by **Boulter and Kulkarni** (**2013**).

The assumptions are summarised in **Table 2.2** below.

Table 2.2: Assumptions used to monetise health impacts

Assumption	Value	Source
Baseline incidence (All-cause mortality 30+)	1.2%	HealthStats NSW
Beta Co-efficient	0.006	Jalaludin and Cowie (2012)
Population of Jerrys Plains (30+)	406	ABS 2011 Census
Population of Warkworth (30+)	28	AQIA modelling
Population of Singleton (30+)	7,572	ABS 2011 Census
Population of Maison Dieu (30+)	94	ABS 2011 Census
Population of Bulga (30+)	223	ABS 2011 Census
Value of Statistical Life	$7.4 million [α]	Boulter and Kulkarni (2013)
Uplift for morbidity	0.05%	Boulter and Kulkarni (2013)

[α] In 2016 prices (converting from $6.5 million in 2011 dollars to 2016 prices using the mid-point of the Reserve Bank of Australia's target band for inflation)

[e] Centre for Epidemiology and Evidence. Health Statistics New South Wales. Sydney: NSW Ministry of Health. Available at: www.healthstats.nsw.gov.au. Accessed (accessed April 2016).

[f] Using Australian Bureau of Statistics 'TableBuilder' tool and data from the 2011 Census (http://www.abs.gov.au/websitedbs/censushome.nsf/home/tablebuilder?opendocument&navpos=240), accessed April 2016.

[g] The AQIA modelling allows for identification of properties in Warkworth Village. Population (30+) for Warkworth was estimated as two times the number of affected properties (assuming two 30+ adults per property).

3 RESULTS

Table 3.1 below compares the results from Method 1 and Method 2 using the central discount rate of 7 per cent and sensitivity analysis using alternative discount rates of 3 per cent and 10 per cent.

Table 3.1: Estimated incremental economic costs from the Project (2016 $ million)

Estimate	Method 1 – using Not in Any Significant Urban Area (NSW) unit damage cost	Method 1 – using Singleton unit damage cost	Method 2
Annual cost in Year 6 (2023)	$0	$9.6	$0.6
PV using a 7% discount rate	$0	$98.5	$5.8
PV using a 4% discount rate	$0	$127.0	$7.5
PV using a 10% discount rate	$0	$78.7	$4.6

Note that Method 1 (using the Not in Any Significant Urban Area (NSW) unit damage cost which is the strict application of Method 1) results in an estimated economic cost of $0. This is because the AQVW assigns a unit damage cost value of $0 per tonne of $PM_{2.5}$ to emissions originating from 'Not in any Significant Urban (NSW)'[h].

Method 2 which provides a more accurate but conservative estimate of the economic costs of air quality impacts, is much lower than the costs estimated from Method 1 (using the unit damage cost corresponding to the Singleton SUA). The results for Method 2 are arrived at by approximating the impact pathway approach and are based primarily on the increase in premature mortality. For example, the projected economic cost in 2023 ($9.6 million) is based on a projected increase of the mortality rate from 1.1966 per cent to 1.1977 per cent (or an increase of 0.001 per cent).

[h] The unit damage cost values have been derived from work undertaken by PAEHolmes (**PAEHolmes al, 2013**). PAEHolmes recommended a value of $360 per tonne of $PM_{2.5}$ for emissions originating from 'Not in any Significant Urban (NSW)'. The AQVW rounds off all unit damage values to the nearest $1,000, resulting in a unit damage value of $0 per t$PM_{2.5}$ for emissions originating from 'Not in any Significant Urban (NSW)'. Retaining the original unit damage value ($360 per tonne of $PM_{2.5}$ in 2011 prices), results in an estimated $0.1 million economic costs in 2023, and $0.9 million, $1.2 million and $0.7 million in total PV costs (using a 7 per cent, 3 per cent and 10 per cent discount rate respectively).

4 CONCLUSION

Pacific Environment has undertaken an assessment of the economic costs of air quality impacts from the Project using two methods (damage cost and an approximation of an impact pathway).

A strict application of the damage cost approach (Method 1), using the Guidelines and associated AQVW, results in an estimate of $0 economic costs. Using the damage cost corresponding to the nearest SUA (Singleton), results in a significant overestimate of the economic costs. In addition to either significantly underestimating the economic cost (using a strict application), or significantly overestimating the economic cost (using the value for the nearest SUA), the base assumptions behind Method 1 do not apply to the Project. The approximation of the impact pathway approach (Method 2) provides a more accurate estimate of the economic costs of air quality impacts.

Using the approximated impact pathway approach (Method 2), the economic costs of air quality impacts are estimated to be **$5.8 million** in Present Value (PV) terms (2016 prices using a 7 per cent real discount rate), or **$7.5 million** or **$4.6 million** (using a 4 per cent or 10 per cent discount rate respectively).

Given that Method 2 is still an approximation of the impact pathway approach, the estimates from application of Method 2 should also be considered approximations (with an associated margin of uncertainty). The most notable data limitation in this analysis was that predictions were not available for the major exposed population centre of Singleton. In the absence of these data the analysis adopted conservative assumptions and therefore the estimates should be considered as an upper bound on the likely economic costs of health impacts associated with the Project.

5 REFERENCES

Boulter P and Kulkarni K (2013). "Final Report – Volume 1: Main Report. Economic Analysis to Inform the National Plan for Clean Air (Particles)". Prepared by Pacific Environment Limited and Marsden Jacob Associates for NEPC Service Corporation, August 2013.

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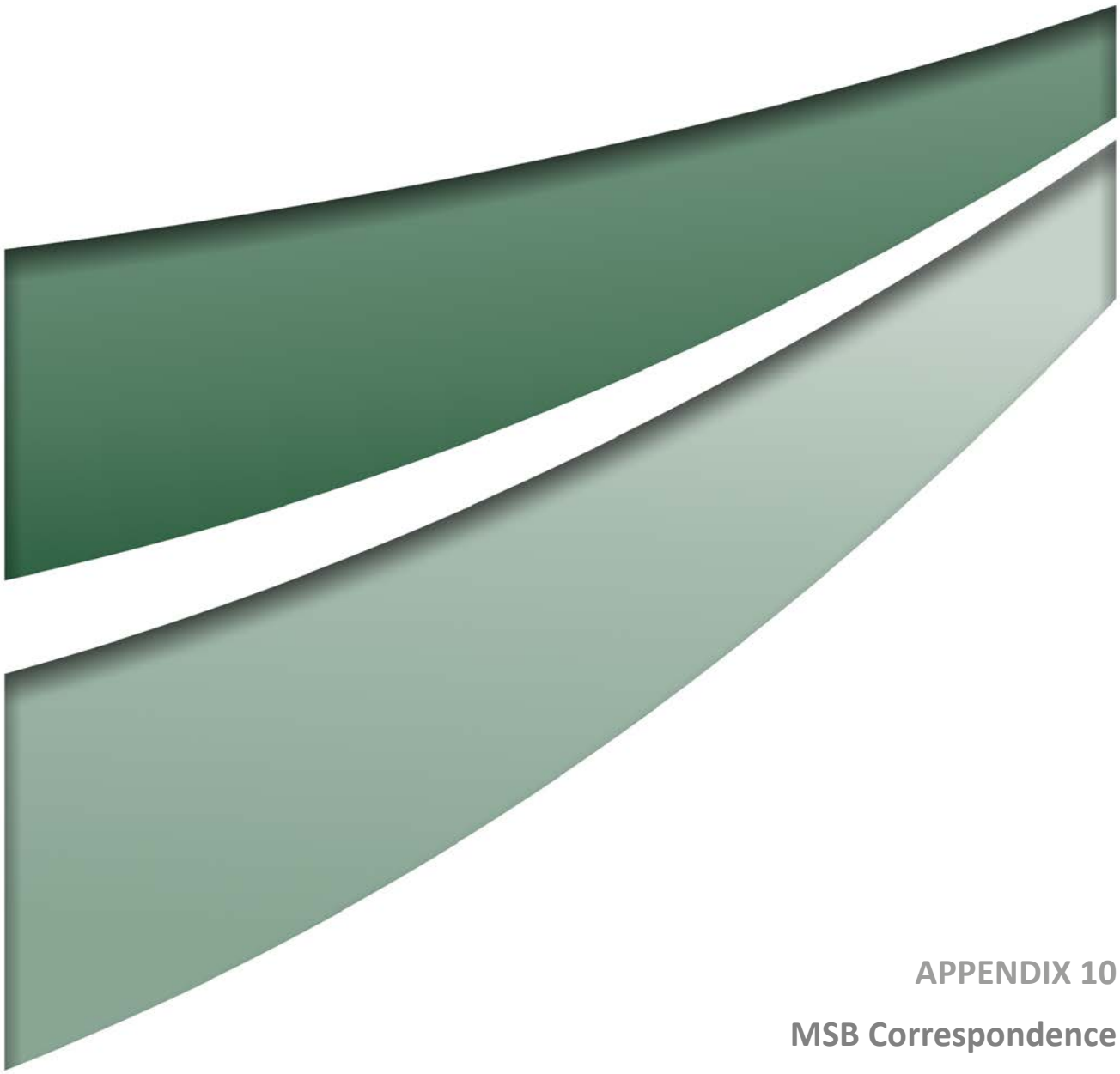


APPENDIX 10

MSB Correspondence

NSW GOVERNMENT | Subsidence Advisory NSW

117 Bull Street, Newcastle West NSW 2302
Tel 02 4908 4300 | www.subsidence.nsw.gov.au
24 Hour Emergency Service: Free Call 1800 248 083

FN90-00183S0
TENQ16-15045S1

Adam Cooney
Adam.Cooney@glencore.com.au

Dear Adam

LOT 1 DP 616303

HIGH VOLTAGE TRANSMISSION LINE RELOCATION WARKWORTH

Subsidence Advisory NSW confirms that the proposed relocation of the high voltage transmission line as shown in the attached plan is clear of any underground mine workings.

Yours sincerely

Paul Gray
Acting District Manager

21 November 2016
Contact phone no: (02) 4908 4375

0 1 2 Kilometers

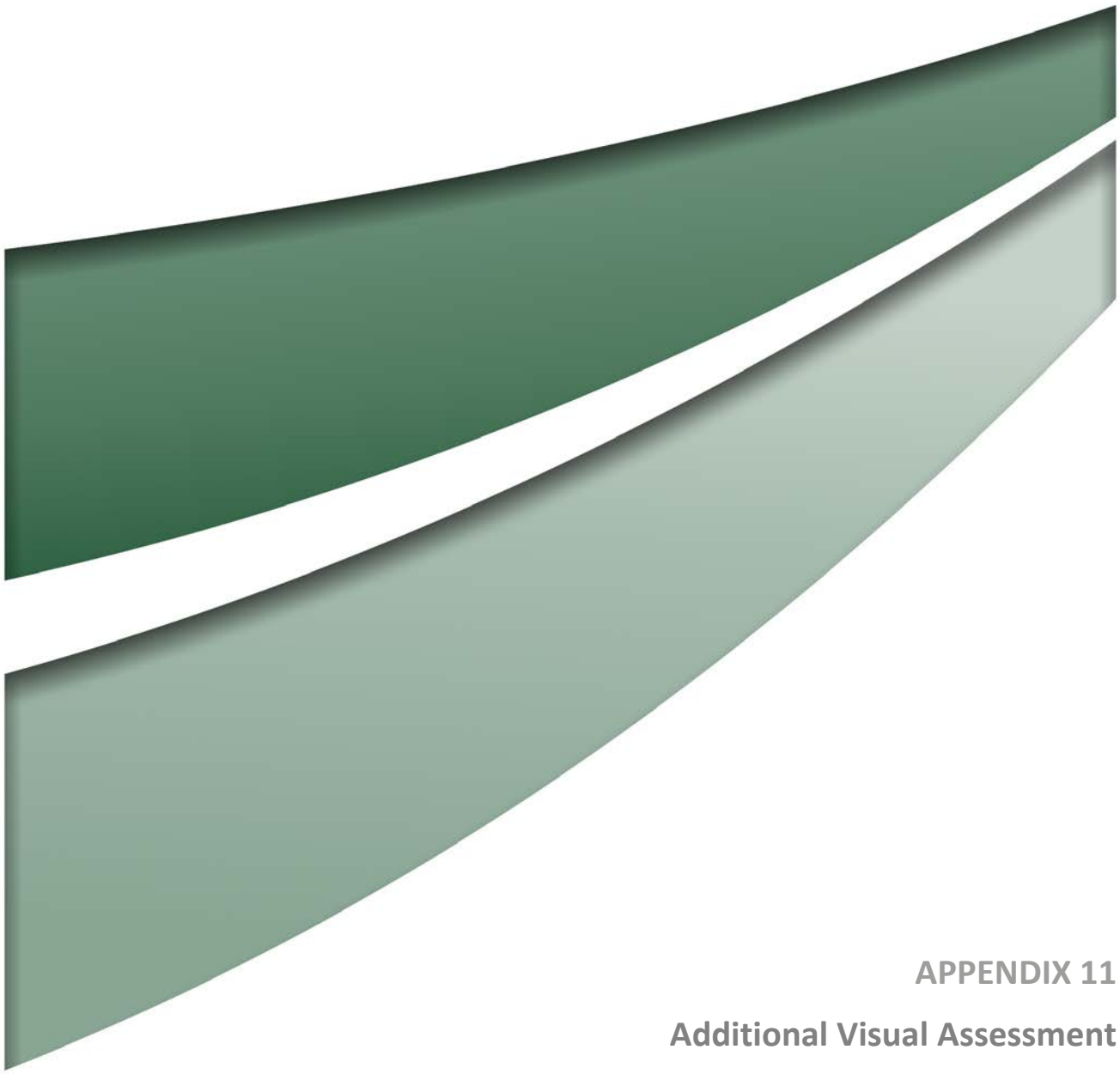
N
W E
S

DISCLAIMER:
This plan has been compiled for use by the Subsidence Advisory NSW from official records held by the Department of Industry-Resources & Energy; surface data supplied by the Department of Finance, Services & Innovation-Land and Property Information, and information from mine owners. Therefore no warranty is expressed or can be implied to any other person as to the accuracy of the map or that it is free from any error or omission. Accordingly the State of New South Wales, Subsidence Advisory NSW and their servants and agents expressly disclaim any liability whatsoever for the consequences arising from any act done or omission made in reliance by others on the information contained in this plan.
The original Record Tracings of the mine workings are held by the Department of Industry-Resources & Energy and are the only records to be referenced for planning purposes.

NSW GOVERNMENT Subsidence Advisory NSW

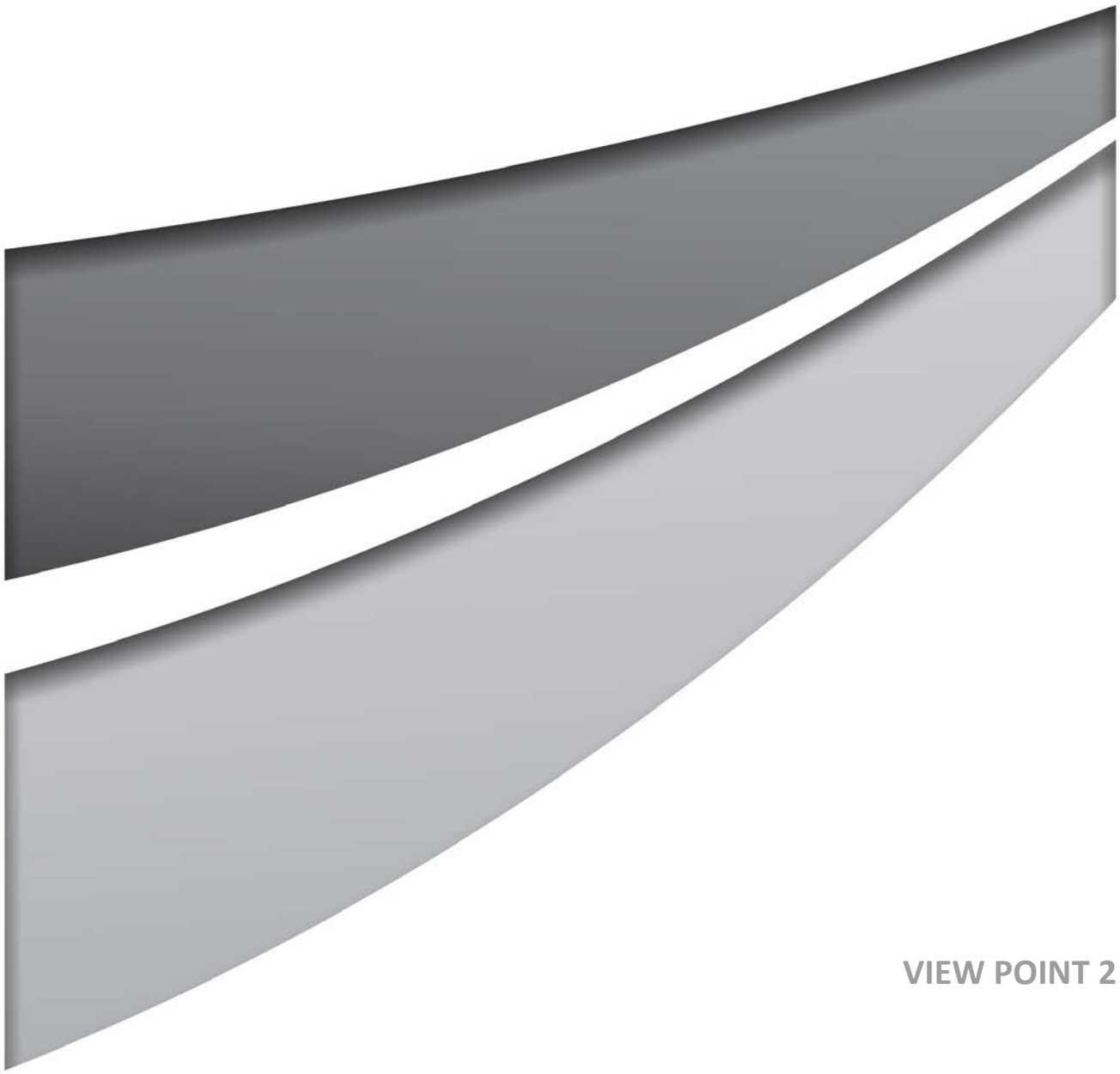
United-Wambo
Location of High Voltage Transmission Lines

Drawn: JS
Date: 23-Nov-16



APPENDIX 11

Additional Visual Assessment



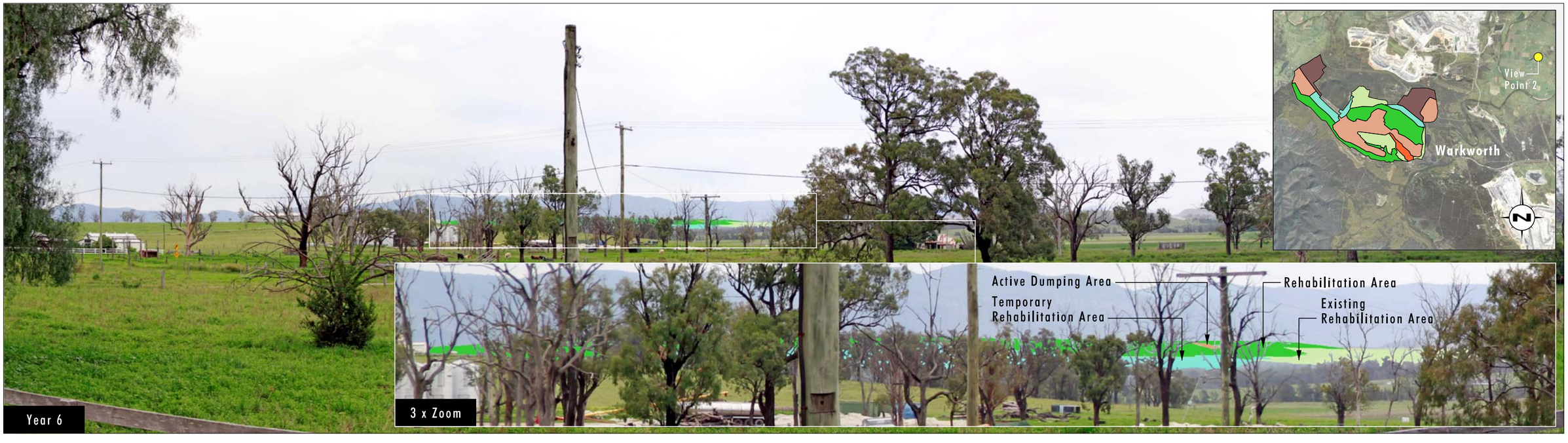
VIEW POINT 2

Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 1

Visual Montage from View Point 2
Year 2



Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 2

Visual Montage from View Point 2
Year 6

File Name (A3): 3509_516.dgn
20161122 13.17

Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

File Name (A3): 3509_517.dgn
20161122 13.30

FIGURE 3

Visual Montage from View Point 2
Year 11

Legend

- Active Mining Area
- Active Dumping Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 4

Visual Montage from View Point 2
Year 16

File Name (A3): 3509_518.dgn
20161122 13.34

Legend

- Agriculture
- Dam
- Infrastructure
- Riparian Vegetation
- Rock
- Woodland

FIGURE 5

Visual Montage from View Point 2
Final Year

File Name (A3): 3509_519.dgn
20161122 13.40

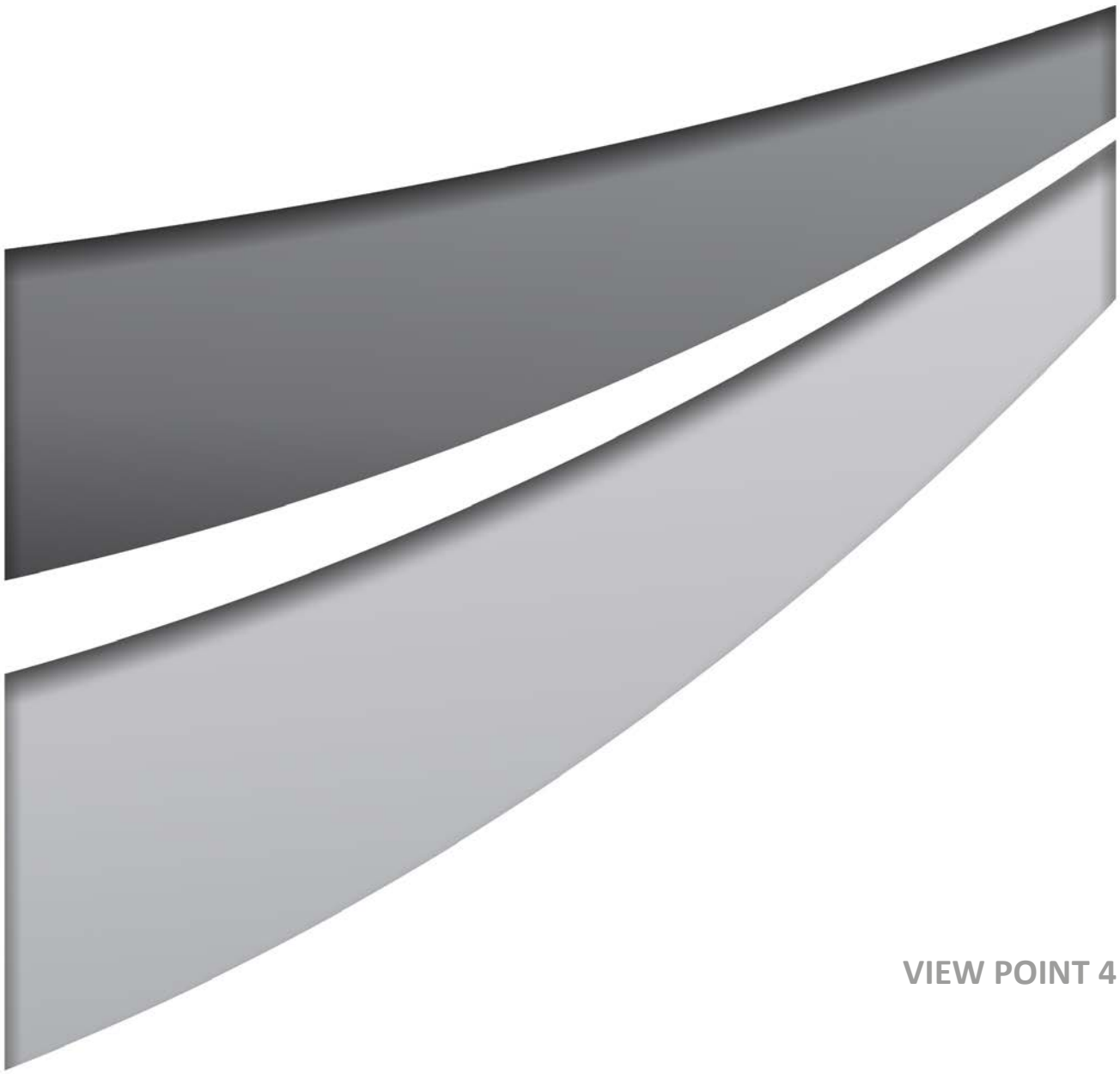
Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE X

Visual Montage from View Point 4
Year 2

File Name (A3): 3509_557.dgn
20170124 11.19



VIEW POINT 4

Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 1

Visual Montage from View Point 4
Year 6

File Name (A3): 3509_536.dgn
20161208 11.13

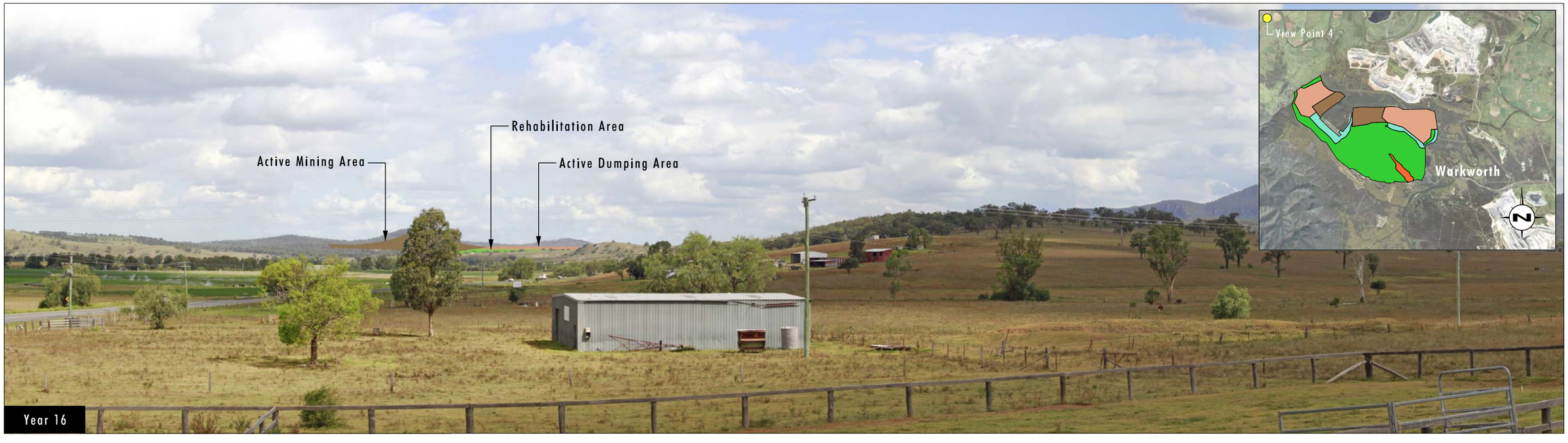
Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 2

Visual Montage from View Point 4
Year 11

File Name (A3): 3509_537.dgn
20161208 11.21



Legend

- Active Mining Area
- Active Dumping Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

File Name (A3): 3509_538.dgn
20161208 11.25

FIGURE 3

Visual Montage from View Point 4
Year 16

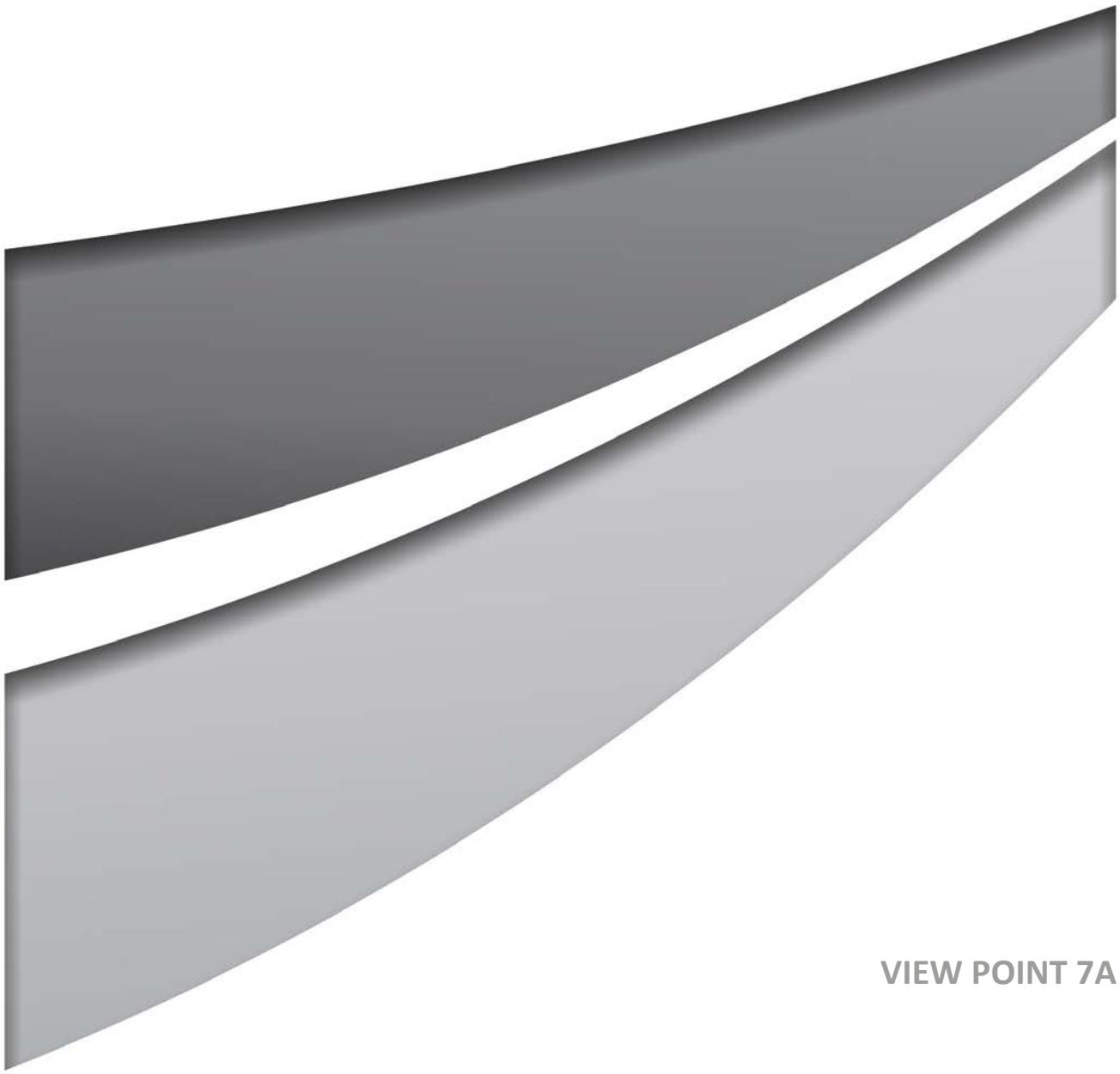
Legend

- Agriculture
- Dam
- Infrastructure
- Riparian Vegetation
- Rock
- Woodland

FIGURE 4

Visual Montage from View Point 4
Final Year

File Name (A3): 3509_539.dgn
20161208 11.33



VIEW POINT 7A

Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 1

Visual Montage from View Point 7A
Year 2

File Name (A3): 3509_540.dgn
20161125 13.01

Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

File Name (A3): 3509_541.dgn
20161222 15.18

FIGURE 2

Visual Montage from View Point 7A
Year 6

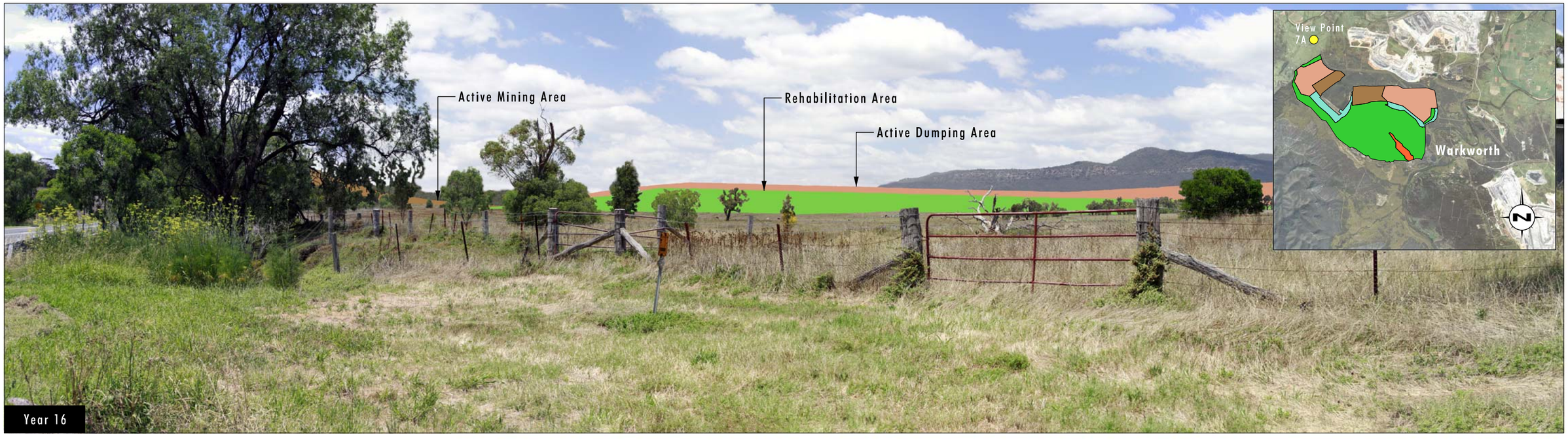
Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 3

Visual Montage from View Point 7A Year 11

File Name (A3): 3509_542.dgn
20161222 15.21



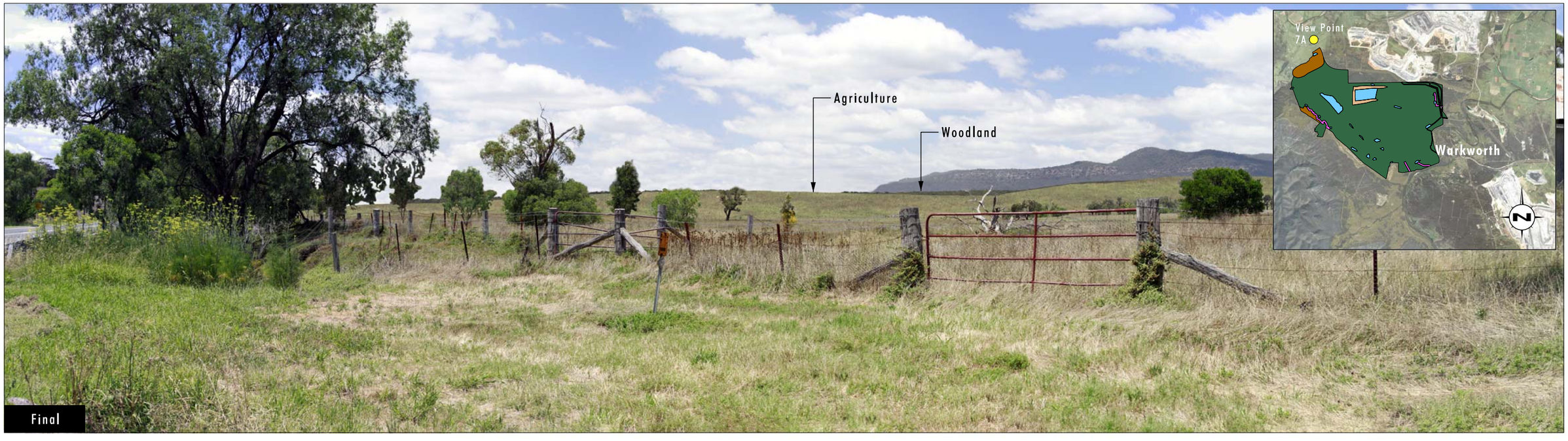
Legend

- Active Mining Area
- Active Dumping Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

File Name (A3): 3509_543.dgn
20161222 15.23

FIGURE 4

Visual Montage from View Point 7A Year 16

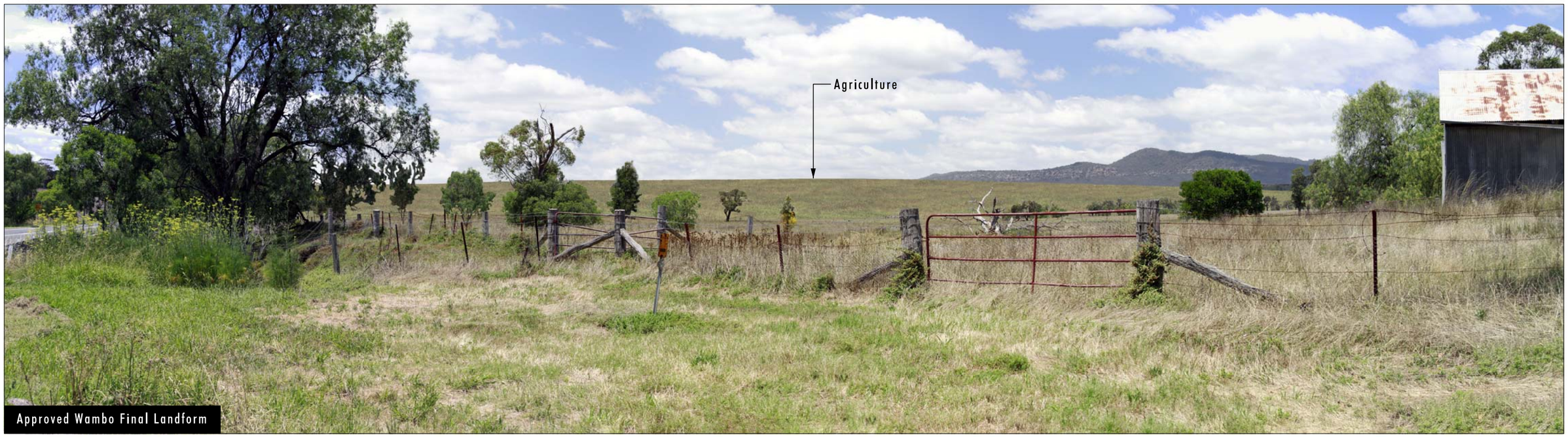


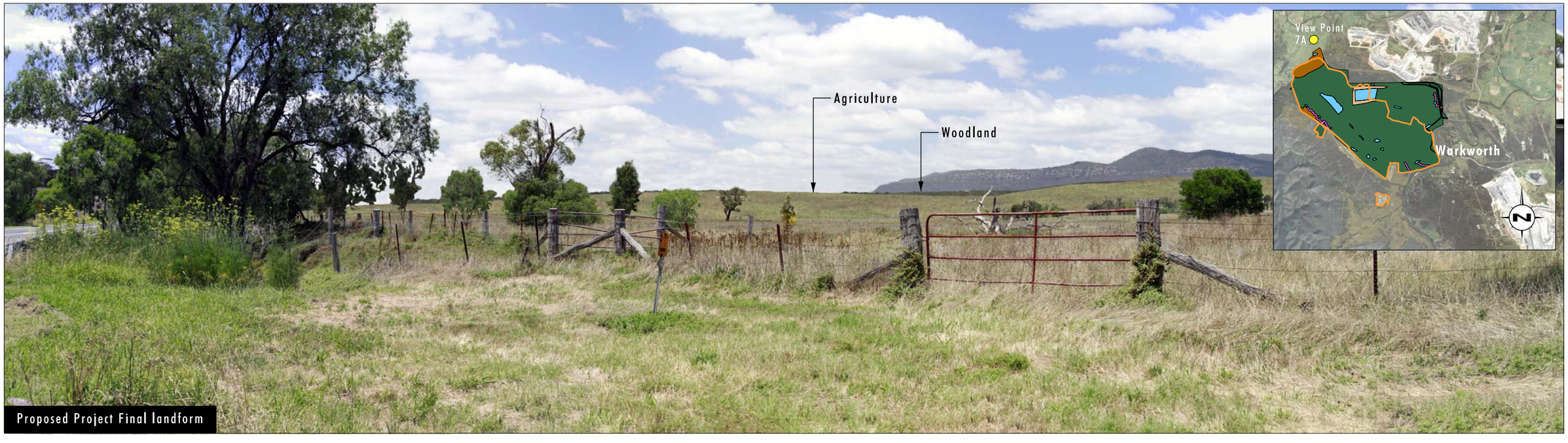
Legend

- Agriculture
- Dam
- Infrastructure
- Riparian Vegetation
- Rock
- Woodland

FIGURE 5

Visual Montage from View Point 7A
Final Year





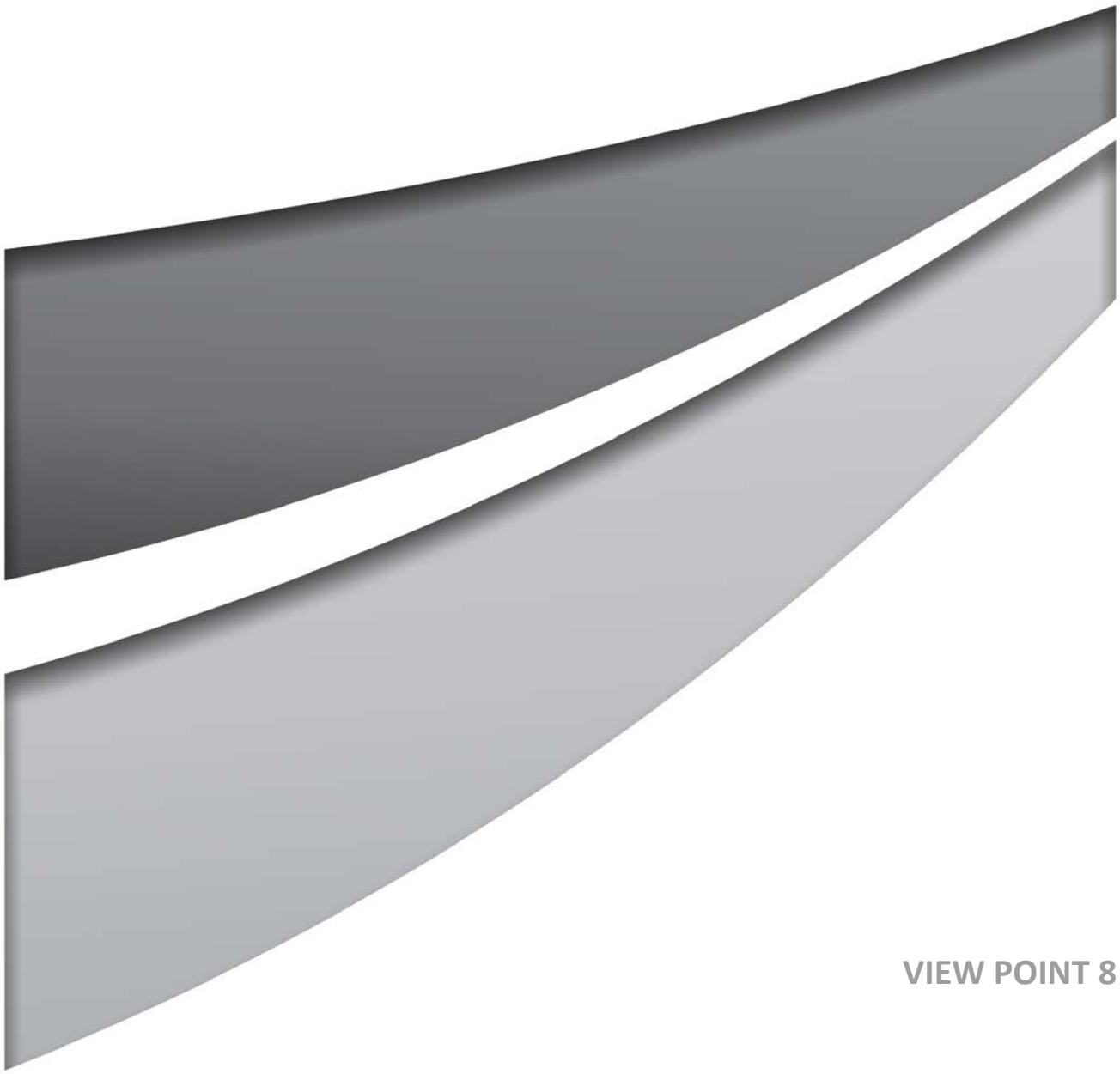
Legend

- Agriculture
- Dam
- Infrastructure
- Riparian Vegetation
- Rock
- Woodland
- Approved Wambo Surface Development Area

FIGURE 6

Visual Montage from View Point 7A Final Year Landform Comparison Wambo and United

File Name (A3): 3509_556.dgn
20170203 14.44



VIEW POINT 8

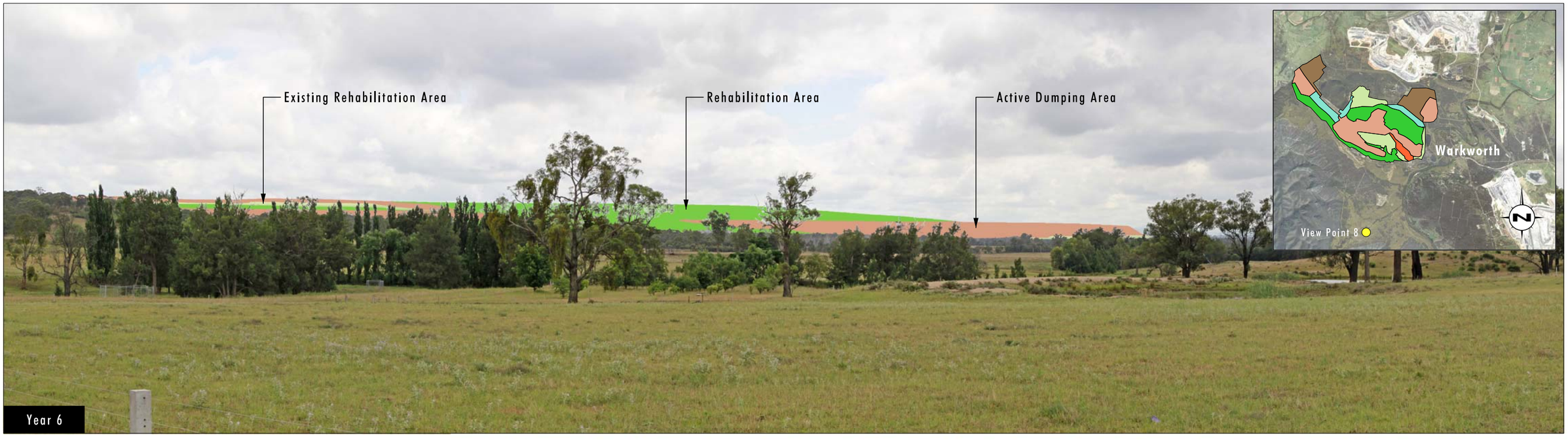
Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 1

Visual Montage from View Point 8
Year 2

File Name (A3): 3509_520.dgn
20161125 13.01



Legend

- Active Mining Area
- Active Dumping Area
- Existing Rehabilitation Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 2

Visual Montage from View Point 8
Year 6

File Name (A3): 3509_521.dgn
20161125 16.04

Legend

- Active Mining Area
- Active Dumping Area
- Rehabilitation Area
- Temporary Rehabilitation Area
- Tailings Emplacement Area

FIGURE 4

Visual Montage from View Point 8
Year 16

File Name (A3): 3509_523.dgn
20161125 16.14

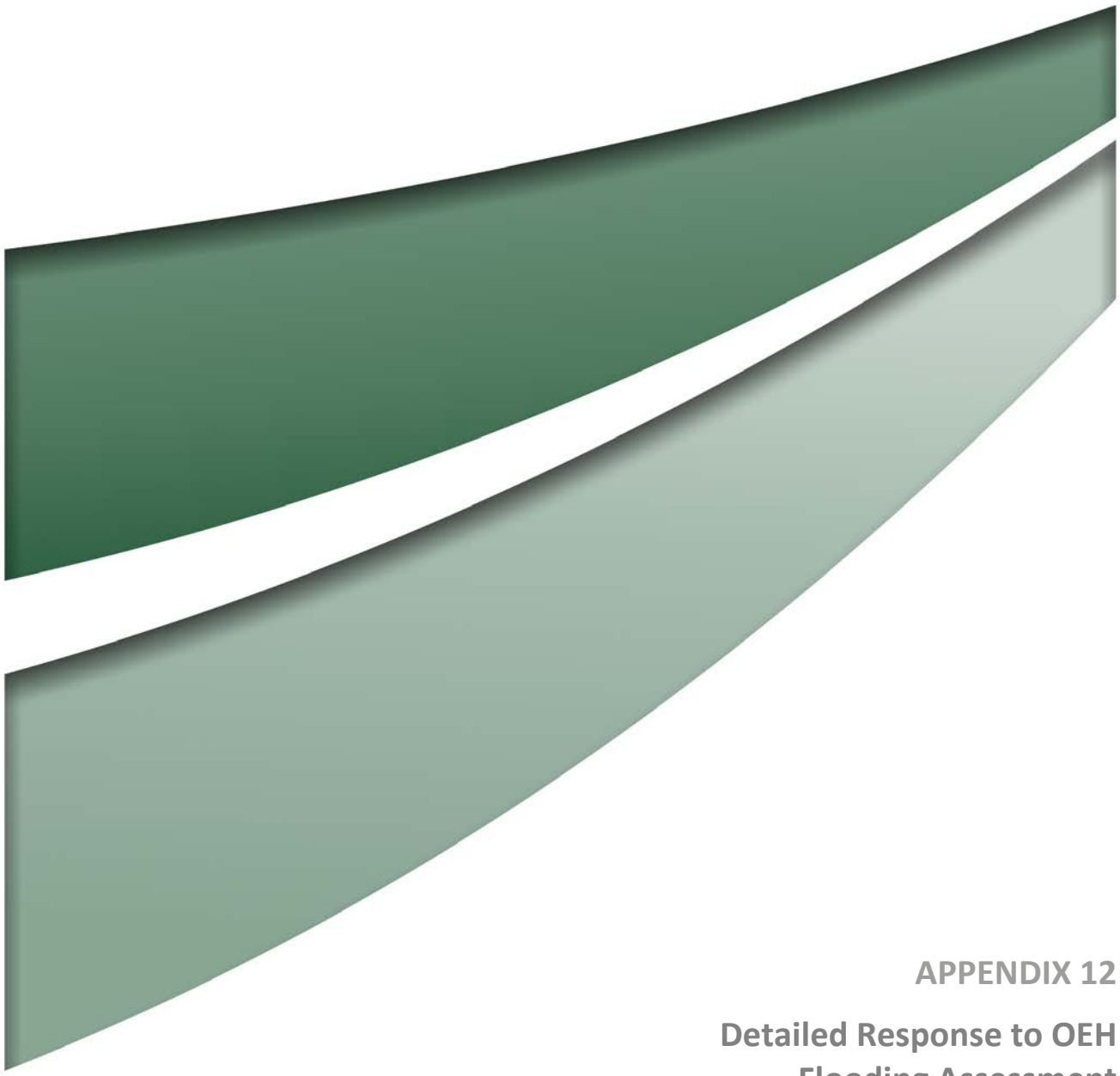
Legend

- Agriculture
- Dam
- Infrastructure
- Riparian Vegetation
- Rock
- Woodland

FIGURE 5

Visual Montage from View Point 8
Final Year

File Name (A3): 3509_524.dgn
20161125 16.23



APPENDIX 12

Detailed Response to OEH Flooding Assessment Comments

The Wollombi Brook Flood Study BMT WBM July 2015 has since been commissioned by Singleton Council and includes the area covered by the Umwelt analysis. The methodology and results of the two studies have been compared to determine if the Umwelt study has provided sufficient information for assessment and has been carried out with the required technical detail. The following comments are made:

- **different software has been used for the two studies for both the hydrological and hydraulic modelling. The methodology used by the BMT study is more in accordance with current best practice**

OEH references the *Wollombi Brook Flood Study BMT WBM July 2015*, which has been commissioned by Singleton Council. No reference could be publically found to this study and the study was not available at the time the Flooding Assessment Report was completed. A copy of the study was received from Singleton Council upon request. The copy received is titled *Wollombi Brook Flood Study – Draft Report for Public Exhibition* and is dated July 2016 (the last date in the revision history is 25 July 2016). The Project was submitted to DPE for exhibition on 8 August 2016.

It is noted that the aims and objectives of the two flood studies are different. The BMT Draft Flood Study is a flooding assessment of the whole Wollombi Brook catchment while the EIS study relates to the vicinity of the Project Area and assesses local changes and impacts on the flooding regime. It is therefore reasonable that different modelling approaches were taken for these two different studies.

The methodology applied to the EIS flood assessment uses a lumped hydrological model (IHACRES) as input to a two dimensional (2D) finite element model (RMA-2). The design inflows to the model were also compared to data from a Flood Frequency Analysis (using data available in PINNEENA).

The 2D modelling approach for the Project is consistent with methods outlined in Australian Rainfall and Runoff Project 15 – Two Dimensional Modelling in Urban and Rural Floodplains (stage 1 and 2 report) (published November 2012). The hydrological modelling approach, although a simpler approach than that undertaken for the BMT Draft Flood Study provides inputs to the 2D model based on a calibration using flow data. However, it should be noted that the key item driving the differences in the peak flows rates of the 2D models appears to be in regards to changes to rating curves that were derived in the BMT Draft Flood Study (see comments below) after the commencement of the Project Flood Assessment.

As discussed in *Chapter 2 – Catchment Representation* of *Australian Rainfall and Runoff* (2016) (www.arr.org.au), "*in situations where the interest is only on the combined hydrograph at the catchment outlet and where good flood records for current conditions are available at that point, modelling of the catchment as a single "lumped" response unit may be sufficient*". This was considered to be the case for the requirements of the Wollombi Brook Flood Assessment for the Project.

- **the Umwelt study is for a small portion of the Wollombi Brook only whereas the BMT study extends from Paynes Crossing to the Hunter River**

This is correct. The boundaries and associated catchment context of the Flood Assessment are shown on **Figure A**. The purpose of the Wollombi Brook Flood Assessment is to determine flooding regimes (and associated flood planning aspects as requested by OEH via the SEARs) and potential

impacts of the Project in relation to flooding in Wollombi Brook. As such the focus of the assessment is only on the reaches of Wollombi Brook immediately upstream of the Project Area, adjacent to the Project area and downstream of the Project Area to the confluence of Wollombi Brook and the Hunter River. The upstream and downstream boundaries of the modelling were selected respectively: at a natural constriction in the floodplain; at the confluence of the Hunter River, and at locations sufficiently far away from the area of interest to remove any boundary effects of modelling on the assessment. The BMT Draft Flood Study has been undertaken for a different purpose (i.e. to define the critical mainstream flooding behaviour of Wollombi Brook and its major tributaries within the Singleton Council Area.

- **the Umwelt study as used the Warkworth gauge for calibration purposes. This gauge is considered unsuitable for this purpose due to backwater effects from the Hunter River. It is noted that the calibration event used was the 1998 event for which there was minimal flooding in the Hunter River**

As stated in the EIS Flood Assessment, the Warkworth gauge is influenced by flooding in the Hunter River. Similarly it was also stated that the 1998 event was used for the hydrology model calibration as there was limited influence by flooding in the Hunter River, good flow records at the Warkworth gauge and hourly rainfall data available. As such the hydrology model calibration took into consideration the influences of the Hunter River impacts on gauge data in Wollombi Brook.

- **it is also noted that the Department of Primary Industries Water (formerly the Office of Water) rating curves for this area have changed significantly over time. The Umwelt study incorrectly assumed this was a backwater effect. The BMT study found that rating curves have changed due to progressive changes in vegetation in the floodplain**

The EIS Flood Assessment states that it is understood that the variation in peak flows relative to flood levels for Wollombi Brook over the last 65 years of data for flood events is primarily a result of tailwater conditions in the Hunter River causing a reduction in peak flows in Wollombi Brook for some of the recorded flood events. We acknowledge that the changes in the rating curves associated with channel bed/bank and vegetation changes will also impact the relationships between flow rates and flood levels. However, the comment above in regards to tailwater conditions is considered to also be correct.

OEH comments that BMT found that the rating curves have changed due to progressive changes in vegetation in the floodplain. However, it does not appear that the BMT Draft Flood Study took into consideration any changes in channel geometry due to erosion and deposition processes but only considered changes to riparian vegetation influencing the rating curves.

As stated in the EIS Flood Assessment, according to Erskine (1998) the lower reaches of the channel (of Wollombi Brook) widened by about 100 per cent and the eroded sand deposited into the bed of the channel (during the major flood event in 1949). As such we believe that changes in channel geometry need also to be considered in updates to the rating curves.

- **the Umwelt study uses simplistic treatment of mannings roughness within the Wollombi Brook whereas the BMT calibration required the use of depth varying mannings n value.**

The approach using a single static mannings n to represent hydraulic roughness is considered appropriate for the Flood Assessment. Whilst the use of varying depth varying mannings n values can provide representation of the changes that occur to vegetation during a flood event (e.g. a channel with dense reeds may have a high hydraulic roughness at low flows but at a certain flow/depth the reeds will lie over and result in a greatly reduced hydraulic roughness), the location of the Project Area relative to the modelled flood extents and associated floodplains is such that the approach used is conservative. It is also considered, that the highly constrained nature of the floodplain adjacent to the Project Area and the smallest flood being modelled the 10% AEP flood event, that fixed mannings n values (regardless of water depth) are appropriate for the assessment requirements.

It should be noted that this same approach, that is static mannings n values, was used in the BMT Draft Flood Study for the historical event modelling with only the design event modelling utilising a depth varying mannings n value.

The outputs of the Umwelt study have been reviewed against the BMT results. In general the Umwelt study indicates a higher degree of flood affectation in this catchment that the BMT study with flow rates and predicted flood levels at least one order of magnitude greater. The Umwelt study also considered flows in minor watercourses which affect the mine area whereas the BMT study focusses on broad scale flowing from Wollombi Brook.

The outputs of the Umwelt study, although not in accordance with the BMT outputs, are therefore considered to be conservative and may be used for assessment of the project. The Umwelt study has provided afflux assessment for the development scenario including changes to topography, water diversions, catchment areas, flood levee and highway realignment. The afflux maps show changes of up to 0.5 metre flood depth in North Wambo Creek due to creek diversions around the mine workings. It appears that flows to North Wambo Creek are reduced from the pre mine scenario; however, afflux modelling has compared the current approved works to be proposed development scenario. The proposed development scenario returns some of the original flow to North Wambo Creek and hence shows increase in flows. Additional flows are also shown in the area of the proposed flood levee. Increased flows around North Wambo Creek and the proposed flood levee occur on mine owned land and can be managed as part of the water management of the site. Afflux mapping for Wollombi Brook outside of mine owned land shows increases no greater than 10 mm which is considered acceptable. Increases in flows on Waterfall Creek are also noted, however, these also occur on mine owned land and do not impact the Golden Highway in the 1% annual exceedance probability (AEP) flood.

The Umwelt study demonstrates minimal impact on privately owned land and has proposed a levee to protect the mine pit from Wollombi Brook flooding up to the 0.1% AEP event.

OEH states that the Flood Assessment flood levels and results are at least one order of magnitude greater than the BMT Draft Flood Study. This is incorrect. It is acknowledged that the flood levels and flows reporting in the Flood Assessment are indeed higher than those reported in the BMT Draft Flood Study. However, referring to these as “an order of magnitude different” is incorrect and misleading.

The BMT Draft Flood Study indicates that there are no historical flood studies for the lower reaches of Wollombi Book. However, as referenced in the Flood Assessment, one such study was undertaken by Water Research Laboratory (WRL) in 1996. The results from this study were used in the Flood Assessment to assist in verifying the model results, inform tailwater influences from the Hunter River on flooding within Wollombi Brook, as well as providing a comparison for model parameters. This study provided data on peak flood levels at Warkworth of 61.7 mAHD in 1949 and 59.3 mAHD in 1955.

The following table, **Table 1**, provides a high level summary of the key aspects of the Flood Assessment and BMT Draft Flood Study that are considered to influence the differences in modelled outcomes. Although it is agreed with OEH, that with the new rating curve data / analysis the Flood Assessment results are conservative, it is also considered that the flood levels presented in the BMT Draft Flood Study underestimate the potential flood levels adjacent to the Project Area and in the general Warkworth area especially in consideration of the potential tailwater levels in the Hunter River.

Table 1 Key Aspects and Differences in the Flood Assessment and BMT Flood Study

Key Aspects	Flood Assessment Approach	BMT Flood Study Approach	Key differences / influences on model results
Rating Curves	Data used from PINNENNA at the time of the assessment (i.e. prior to the release of the April 2015 updated rating curve for Warkworth gauge).	Study included review of PINNEENA rating curve and historical data, including the recently released rating curve for the Warkworth Gauge April 2015 and estimation of a new set of rating curves for the streamflow gauges on Wollombi Brook.	BMT analysis gives lower flow rates for higher flood levels.
Hydrology Model Calibration	Hydrology model was calibrated to a small flood event at the Warkworth Gauge and outputs for design storm events compared to a Flood Frequency Analysis (at the Warkworth Gauge) (i.e. based on the rating curve data as per above).	Hydrology model was calibrated to provide outputs similar to the estimated rating curves (see above) for three flood events (2007, 1949 and 2015).	BMT hydrograph shape is flatter (i.e. increased duration of higher flow rates) with lower peak flow rates.
Digital Terrain Data / Model Base	Triangular irregular mesh used to represent the varying scale of features associated with the channel, overbank and hydraulic features of the floodplain. Mesh orientated to represent hydraulic features. Estimated no flow in the brook at the time of LiDAR survey.	Gridded network used with 5 metre spacing. Not orientated to hydraulic features. No information of water level/flow conditions in the flood at the time of LiDAR survey.	Channel shape / capacity could be influenced by water levels in base LiDAR survey data.

Key Aspects	Flood Assessment Approach	BMT Flood Study Approach	Key differences / influences on model results
Hydraulic Roughness	In channel roughness, mannings n, for Wollombi Brook of 0.075	In channel roughness, mannings n, for Wollombi Brook in lower reaches, of 0.045. Depth varying mannings n only used for design events, not for calibration.	BMT Wollombi Brook channel (adjacent to Project Area) is smoother.
Hydraulic Calibration	Model results verified by comparison to historical flood levels (as presented in PINNEENA) and WRL (1996) flood study.	Model results calibrated to estimated rating curves (see above).	BMT analysis gives lower flow rates for higher flood levels.
Tailwater Influences	Tailwater analysis for Hunter River used long term gauging stations (Singleton, 1914 to 2005 and Liddell, 1973 to 2006) with 81 flood records presented in PINNEENA in the Log Pearson 3 (LP3) Distribution Frequency Analysis. Tailwater modelled as a static level. LP3 preferred method of analysis in PINNEENA at the time of preparation of the flood assessment.	Tailwater analysis for the Hunter River uses data from Mason Dieu, 1993 to 2015 (13 flood records only presented in PINNEENA, although Gumbel distribution method in BMT study provides for a wider range of values to be used in the analysis). Gumbel distribution method used to determine flood frequency (Gumbel is now the preferred model of analysis). Tailwater hydrograph shape based on 2007 flood hydrograph shape.	BMT analysis provided lower tailwater levels compared to Flood Assessment. BMT analysis does not consider data from earlier major floods in the Hunter River (e.g. 1955). BMT analysis does not consider the potential for increased duration of flooding in the Hunter River (e.g. flood duration recorded at Singleton for the 1995 flood was twice as long as the flood duration recorded for the 2007 flood, although similar peak flood levels were recorded).

Note: PINNEENA is a data dvd published by the NSW Government containing continuous monitoring data for surface water and groundwater systems. The dvd includes analysis outputs/methods from NSW Government including outputs from rating curves (i.e. translation of water levels during floods to flow rates).

Table 2 provides a comparison of the model data for peak flows, peak flood levels and associated tailwater conditions for both the Flood Assessment and the BMT Draft Flood Study.

It should be noted that the impact assessment has been accepted by OEH. It is considered that the new data that has come to light since the commencement of the Flood Assessment (i.e. new rating curve by DPI Water for Warkworth gauge and rating curve analysis/estimates undertaken for the BMT Draft Flood study) should be considered as part of the flood model updates for future design works for the proposed flood levee and highway alignments.

Table 2 Comparison of Results

Flood Event	Peak Flows (m3/s)		Peak Flood Levels (mAHD)		Tailwater Conditions	
Flood Event	Umwelt Flood Assessment 1	WMB BMT Flood Study	Umwelt Flood Assessment 1	WMB BMT Flood Study	Umwelt Flood Assessment 1	WMB BMT Flood Study
20%		426		54.2		2 yr ARI, 48.2
10%	944	553	56.6	54.6	Bank full, 54.5	2 yr ARI, 48.2
5%	1,179	717	57.2	55.2	Bank full, 54.5	20%, 51.3
1%	1,695	1,142	58.4	55.9	10%, 56.0	10%, 53.3
0.5%	1,952	1,453		56.7	1%, 59.1	5%, 55.3
0.2%	2,258			57.9	1%, 59.1	2%, 57.8
PMF	7,452		63.2		1%, 59.1	
Extreme Flood		7,146		62.8		1%, 59.8

1. Source: Table 4.1 SWA

Recommended conditions of consent for flooding / floodplain management:

1. **Detailed design of the flood levee and Golden Highway diversion is to include updated flood modelling.**

OEH's recommended conditions are noted.

2. **Flood modelling is to demonstrate no increase in flood attenuation of the highway or privately owned lands.**

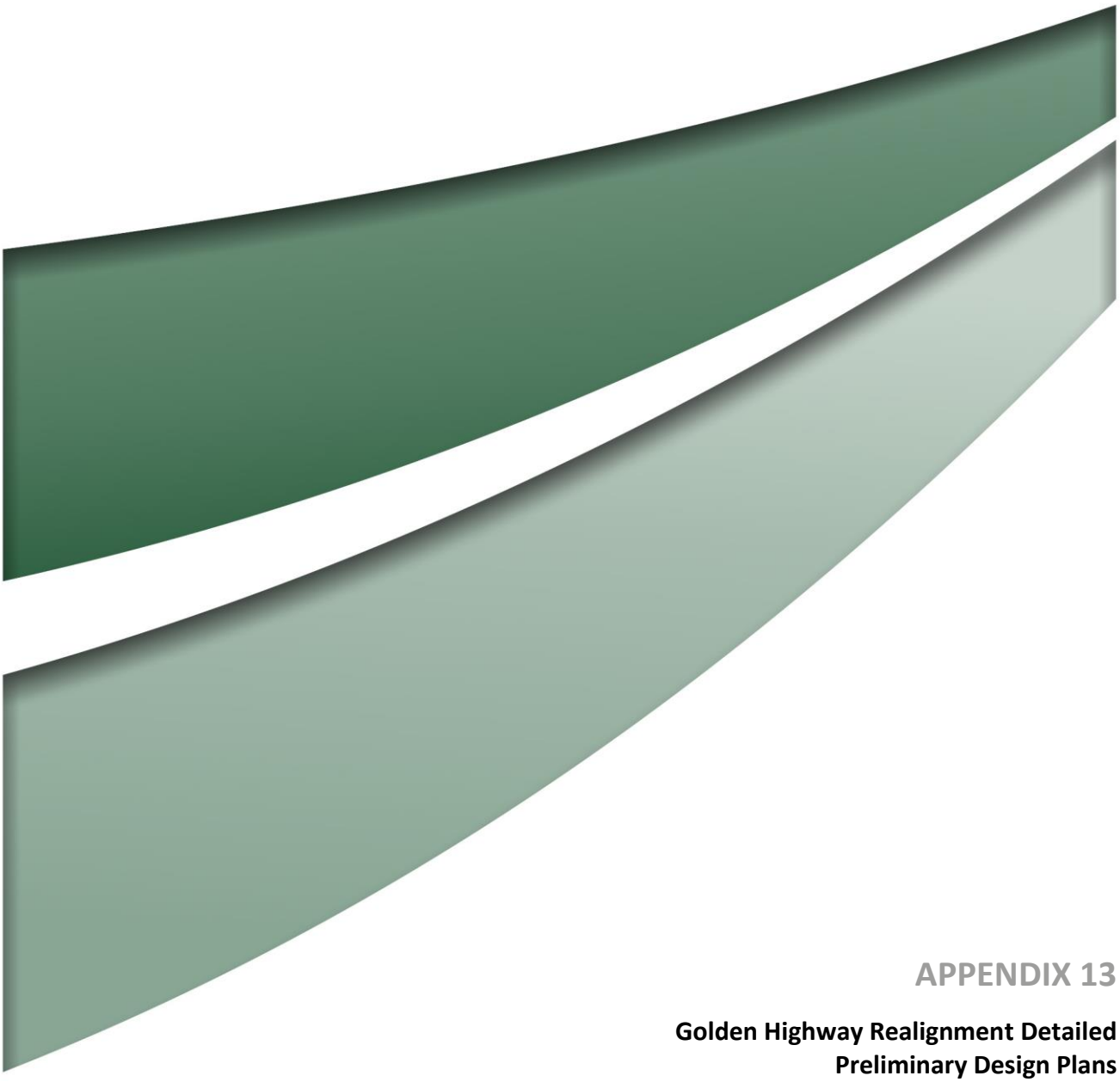
Noted. The majority of Project infrastructure associated with the highway realignment is outside of the flood prone land.

3. **If the flood levee and highway diversions are to be constructed at different times the impact of each in isolation should be modelled in addition to the final form of the development.**

OEH's suggested approach to separate modelling scenarios is noted. This request would only be relevant to the parts of these infrastructure components that are located in flood prone land.

4. Detailed design of outlet works for flood diversion channels is to include appropriate energy dissipation to protect natural waterways from erosion.

There are no flood diversion channels proposed as part of the Project. Therefore this proposed condition is not considered necessary.



APPENDIX 13

Golden Highway Realignment Detailed Preliminary Design Plans

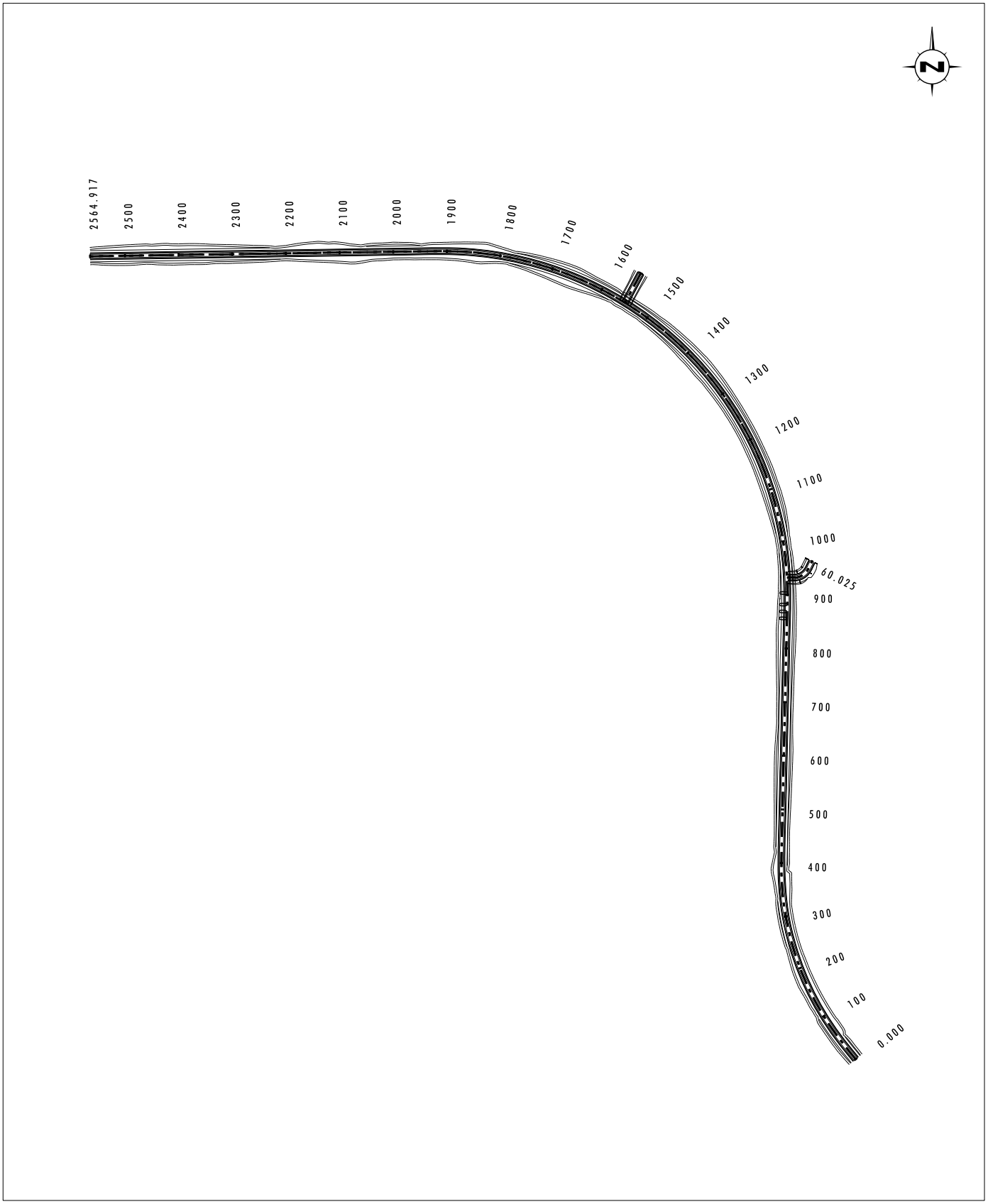


Image Source: Image Source: Nearmap (Nov 2016)
Data Source: Glencore (2017)

0 100 250 500m
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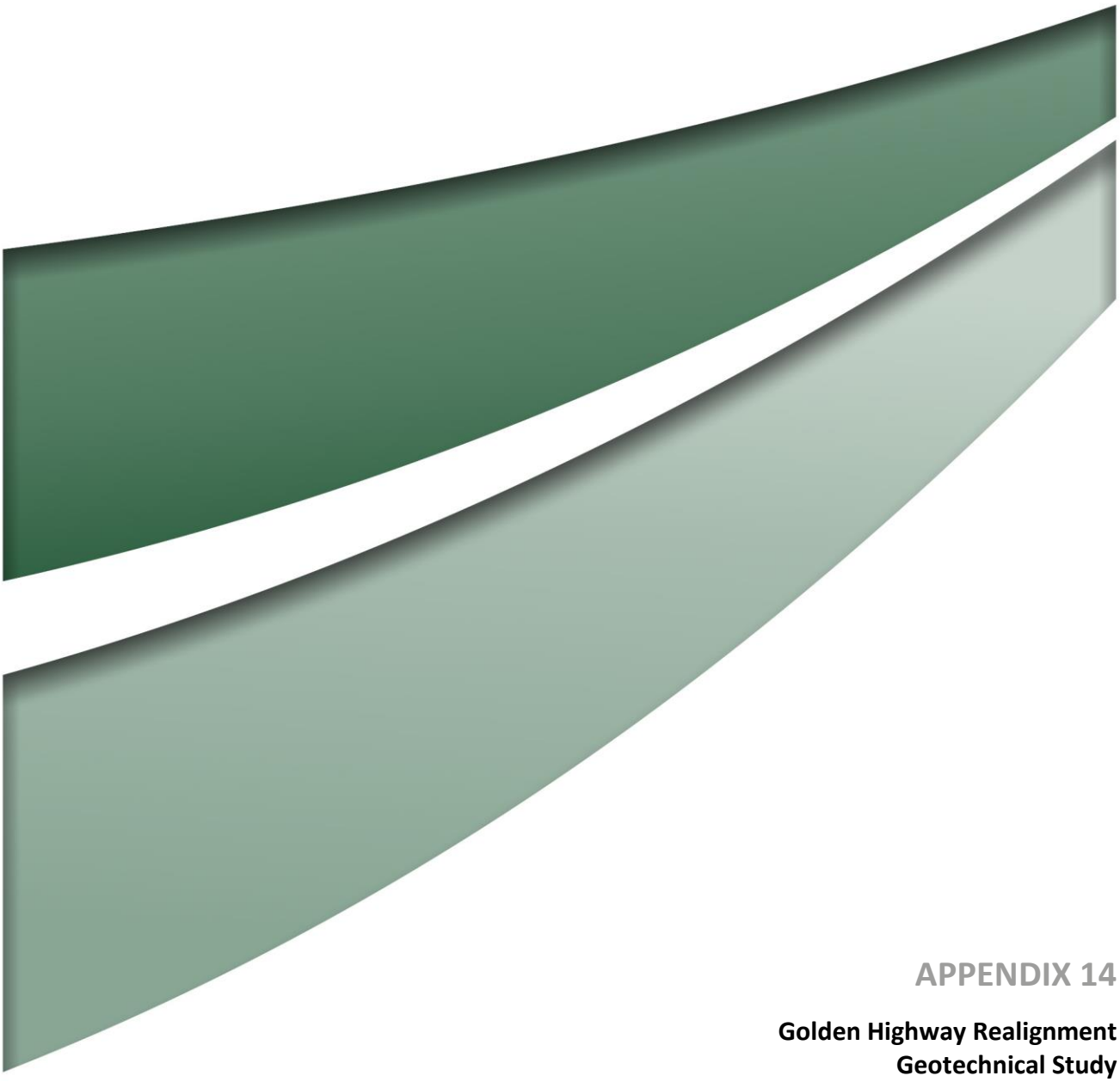
Legend

— - Proposed Golden Highway Realignment

FIGURE 1

Golden Highway Realignment
Detailed Preliminary Design Plan



APPENDIX 14

Golden Highway Realignment
Geotechnical Study

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Our ref: PSM1448-141R

14 March 2017

United Collieries Pty Ltd
134 Jerry's Plains Road
WARKWORTH NSW 2330

ATTENTION: Gary Wills (via email: Gary.Wills@glencore.com.au)

Dear Gary,

RE: STABILITY OF THE ROCK PILLAR BENEATH THE GOLDEN HIGHWAY

We are pleased to submit our report for the stability of the rock pillar beneath the Golden Highway.

We trust this report is in keeping with your requirements. Please do not hesitate to contact the undersigned should you require further assistance on this matter.

For and on behalf of
PELLS SULLIVAN MEYNINK

TIM SULLIVAN

Distribution: pdf copy emailed to United Collieries
Original held by PSM

United Collieries Pty Ltd

STABILITY OF THE ROCK PILLAR BENEATH THE GOLDEN HIGHWAY

GEOTECHNICAL STUDY

PSM1448-141R REV 1 March 2017

EXECUTIVE SUMMARY

This report presents the results of a detailed investigation and analysis of the stability of the rock pillar under the Golden Highway. The evaluation has been completed in a number of stages over the past six years. At the outset it was inferred that that major adverse structures would intersect the Rock Pillar beneath the Golden Highway to the north and east of the United Pit. Concerns were expressed about the stability but despite a detailed geotechnical investigation, those inferred structures would not be identified.

However, because of the importance of the infrastructure and the gaps and uncertainties a further detailed geotechnical investigation was undertaken to better determine the locations, orientations and characteristics of any adverse structures in the rock pillar. A focussed rigorous investigation and validation process was developed and then followed to interpret and validate the structural geology. Although some structures were identified in the area of the United Pit, these were much more favourable and with flatter dips than the adverse structures that were initially inferred. Furthermore, no similar fault structures were identified in the planned slopes of the Montrose Pit.

Slope stability analyses for failures impacting on the Golden Highway were then undertaken using conservative parameters. Despite this, the analyses still produced FOS values in excess 1.5 at the Golden Highway. A sensitivity analysis was then also undertaken and demonstrated that all FOS values are more likely to the closer to or greater than 2. These results indicate that pit slope failures will not impact on the Golden Highway.

However, notwithstanding this study a rigorous pit slope management program is required during mining. This will include depressurisation drilling, pore pressure monitoring, pit slope deformation monitoring and ongoing assessment of the structural geology. This is a fundamental part of the risk management strategy for the planned mining.

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1 INTRODUCTION

United Collieries Pty Ltd (United) is planning for future open cut mining of two separate pits as part of the Wambo United Project. Both pits will mine to within 150 m of the Golden Highway which is owned by Roads and Maritime Services (RMS).

At the request of United a geotechnical and hydrogeological study has been prepared to assess the stability of the rock pillar beneath the Golden Highway. Stability studies for open pit mining have been in progress since 2010 and this report is a compilation and update of studies related to the stability of the Golden Highway.

The aims and focus for the assessment of the stability of the rock pillar under the Golden Highway are to:

1. Review the proposed mine development.
2. Develop detailed geotechnical and hydrogeological models of the area.
3. Identify and address any potential risks associated with this project.
4. Assess the stability of the rock pillar.
5. Assess pit wall depressurisation requirements.
6. Document the analysis results.
7. Provide recommendations as appropriate.
8. Identify risk mitigation strategies and approaches to be incorporated into the Ground Management Plans for the planned mining.

This report only deals with the proposed pit slopes immediately adjacent to the Golden Highway. The stability of other pit slopes has been addressed and documented in other reports.

2 SCOPE OF WORKS THIS STUDY

The purpose of this report is to provide a consolidated document that details the investigations and stability analyses for the rock pillar and Golden Highway immediately adjacent the proposed United and Montrose Pits.

The scope of works for this study has comprised the following:

1. Review and summarise the history of geotechnical and hydrogeological studies for the United project, detailing the rigour applied for derivation of the geotechnical models.
2. Document the current geotechnical and hydrogeological models for the rock pillar and the Golden Highway.
3. Document the results from stability analyses.
4. Discuss the nature of the assumptions and document any conservative elements used for the stability assessments.
5. Demonstrate the impact on the FOS of any conservative assumptions.
6. Evaluate any potential impacts on the Golden Highway.
7. Detail recommendations for ongoing pit slope management prior to and throughout mining.

3 PLANNED MINING

3.1 Open Pits

Two separate mining areas are planned, the Montrose and the United Pits. Figure 1 shows the designs for each pit, noting that:

- A single design was investigated for the Montrose Pit; and
- Two designs were investigated for the United Pit:
  - Design A which is shown in the Project Environmental Impact Statement and requires the Golden Highway to be relocated.
  - Design B which was the original design and did not require the Golden Highway to be relocated.

The United Pit will extract coal down to the Vaux Seams, whilst the Montrose Pit will extract coal down to the Warkworth Seams, Figure 2. The pits will each have a maximum depth of around 250 m.

Staged pit and in-pit dump designs for years between 2019 and 2039 are shown for the Design A in Figures 3 and 4. Staged pit and dump designs for years between 2019 and 2029 are shown for the Design B in Figures 5 and 6. When comparing these designs the following points are noted:

1. The United Pit will be initially developed in the south-east, then advance to the north-west, and then to the west.
2. Design A for the United Pit has a considerably larger footprint and extends further west than Design B, providing a longer mine life.
3. The Montrose Pit will be initially developed in the north-west before advancing towards the south-east.
4. The Montrose Pit has the same footprint for both designs, but extends deeper for Design A.
5. Final pit walls adjacent to the Golden Highway will be formed progressively as both pits advance.
6. Pits will be progressively backfilled as they advance utilising in-pit dumping.

The United Pit has been designed using 75° bench faces angles up to 50 m high. Shallower bench face angles of 45° have been adopted above Woodlands Hill Seam which was partially extracted by underground mining (Figure 7). The Montrose pit has also been designed using 75° bench faces angles up to 50 m high. Unlike the United Pit, reduced batter faces angles have not been adopted above the Woodlands Hill Seam in the Montrose Pit, as the Woodlands Hill Seam was not mined in this area.

3.2 Dumps

Both in-pit and ex-pit dumping is planned. The ex-pit dumps are located mainly to the south and south-west of the planned pits and are not of concern for the stability of the rock pillar.

In-pit dumping activities will progressively backfill the void left by mining and advance at roughly the same rate as the mining faces (Figure 3 to 6). The progressive backfilling means that:

- Effective pit sizes at any given time are much less than the total planned pit;
- The in-pit dumps will serve as a buttress for the rock pillar,
- The potential exposure of the Golden Highway to any stability hazards will move progressively to the north northwest; and
- Any possible zones of pit wall movement and or instability will be at least in part forced to be three dimensional in plan.

3.3 Existing and Planned Infrastructure

The existing and planned infrastructure comprises, Figure 1:

- Golden Highway in the current and realigned location,
- 330 kV powerlines and
- 66 kV powerlines.

Design A and B both entail re-locating the 330 kV powerline from the current alignment through the middle of the United Pit.

The Riverview Pit, which is owned by Coal and Allied, has also been excavated on the northern side of the Golden Highway, directly north of the proposed United Pit (Figure 1). This pit was excavated down to the floor of the Bowfield Seam, with the final pit crest approximately 50m from the Golden Highway in some locations. It is understood that no major stability issues were encountered during the mining of this pit.

Furthermore a number of smaller pits, termed the "Glider Pits", are planned to the east of the Riverview Pit in the immediate area where realignment of the Golden Highway is proposed. The current status, designs and timing surrounding the development of these pits is unknown.

3.4 Underground Workings

The proposed United Pit will be impacted by previous underground mining of the Woodlands Hill Seam. Various methods were employed in the underground from 1992 until the mine's closure in 2010, including bord and pillar, cut and flit, pillar extraction and longwall methods. The location of the various underground workings means that, Figure 7:

- The United workings only extend beneath the southern and western pit slopes;

- There are no underground workings beneath the rock pillar or the Golden Highway;
- There are no workings beneath the Montrose Pit and
- The Lemington Underground workings, which extracted the Mt Arthur Seam, are located to the east of the Golden Highway.

4 PREVIOUS STUDIES

4.1 Introduction

A number of geotechnical and hydrogeological studies for various pit developments have been undertaken since 2010. The principal documents relevant to the Golden Highway are:

1. Assessment of Rock Pillar Stability Golden Highway, [Report] PSM1448-R1, 3rd May 2010.
2. Rock Pillar Stability and Pit Stability, United Pit, [Report] PSM1448-110R, 9th February 2011.
3. Wambo United Project Geotechnical Study [Report] PSM1448-136R, 22nd June 2016.
4. United Pit Drainage Requirements [Memorandum] PSM1448-139M, 23rd March 2016.

Other studies have also been undertaken to assess the effects of subsidence from underground mining, and the stability of pit slopes not in the vicinity of the Golden Highway. These other studies are not included because they are not relevant to stability of the Golden Highway.

4.2 Assessment of Rock Pillar Golden Highway (PSM1448.R1)

The Pre-Feasibility study in 2010, Report PSM1448.R1, was focussed on providing information to assist with a planned swap/sale of mining leases and land north of the Golden Highway. United planned to develop an open pit on the south western side of the highway and to sell the land on the north eastern side of the highway to Coal and Allied (CNA) who also planned to develop an open pit.

This meant the Golden Highway and related infrastructure corridors would sit on top of rock pillar and this report addressed the pillar stability. The pillar was quite wide and greater than 350m at the Woodland Hill Coal Seam level. However the future mining, post the sale to CNA, was uncertain and the final use of the pit was also uncertain and considerations needed to include backfilling with tailings.

Based on local anecdotal understanding and data from within the United Pit, seven thrust faults were interpreted by the geological consultants. Some of these faults extended into the area of the rock pillar. All the faults were interpreted as dipping to the southwest at angles between 10 and 40 degrees.

In order to confirm the fault models and to evaluate gaps or uncertainties a thorough review of the available data was undertaken. The methodology followed a rigorous process commencing with the basic factual data, progressing through development of models and the evaluation of stability. Initially the Acoustic Televiewer Data (ATV) together with the logs, core photos, cross sections and fault trend lines were used to construct 3D models in order to try and confirm the fault orientations and positions.

This process showed there were some gaps and uncertainties in the data and interpretations. There was insufficient technical data and rigor in the original fault interpretations to provide sound geotechnical models for analysis. The review process indicated much flatter dipping faults than in the model.

Because the study was only at Pre-Feasibility Level, associated with the sale/swap process and because of the gaps and uncertainties in the data; it was decided to undertake a parametric analysis using a range of hypothetical models. These hypothetical models included a very wide range of potential failure paths and represented worst case scenarios.

The stability was assessed for a range of assumed fault geometries, a range of assumed fault locations, a range of assumed failure depths and a range of assumed groundwater conditions. A conservative approach was taken in these analyses. These analyses showed that under adverse groundwater conditions and assumed adverse fault geometries the slope may be unstable. It was demonstrated however that adequate stability could be achieved using long horizontal drains to control groundwater pressures together with an in-situ buttress formed by a step-in at the toe above the Vaux Seam.

Overall this study did not identify any major reason why the sale/swap should not proceed.

While these analyses were considered adequate for planning purposes a more rigorous structural, geotechnical and groundwater model of the area was required for detailed design. The main recommendations were for more detailed investigations and testing to:

1. Further characterise the location, extent, orientation and characteristics of the fault(s) and other major defects.
2. Further characterise the location, extent, orientation and characteristics of the other low strength planes, bedding plane shears and tuffs.
3. Provide hydrogeological information.

For the detailed investigation, it was recommended that six to nine boreholes be drilled along two to three section lines through the rock pillar, so that correlations could be made along the section lines using new and existing borehole data. It was recommended that the new bore holes should have a full suite of geophysical logs, ATV logging and multipoint vibrating wire piezometers installed.

4.3 Rock Pillar and Pit Stability Report (PSM1448-110R)

A new design pit design was proposed by United in 2011. The study for this pit commenced with a review of all available geological and drilling information comprising, Figure 8:

- Seven fully cored holes,
- Stratigraphic logs for 85 boreholes,
- Core photos from 37 boreholes,
- Downhole geophysical surveys for 69 boreholes and
- ATV logs for 26 boreholes.

Borehole locations are shown on Figure 8.

A thorough data and interpretation validation process was developed as part of this study and formed the basis for the geotechnical models. This process had two streams; interpretation and validation. The steps undertaken to formulate the geotechnical model (interpretation) comprised:

1. Identification of probable major structures in core photos. This evaluation focussed on faults, bedding plane shears and shears; and was based on different confidence levels in the interpretations (high, medium and low reliability).
2. Detailed field inspection of rock cores from ten of these boreholes. This was used to calibrate and validate the core photo review.
3. Increasing the confidence level and confirming these structures by using the ATV and geophysics to validate the structure type and determine the orientation. It should be noted that different confidence levels remained even after this analysis.
4. Plotting of these structures in their 3D spatial locations.
5. Interpolating structures between adjacent boreholes using major structures with the highest confidence levels to create structure planes. Once a structural plane was created, this plane was extrapolated to the next closest borehole to try and confirm the structure. In general confirmation of the presence of a large-scale structure required at least five boreholes.
6. The extrapolation and checking process continued until the limit of the project area was reached, or until the process encountered a borehole showing no structure at the depth range within the interpretation window. In this case the core photos, ATV and bore logs were reviewed again. If no structures were found, then the large-scale structure was deemed to terminate before the borehole.
7. Once the complete extent of a large-scale structure was determined, the fault plane geometry was generated using actual borehole coordinates with an overall dip and dip direction determined by examining the fault plane in its entirety.
8. The orientations of these large scale structures were then checked using the mapping from the underground. Mapping data was obtained from Longwalls 1 to 8 and 10.
9. Identification of the location of three tuff bands from bore logs, and plotting of these tuff bands in 3D space and incorporation into the 3D model.
10. Assigning shear strength parameters for faults based on laboratory testing, literature and experience.
11. Collation and interpretation of the piezometer readings from all piezometers. From these the groundwater flow direction and depth profile was determined, which was the "baseline" reference case.

During this structural interpretation process it was recognised that different confidence levels resulted and a thorough data validation process was also formulated. This data validation process was undertaken in two stages during the model formulation:

- Firstly, in the initial step, to calibrate all forms of data with one another (core photos, geophysics, ATV and visual assessment); and
- Secondly, during the interpolation of structures between boreholes, in order to review and identify any structures that had not been identified previously in individual borehole at the specific target depths.

The validation steps comprised:

1. Inspection of actual rock cores in the field after the initial identification in core photos.
2. Review of ATV for these holes and determination of the orientation of those structures confirmed in the field.
3. Comparison with the downhole geophysical logging, to confirm the signatures of significant structures. These signatures included:
   (a) Confirming no change in the density traces, which showed b) and c) were not due to a change in lithology;
   (b) Increased borehole size from the caliper logs (either from the geophysics or interpreted using travel time data); and or
   (c) Different gamma traces signifying a different mineralogy;
4. In this process it was recognised these "signatures" may not be unique to faults, for example an increased caliper is also associated with tuff and siderite bands. However it was found that a combination of all three "signatures", coupled with the positive identification of structures in core photos in nearly all cases gave strong evidence that a fault was present at that location.
5. Checking whether this process missed anything, using the ATV and geophysics, for example faults in coal.
6. Plotting of the data downhole, then plotting on sections and the using the same signature recognition process to investigate the surrounding holes.

The interpretation and validation process including the initial field core inspections, logging, core photograph structure identification and ATV correlation was all undertaken by Tim Sullivan who is Principal Engineering Geologist with PSM with more than 35 years' experience.

The resulting geotechnical model comprised:

1. A shallow weathering profile about 6.5 to 23 m below the ground surface.
2. The bedding was confirmed to be flat, approximately 2 to 3 degrees to the southwest.
3. A number of tuff layers and bedding shears parallel to bedding were identified. However these tuff layers were generally intact and not sheared.
4. Sub-vertical normal faults, striking northeast and approximately orthogonal to bedding.

5. Seven flat dipping faults, interpreted as "thrust faults", which dip to the southwest at angles between 5 and 25 degrees, which is significantly lower than previous interpretations.

The stability was then analysed for a combination of failure mechanisms, materials strengths and groundwater conditions. These analyses showed that under adverse groundwater conditions and assumed adverse fault geometries some parts of the pit wall may be unstable. It was demonstrated however that adequate stability could be achieved for the proposed design using 100 m long horizontal drains to control groundwater pressures.

However as noted in the report these analyses were conservative given that:

- The interpreted fault structures were modelled to be continuous, planar, and at residual strength and with no cohesion;
- The tuffs units were assumed to be pre-sheared and at residual strength;
- Conservative strengths were assumed for the rockmass;
- Where sub-vertical faults comprised part of the failure path, they were modelled to have no shear strength (modelled as tension crack), and be planar, vertically and vertically continuous for up to 40m;
- Dewatering assumed the groundwater table was hydrostatic, even though monitoring of piezometers adjacent to Longwall 10 indicated the pore pressure was less than hydrostatic; and
- Stability analyses used 2-D models only and did not include any 3-D buttressing effects from in pit dumping which will be favourable for stability.

Parametric studies showed that if higher rock strengths were considered, shorter horizontal drain lengths could be used and achieve adequate stability.

4.4 Wambo United Project Geotechnical Study (PSM1448-136R)

In November 2014 United and Peabody Energy entered into a 50:50 joint venture (United-Wambo JV) to enable development of their neighbouring deposits as a single operation. Subsequent updates to the mine plans were made and a further geotechnical assessment of the updated designs was undertaken. The aim of this study was to ensure that geotechnical and hydrogeological risks associated with the proposed developments were clearly identified and adequately addressed.

The significant changes or modifications since earlier studies include:

1. The mine plan now included the Montrose Pit (formerly owned by Peabody).
2. The crest of the Montrose Pit is within 150 m of the Golden Highway.
3. Two designs were investigated for the United Pit.
4. One of the designs for the United Pit will require that the Golden Highway to be relocated to the northeast.
5. United will be responsible for mine development and managing the joint venture.

6. Peabody will be in charge of tailings disposal into mined out voids, but United will be responsible for dumping over them.
7. Various ex-pit waste dumps are proposed to the south of the both pits.

Additional data supplied for this study included:

- Updated pit designs for the Montrose and United Pits;
- Topographic contours from 2015, including the Riverview pit void;
- Updated roof and floor surfaces for the coal seams;
- Underground void models for the United and Lemington underground mines;
- Borehole logs, ATV logs and core photos for the Montrose pit area;
- Updated piezometer data for Piezometers;
- Stage plans for 2019, 2023 and 2039;
- Proposed and current locations for the Golden Highway and powerlines; and
- Mapping data showing fault and dyke locations obtained from the nearby Riverview and Wambo pits.

The piezometer information was used to update the hydrogeological model, Figure 9. The new model showed that:

1. Pressures heads around the Montrose Pit were reduced and generally between 80 and 100% of the hydrostatic pressure.
2. The hydrogeological regime surrounding the United Pit is more complex than the Montrose Pit, due to the interaction with the United and Lemington underground workings to the south and east, and the Riverview Pit to the north.
3. Pressure heads through the Rock Pillar were reduced and on average approximately around 80% of hydrostatic.
4. The phreatic surface is generally located 15 to 30 m below surface through the Rock Pillar.

This new model is favourable for stability because it confirms that depressurisation of the rock mass will be possible with drainage measures.

The geotechnical structural model was adopted for analysis of the United Pit rock pillar. This model was derived using the rigorous interpretation/validation process described above for the PSM1448-110R study. Review of the data for the Montrose Pit only identified potential faulting in one drill hole, at a depth below the final pit floor. Consequently, no thrust faults were modelled in the area of the Montrose Pit. Review of the new structural data from Riverview and Wambo showed that normal faults and dykes have a dominant structural orientation striking to the north northeast, and a less dominant orientations striking to the northwest. Tuff bands were also updated in the geotechnical models based on the locations of new roof and floor data for the coal seams.

The assumed shear strength parameters for the various materials were based on:

- Lower-bound residual shear strengths for the tuff bands (c'=0 kPa and ϕ'=13°);
- Residual shear strengths for the bedding defects, coal seams and fault planes based on laboratory testing (c'=0 kPa and ϕ'=22°);
- Downgraded UCS values for the rockmass shear strengths based on laboratory testing; and
- Lower UCS values for the near-surface weathered rock.

Stability analyses were undertaken for a range of potential failure mechanisms and demonstrated that:

1. For the northern and eastern slopes of the United Pit beneath the Rock Pillar:
   a) Stability will be controlled by the moderate and shallow dipping thrust faults;
   b) Depressurisation of the rockmass in these slopes is required to achieve adequate stability;
   c) Potential large-scale slope failures will not impact on the proposed powerline easements and the Golden Highway; and
   d) Minor in-pit slope design modifications were required in two areas.
2. For the Montrose Pit:
   a) Large-scale slope stability will be controlled by basal shearing along weak tuff bands,
   b) The available data indicates that no major faults will daylight in the final pit walls;
   c) Stability will depend on mining-induced drawdown of the groundwater table.
   d) For the expected groundwater conditions, the analyses indicate that the current designs will provide adequate stability and do not require modification; and
   e) Potential large-scale slope failures will not impact on the Golden Highway to the north of the pit.

Despite the slope stability assessments indicating that large-scale slope stability will be adequate a pit slope management program was recommended for ongoing mining as a fundamental part of the mining operations.

4.5 United Pit Drainage Requirements (PSM1448-139M)

United would prefer to not have ancillary equipment operating within the open pit and hence questions were raised regarding depressurisation of faults which intersect the rock pillar. Hence the planned drains will be pre-drilled from outside the pit crest using standard directional drilling techniques. The exact details of this drilling will need to be determined during mining based on the actual structures exposed in the pit wall.

However, three faults were identified in the geotechnical structural model as potential stability risks to the north and east walls. These faults are N1, C and A, and are the same as those included in previous reports. Areas where these faults dip out of the wall at angles greater than approximately 10 degrees were identified as significant risk areas.

Consequently for mine planning and costing United requested that an estimate of the number, length and location of dewatering drains. It was recommended that 44 direction drill holes be drilled, from 7 different sites. Each drain should be drilled towards the pit to daylight in the pit wall and aligned approximately sub-parallel to the structure dip, to drain the rock above each fault plane.

4.6 Summary of Overall Approach to Rock Pillar Stability in Previous Studies

In summary a very careful approach to the assessment of the stability of the rock pillar and Golden Highway has been adopted from the commencement of the studies in 2010, comprising:

- Geotechnical studies commenced on the assumption that major adverse structures were present in the Rock Pillar;
- A careful study of the facts established these structures could not be found;
- However because of the importance of the infrastructure and the gaps and uncertainties a further detailed geotechnical investigation was undertaken;
- A focussed rigorous investigation and validation process was developed and followed;
- Some structures were identified but not the major adverse structures originally thought to be present. However, even the evidence for these "structures" was equivocal;
- Notwithstanding this, the structures were assumed to be present and continuous, even where only limited evidence was available in support;
- Rigorous stability analyses were then carried out for a comprehensive range of possible failure mechanisms involving these structures;
- The assumed strength parameters in the analyses were conservative, with residual friction angles, zero cohesion and lower bound estimates; and
- Despite adopting this conservative approach, the analyses show high, conventional, civil factors of safety (greater than 1.5) can be achieved for instabilities which might impact directly on the Golden Highway.

5 GEOTECHNICAL MODEL

5.1 Geological Model

Coal seams which comprise the deposit belong to the Jerry's Planes Subgroup contained within the Permian aged Whittingham Coal Measures. The basal seam of the Jerry's Plane Subgroup is the Bayswater Seam. This Seam is underlain by the Archerfield Sandstone (Figure 2) which is well-known regional lithology unit.

Open cut mining in the United Pit will extract coal from the Whybrow Seam, extending down to and including the Vaux Seams. Parts of the Woodlands Hill Seam, to be exposed in the final southern wall, have already been extracted by underground mining activities (Figure 7). Although none of these workings are in the area of the rock pillar.

Open cut mining in the Montrose Pit will extract coal from the Whybrow Seam, extending down to the Whynot Seam in the shallower areas of the pit (Figure 1). In the northern, deeper part of the Montrose Pit immediately south of the Golden Highway, open cut mining will extend down to and extract the Warkworth Seam. It is understood that this deeper area will only be mined if United proceed with Design A.

Typical coal measure rocks, including interbedded sandstones, siltstones, and to a lesser extent, claystones and conglomerates, will comprise the overburden units which separate the coal seams in both pits.

The modelled base of weathering in the United Pit extends to a depth of approximately 15 m depth at the eastern end of the pit, and down to approximately 25 m depth at the western end. The modelled base of weathering in the Montrose Pit is generally less than 25 m below surface.

Bedding dips across the deposit are flat and generally between 2° and 5° towards the south south-west. Some localised variation may be expected, particularly around geological structures. Faulting and igneous intrusions of varying displacements, thickness and continuity have been interpreted from a number of data sources, and will intersect the final pit walls. More discussion on key geological structures is presented in a later section.

5.2 Hydrogeological Model

The locations of existing piezometers used to interpret the local hydrogeology are presented in Figure 9. Multiple VWPs were installed into each borehole, generally within, or within close proximity to major coal seams. Recorded pore pressure measurements, and their interpretations, are included in Appendix A.

For the Montrose Pit, UG166A is the nearest borehole to the Golden Highway which contains VWPs. Figure A1 shows that pressures heads in this borehole have decreased slightly since the instruments were installed. Figure A2 shows that the phreatic surface is approximately 40 m below surface, and pressures are 77% of the hydrostatic pressure.

The hydrogeological regime surrounding the United Pit and within the Rock Pillar is more complex than that surrounding the Montrose Pit. This is due to the interaction with the United and Lemington underground workings to the south and east, and the interaction with the Riverview Pit to the North (Figure 9).

Transient pressure heads for the United Pit VWPs can be seen in Figures A3, A4 and A5, whilst interpretation of the most recent pressure heads are provided in Figures A6, A7 and A8. From the head profiles it is clear that pressure distributions in the rock pillar are generally non-linear and less than hydrostatic. This is likely due to the influence of the Woodlands Hill and Mt Arthur Seams, which were extracted by undergrounding mining at United and Lemington.

A summary of the pore pressure interpretations for the United Pit is provided in Table 5.1 and are summarised below;

1. For each VWP cluster the phreatic surface is located at an average depth of 20 to 25 m below the surface.
2. The phreatic surface is at a depth of 88 m in borehole UG147, and much deeper than the phreatic surface interpreted in VWP clusters 1, 2 and 3. This is likely due to the close proximity of borehole UG147 to the United underground workings in Woodlands Hill Seam.
3. Pressure distributions in all boreholes were interpreted to be less than 90% of the hydrostatic pressure.
4. The average pressure distributions in VWP clusters 1 and 2 were calculated to be 78% of the hydrostatic pressure.
5. The average pressure distribution in VWP cluster 3 was higher, and on average, 84% of the hydrostatic pressure. This was despite VWP cluster 3 being located closer to the Lemington and United Underground workings (Figure 9), and is perhaps indicative that the Riverview Pit has assisted with dewatering around VWP clusters 1 and 2.

Piezometer data from boreholes UG134, P33, P34 and P35 have not been analysed as no new data was provided.

TABLE 5.1
SUMMARY OF VWP PORE PRESSURE DATA FOR THE UNITED PIT

HOLE ID	COLLAR RL	PHREATIC SURFACE		% HYDROSTATIC PRESSURE	VWP CLUSTER	PHREATIC SURFACE		% HYDROSTATIC PRESSURE
		RL OF (M)	DEPTH TO (M)			RL OF (M)	DEPTH TO (M)	
UG147	108	20	88	81%	N/A	N/A	N/A	N/A
UG194	81.66	68	13.66	72%	1	59	22.5	78%
UG196	81	59	22	75%				
UG220	81.98	50	31.98	88%				
UG225	68.9	46	22.9	83%	2	49	25.5	78%
UG136	72.9	40	32.9	79%				
UG200	70.66	50	20.66	75%				
UG201	68.78	60	8.78	75%				
UG224	58.83	45	13.83	85%	3	39.25	21	84%
UG193	58.21	38	20.21	86%				
UG192R	58.85	30	28.85	84%				
UG133	62.566	44	18.566	80%				

5.3 Structural Model

5.3.1 General Conditions

The general ground conditions around the site may be summarised as:

1. A shallow weathering profile below the surface, of about 5 to 25 m depth.
2. Bedding dipping southwest at shallow angles (~ 2° to 5°).
3. The stratigraphy consists of multiple coal seams up to about 10 m thick, separated by various thicknesses of predominately Sandstone, Siltstone, Claystone, Conglomerate and minor Tuff.
4. The rocks are high strength and massive to broadly jointed.
5. Seven interpreted faults, probably thrust faults, dipping at flat to moderate angles to the southwest within the United pit area.
6. Sub-vertical normal faults with a general north-northeast strike.

5.3.2 United Pit Thrust Faults

Seven thrust faults have been identified within the United Pit area using a highly rigorous assessment of all the data. Detailed discussions on the identification and interpretation of these faults are provided in PSM1448-110R and are not reproduced here.

The general orientations of the interpreted thrust faults are listed in Table 5.2. Their intersections with the United Pit and possible surface intercepts are presented in Figure 10 and Figure 11.

TABLE 5.2
OVERALL FAULT ORIENTATIONS

FAULT NUMBER	DIP (DEGREES)	DIP DIRECTION (DEGREES)
A	8.7	222
C	12.5	211
D	7.5	209
E	17	206
N1	11	237
N6	4.6	144
N7	24	234

5.3.3 Montrose Pit Thrust Faults

No thrust faults have been modelled for the Montrose pit. A detailed review of available data was undertaken which included interpretation and assessment of ATV logs and core photographs.

Four ATV logs were interpreted by PSM have been included in Appendix B. The locations of boreholes are presented in Figure 3. A number of cross sections with downhole interpretations and selected lithological units are presented in Appendix C.

The characterisation of faulting from the borehole imaging surveys consisted of the following steps and processes described above for the previous studies.

From the borehole imaging, potential faulting was only identified in one drill hole, UG237A, in the Montrose Pit area. Since this faulting was below the final pit floor (Appendix C), the fault is not expected to intersect the final pit wall. As such no thrust faults were modelled for the Montrose Pit.

5.3.4 Normal Faults

Results from geological mapping of the underground indicate that normal faults are sub-vertical and strike approximately north-south and east-west, Appendix D.

A number of large scale structures have also been identified in the area from various sources including;

- Underground mapping,
- Open pit exposures,
- Borehole data and
- Aerial surveys.

As shown in Figure D2 this data suggests that normal faults have a dominant structural orientation striking to the north-northeast. A less dominant structural orientation is seen to strike northwest.

Importantly, Figure D2 shows there are no known faults that are sub parallel to the pit wall, between the pit crest and the Golden Highway. As such, fault plans are not expected to form laterally extensive release planes in the rock pillar, and the inclusion of a tension crack formed by these structures is conservative. The potential for sub vertical faults has been captured in stability models by including 30m deep tension cracks.

5.3.5 Dykes

A number of dykes have also been mapped in the area, and their locations are shown in Figure D2. In addition to these known dyke locations, additional dykes may also be uncovered elsewhere in the deposit given that some dolerite has been intercepted in a number of drill cores (see for example the borehole imaging cross sections in Appendix C).

Much like the faults, the dykes tend to be sub vertical, except in coal seams where they may "sill-out" and extend horizontally. Local experience with similar dyke structures suggests that:

- The dykes are composed of dolerite, which can degrade on exposure to a very low strength material;
- Structures are often continuous and may provide a structural weakness for minor local kinematic failures such as toppling; and
- Particularly large/wide dyke structures may cause localised steepening and rotation of the bedding.

Much like the normal faults discussed above, the dykes may also provide a structural weakness for larger scale failure. Tension cracks have therefore been included in all slope stability models. This approach is considered conservative, given the structural information in Figure D2, which shows there are no known dykes that are sub parallel to the pit walls adjacent to the Golden Highway.

5.3.6 Tuff

Three major tuff bands occur in the area:

- "Millbrodale Tuff", located above the Glen Munro seam, approx. 0.5 m thick;
- Tuff located above the Warkworth seam, approx. 0.5 m thick; and
- "Fairford Claystone", located above the Mt Arthur seam, approx. 1.0 m thick.

Inspection of these tuff materials in core photos and geophysics was undertaken as part of PSM1448-110R. From these inspections the tuff bands indicated little evidence of shearing or displacement. Nonetheless, the tuff bands have been assumed to have lower-bound strength in slope stability models, and this approach is considered to be conservative.

5.4 Rockmass Model

5.4.1 Direct Shear Testing

Results from laboratory direct shear testing were reported in PSM1448-110R and are summarised in Table 5.3 below.

Six direct shear test results were available for analysis. All samples were planar and clean bedding partings (with no infilling) from sandstone, siltstone and claystone lithologies. The samples were loaded to peak (until the bedding parting failed), then allowed to continue to displace until the residual state was reached. Residual strengths are reported in Table 5.3.

The log-mean residual strength of all testing is:

- Cohesion 5 kPa and
- Friction angle 21.6°.

TABLE 5.3
LAB REPORTED RESULTS FROM DIRECT SHEAR TESTING

SAMPLE DETAILS	ROCK TYPE	COHESION (kPa)	FRICTION ANGLE (°)
UG193, 167.9m	Claystone	0	17
UG193, 176.3m	Claystone	-20	20.2
UG196, 23.28m	Sandstone/Siltstone	45	21.5
UG196, 73.11m	Siltstone	0	24
UG196, 100.17m	Siltstone	8	28.7
UG200, 113.3m	Sandstone/Siltstone	38	20.1

5.4.2 Structure Shear Strengths

Table 5.4 presents the shear strength parameters adopted for the stability analyses.

The strength for the faults is based on the log-mean average of residual shear strengths from direct shear testing, with zero cohesion assumed.

Tuff shear strengths were based on lower-bound estimates of residual strengths from empirical local evidence and testing. Sheared tuff units at residual state were not observed, and the adopted parameters are considered to be a "worst case" scenario.

The coal units were also given a lower bound residual strengths assuming that significant movements had already occurred along the contacts. Again, this is considered to be conservative.

TABLE 5.4
MATERIAL STRENGTHS USED FOR ANALYSIS

UNIT	COHESION (kPa)	FRICTION ANGLE (°)
Fault (residual)	0	22
Tuff (residual)	0	13
Coal (residual)	0	20

5.4.3 Unconfined Compressive Strength Testing

Results from laboratory testing of 105 UCS samples were made available for this study. A summary of the reported lithologies and reported test results are presented in Table 5.5.

Further analyses were conducted on the UCS values reported for the sandstone, siltstone and mixed siltstone/sandstone lithology groups. These lithologies are expected to comprise most of the rockmass exposed in the final pit slopes. The data which is presented in Figure E1 illustrates that each group has a very similar distribution of UCS. When grouped together, the mean UCS of all three groups was found to be 73 MPa.

Of note however was that all UCS samples from United were collected at depths typically ranging between 150 and 400 m (Figure E1). When compared with shallower UCS data from Mt Owen, it was apparent that UCS values appear to increase as a function of depth. Because the United and Montrose Pits will only extend to 250 m depth, assuming UCS values based on specimens samples from depth between 150 to 400 m may therefore overestimate the mean UCS values in the final pit walls.

As such the value corresponding to the 25th percentile was adopted as the UCS value for the interburden in the United and Montrose pits. This is shown in the cumulative distribution plot to be equal to 50 MPa.

TABLE 5.5
UCS TESTING RESULTS

LITHOLOGY	LITHOLOGY GROUPING	UCS TEST RESULTS (MPa)			
		NUMBER	LOW	HIGH	MEAN
Basalt		2	131.8	154.1	143
Claystone		14	14	59.6	38
Sandstone / Claystone		13	6.74	61.7	37
Siltstone / Claystone		1	----	----	25.1
Conglomerate		2	40.9	57.4	49
Sandstone	Sandstones	11	36.1	154.3	67
Sandstone (cg)		5	65.2	137.4	98
Sandstone (fg)		11	20.2	151.7	74
Sandstone (mg)		6	5.17	80.3	56
Siltstone	Siltstones	12	21.3	135.3	71
Sandstone / Siltstone	Siltstone / Sandstone	10	28.2	93.4	63
Siltstone / Sandstone		8	60.3	106.8	84
Tuff		3	35.2	64.9	54
Coal		7	2.2	44.3	15
TOTAL		**105**	**2.2**	**154.3**	**60**

5.4.4 Triaxial Testing

Twenty-four triaxial tests results were available for samples collected from United Colliery. Shear strength interpretations for different lithology groups are shown in Appendix E. Results for each group are summarised in Table 5.6 below.

Although these shear strength interpretations pertain to intact rock, and will therefore overestimate "rockmass" strengths, they do provide a useful reference against which rockmass shear strengths estimates may be validated.

TABLE 5.6
INTERPRETED RESULTS FROM TRIAXIAL TESTING

LITHOLOGY GROUPING	LOWER BOUND		UPPER BOUND	
	COHESION (MPa)	FRICTION ANGLE (°)	COHESION (MPa)	FRICTION ANGLE (°)
Claystones	0.55	43	1.94	59
Sandstones/siltstones	0.48	51	2.27	69
Sandstones	3.63	46	4.82	66
Siltstones	1.08	50	1.82	67

5.4.5 Rockmass Shear Strengths

Rockmass shear strengths were derived for weathered and fresh interburden using RocLab and the Generalised Hoek-Brown (GHB) Failure Criterion. This included the following assumptions:

1. The fresh interburden was assumed to have a UCS of 50 MPa based on previously discussed results from UCS testing (see Appendix E). No UCS data was available for the weathered interburden which is expected at shallow depths. The UCS was therefore assumed to be 25 MPa and equal to half that of the fresh interburden. Weathered rockmass is not expected to impact on large-scale stability.
2. An m_i value of 10 was assumed for weathered and fresh domains. This value was calculated by inputting the triaxial results into RocLab. The calculated values are very close to the value of 9:6 which is reported by Reference 1 for siltstones.
3. A GSI of 62 was assumed for the fresh rock based on UCS test results, visual inspection of the core photos, and limited geotechnical logging. No core was available for the near-surface weathered material. Experience has therefore been used to infer conditions for the weathered rock. This included downgrading of the UCS, RQD, joint spacing and defect conditions to derive a GSI value of 48. Assessment of the GSI for each domain can be found in Appendix F.
4. Two blast disturbance factors (D) were used for each rockmass domain. This was done in accordance with recommendations from Reference 2 which states that:

   > *"The most important point in relation to the estimation of the extent of blast damage is that the blast damage factor D should NOT be applied to the entire rock mass surrounding the excavation"* and that *"The thickness of the blast damaged zone [beyond the slope face] will depend upon the design of the blast".*

   Based on recommendations in Reference 2 and the expected site conditions, it was assumed that rockmass within 30 m of the slope face has a D value of 0.85, whilst rockmass greater than 30 m from the face has a D value of 0.

Division of the fresh and weathered rockmass into blast disturbed and undisturbed zones resulted in the definition of four rockmass domains. A summary of the GHB input parameters adopted for each domain are listed in Table 5.7. Slope stability modelling made use of the curved GHB Failure envelopes shown in Appendix F. Equivalent Mohr-Coulomb parameters are reported in Table 5.8 simply for reference.

TABLE 5.7
INPUT PARAMETER FOR THE HOEK-BROWN FAILURE CRITERIA

ROCKMASS DOMAIN	UCS (MPa)	GSI	M_I	D
Weathered Rock (disturbed)	25	48	10	0.85
Weathered Rock (undisturbed)	25	48	10	0
Fresh Rock (disturbed)	50	62	10	0.85
Fresh Rock (undisturbed)	50	62	10	0

TABLE 5.8
EQUIVALENT MOHR-COULOMB PARAMETERS FOR ROCKMASS STRENGTHS

ROCKMASS DOMAIN	AT 0.5 MPA OF NORMAL STRESS		AT 3 MPA OF NORMAL STRESS	
	COHESION (MPA)	FRICTION ANGLE (°)	COHESION (MPA)	FRICTION ANGLE (°)
Weathered Rock (disturbed)	0.20	41	0.84	23
Weathered Rock (Undisturbed)	0.32	53	1.20	36
Fresh Rock (disturbed)	0.47	53	1.34	38
Fresh Rock (Undisturbed)	0.80	60	1.82	47

6 STABILITY ANALYSES

6.1 Introduction

The stability analyses detailed in the following section were undertaken as part of PSM1448-136R. The following sections only detail the analysis of the pit slopes immediately adjacent to the Golden Highway. The stability of other pit slopes, away from the Golden Highway are not relevant to this study.

6.2 Potential Failure Mechanisms

A 3-dimensional model of the study area was created to investigate the potential for the interpreted faults impacting the integrity of the pit walls, powerline easements and highway corridor.

6.2.1 United Pit

For the United Pit three potential failure mechanisms have been identified:

1. Planar sliding on a low-angle thrust fault that daylights in the pit wall.

   A few faults that daylight the pit wall were identified (Figure 10), however, very few of these faults also daylight at the surface within the Golden Highway pillar.

2. Bi-planar failure along a non-daylighting fault and a tuff or coal bed at the base.

3. Bi-planar failure with the backscarp extending through rock mass, a deep tension crack, sub-vertical fault or dyke, and basal sliding along a fault, weak bed or tuff band at the base.

The seven thrust faults described in Section 5.3.2 and the three tuff bands described in Section 5.3.6 were considered in the analysis of the United Pit, along with the updated coal seams and major structures.

6.2.2 Montrose Pit

For the Montrose Pit only mechanism 1, as listed above, has been deemed applicable. This is because the only fault identified in the Montrose Pit area occurs below the pit floor, and will there not daylight in the final pit walls. Hence mechanisms 2 and 3 are not applicable to the Montrose Pit.

However, sliding on the tuff bands overlying the Warkworth and Glen Munro seams has been considered. The Fairford Claystone, overlying the Mt Arthur Seam, is below the pit floor and will not impact on pit wall stability.

6.3 Adopted Groundwater Conditions

6.3.1 United Pit

The mine plan incorporates directional drilling parallel to any significant fault planes in the northern and eastern walls of the United Pit for depressurisation. Slope stability analyses in the United Pit therefore assumed that the rockmass above these faults will be dewatered. The groundwater table was then defined immediately beneath the dewatered fault planes for the deeper seated analyses which considered sliding along the tuff bands.

6.3.2 Montrose Pit

Groundwater conditions for the Montrose Pit were based on VWP data from borehole UG166A (Figure 9). This data suggests that the pre-mining groundwater table is at 100 mRL and that the pore pressure distribution beneath the groundwater table is approximately 80% hydrostatic. The groundwater table was therefore defined at 100 mRL at the edge of model, with expected drawn towards the slope toe.

6.4 Analysis Results for the United Pit

The section locations used for stability analysis of the United Pit are shown Figure 12. The section locations were selected in areas that were deemed to be of the highest risk. The analysis results for each section are included in Appendix G. A summary of the stability analysis results is presented in Table 6.1.

These analyses only relate to the local stability of slopes with no critical failure surfaces extending back to the Golden Highway. Further analysis of possible failure surfaces extending back to the Golden Highway is presented in a later section.

The results show:

1. The inter-ramp scale stability for deep-seated failures due to sliding on faults and tuff bands had FOS greater than 1.2.
2. Low FOS are recorded for planar sliding on faults at two at locations. However these failure surfaces did not extend beyond the crest of the pit, and were localised to a single batter only.
3. A minor redesign was required to increase the FOS at these locations consisting of a 40° blasted softwall to buttress potential sliding masses.
4. The new designs did not change the crest or toe position of the highwall, but only changed the batter berm configuration. (Figure G11).
5. The soft wall designs are only required in two slope sectors (Figure G12).
6. The depressurisation will still be implemented, regardless of the minor design change.
7. It is noted that these results are conservative, and more discussion on this is presented in a later section.

TABLE 6.1
ANALYSIS RESULTS FOR SECTION 1 TO 4 IN THE UNITED PIT

ANALYSIS SECTION	FAILURE MECHANISM	SEE FIGURE	FACTOR OF SAFETY
1	a) Basal shearing along Fault C and tuff band overlying the Mt Arthur Seam. Fault dip is 20°.	G1	1.63
	b) Planar slide along Fault E daylighting in the upper slope face. Fault dip is 22°. Backscarp through tension crack. Note the failure surface does not extend beyond the pit crest.	G2	0.98
	c) As above in 1b, but redesign considering a 40° softwall in upper batter to improve the FOS.	G3	1.23
2	a) Basal shear along Tuff band above Mt Arthur Seam with influence from groundwater modelled at base of fault	G4	1.60
	b) Planar slide along Fault C daylighting in the slope face. Fault dip is Backscarp through tension crack. Note the failure surface does not extend beyond the pit crest.	G5	0.84
	c) As above in 2b, but redesign considering a 40° softwall in upper batter to improve the FOS.	G6	1.26
3	a) Basal shear along Tuff band above Mt Arthur Seam with influence from groundwater modelled at base of fault	G7	1.45
	b) Planar slide along Fault C daylighting in the upper slope face. Fault dip is 11°. Backscarp through tension crack.	G8	1.56
4	a) Basal shearing along Fault N1 and tuff band overlying the Mt Arthur Seam. Fault dip is 13°.	G9	1.70
	b) Planar slide along Fault E daylighting in the upper slope face. Fault dip is 22°. Backscarp through tension crack.	G10	2.20

6.5 Analysis Results for the Montrose Pit

The section locations that were considered for slope stability analysis in the Montrose Pit are shown in Figure 13. These sections did not contain any faults, but contained two tuff bands, above the Glen Munro and Warkworth Seams. The results for XS2 intersecting the Golden Highway are included in Appendix H and summarised in Table 6.2.

TABLE 6.2
ANALYSIS RESULTS FOR THE MONTROSE PIT

GROUNDWATER CONDITION	SEE FIGURE	FACTOR OF SAFETY
Mining induced drawdown	H1	1.40
Dewatered to 100 m from slope	H2	1.75
Completely dewatered (no water table)	H3	1.76

The results show:

1. For all cases the lowest FOS occurred due to sliding along the tuff band above the Warkworth Seams.
2. The mining induced drawdown case gave an adequate FOS value equal to 1.4. This indicates the slopes will remains stable, and is consistent with local experience for similar slope configurations with similar geological conditions.
3. The FOS improved further to 1.75 when the groundwater table was offset by 100m. This simulates the installation of horizontal drains, and demonstrates that these can be implemented during mining to improve stability as required (noting that stability without the drains is already adequate).
4. There was no additional improvement in the FOS when the slope was considered to be completely dewatered. This is because the failure surface was above the water table for the case dewatered to 100 m. Hence additional dewatering did not decrease pore pressures along the critical failure surface.
5. It is noted that these results are considered to be conservative and more discussion on conservatism is presented in a later section.

7 ANALYSIS OF POSSIBLE IMPACT ON GOLDEN HIGHWAY

7.1 Introduction

The potential failure analyses in the preceding sections mainly impacted on the pit wall stability. Figures 14 to 16 show the locations of the planned pit crests in relation to the Golden Highway and the offset distances are summarised in Table 7.1. The stability analysis results are presented in Appendix I and summarised in Table 7.2.

TABLE 7.1
SUMMARY OF OFFSET DISTANCES TO GOLDEN HIGHWAY

PIT	PIT DESIGN	SEE FIGURE	HIGHWAY OFFSET FROM PIT CREST
United	Design B	14	Minimum offset is 160m around XS4. Larger offset of 250m to the north near XS2 and XS3
United	Design A	15	Minimum offset is 200m south of XS4. Larger offset of 250m to the north near XS2 and XS3.
Montrose	Design A & B [1]	16	Minimum offset is 140m to the east of XS2. Geometry and decreasing pit depth is more favourable in this location than at XS2. Offset at XS2 is 150m.

[1] Pit crest location does not change for different mine plans, only the depth changes.

When assessing the stability of mine slopes a FOS of 1.2 is often adopted as the design acceptance criteria. This criterion has been adopted in all the analyses for failure surfaces affecting the pit slopes. However for failure surfaces that may extend back to the Golden Highway a higher FOS of 1.5 has been adopted. This is in accordance with conventional civil design standards.

For the assessment of potential effects on the Golden Highway, Sections 2 and 4 were considered for the United Pit, whilst for the Montrose Pit, only Section 2 was considered. As shown in Figures 14 to 16 these sections are in the locations where the Golden Highway is within 250m of the proposed pit crests.

TABLE 7.2
FOS FOR FAILURE SURFACES EXTENDING BACK TO GOLDEN HIGHWAY

PIT	ANALYSIS SECTION	OFFSET FROM PIT CREST TO GOLDEN HIGHWAY	SEE FIGURE	FACTOR OF SAFETY AT GOLDEN HIGHWAY
United (Design B)	2	250m	I1	2.33
United (Design B)	4	160m	I2	1.93
Montrose	2	150m	I3	1.52

Figure 17 is a summary of the results and shows how the FOS changes as a function of distance from the pit crest. In all cases a FOS greater than 1.5 was achieved for failure surfaces extending back to the Golden Highway.

For the United Pit, stability assessments of the Golden Highway were only undertaken for the Design B design and not Design A. When comparing the two designs in Figures 14 and Figure 15, it is noted that:

1. Design A and B will have the same crest location and slope configuration along the northern slope. Given these same conditions, both designs are expected to have same FOS of 2.33 for failure surfaces extending back to the Golden Highway.
2. For Design B the minimum offset from the Golden Highway will be 160 m (Figure 14), whilst for Design A the minimum offset will be 200 m (Figure 15).
3. A comparison in Figure I4 shows the geology and slope profiles are very similar at XS4 and XS4a, yet there is a greater offset for Design A.
4. It is therefore expected that for failure surfaces extending back to the Golden Highway, the Design A at XS4a will have a higher FOS than Design B at XS4. This is because both slopes have similar slope conditions, yet the Design A at XS4a has a greater offset from the Golden Highway.

The results from this analysis shows that slope instability will not affect the Golden Highway.

8 DISCUSSION ON CONSERVATISM AND SENSITIVITY ANALYSES

8.1 Introduction

The possible presence of thrust faulting in the Rock Pillar has warranted the use of caution during all of the design process. However in evaluating the analysis results it is important to not only recognise the detail and rigor included in that process, but also to understand where a conservative parameters have been adopted and what the impacts of these are.

Although these conservatisms have been addressed in the body of the report it is valuable to list them again here as a precursor to additional sensitivity analyses of some of these factors. The conservative assumptions include:

- The thrust faults have been modelled as continuous, planar and at a residual strength with no cohesion;
- Tuff band shear strengths were based on lower-bound estimates of residual strengths;
- However sheared tuff units at residual state were not observed at the site;
- The coal units were also given a lower bound residual strength parallel to bedding and assumed that significant movements had already occurred along the contacts;
- A 30m deep tension cracks have been included in all slope stability models and that is conservative, given the structural information, which shows there are no known dykes or faults that are sub parallel to the highwalls adjacent to the Golden Highway;
- The underground workings are causing natural depressurisation and less than hydrostatic pore pressures occur throughout the rock pillar;
- This underground induced depressurisation indicates that the rocks are permeable, and will depressurise as excavation progresses;
- When estimating rockmass strengths, a blast disturbance factor of 0.85 was applied to all the rockmass within 30m of the face; and
- Stability analyses were conducted using 2-D models only and did not consider 3-D buttressing effects from in-pit dumping or the in situ highwall.

The analyses detailed below show how the FOS improves if less conservative assumptions are adopted.

8.2 Sensitivity Analysis of Tuff Band Shear Strengths for Montrose Pit

For the Montrose Pit, the FOS for failures surfaces extending back to the Golden Highway was calculated to be 1.52. Figure I3 shows the failure surface extending back to the Golden Highway is controlled by basal shearing along the tuff band in the Warkworth sequence. Tuff band shear strength estimates in this analysis were based on lower-bound estimates of residual shear strengths.

A review of the available core indicates that the tuff bands are reasonably competent, in which case, their strengths are expected to be much higher than used in the previous analyses. Core photographs of the Warkworth tuff band and the Fairford Claystone are shown in Appendix J, demonstrating that the tuff bands have reasonably favourable characteristics. It is also known that due to the high strength and ability to withstand degradation, the Fairford Claystone is crushed and used to the sheet the haul roads in the CNA pits immediately to the north of the United Pit.

Figure 18 show how the FOS varies with increasing angle of friction and cohesion. Even a modest increase in the angle of friction of only 3° increases the FOS from 1.5 to 1.7. Adding cohesion of 100 kPa has a similar magnitude effect.

8.3 Impact of 30 m Deep Tension Crack

The specification of 30m deep tension in crack in both sensitivity analyses is also considered to be conservative, given there are no know structures subparallel to the Golden Highway. As shown in Figure 18, the case with no tension crack increases the FOS by 0.1 to 0.3 depending on the friction angle of the tuff band.

8.4 Summary for Montrose Pit

These sensitivity analyses show that with less conservative assumptions failure surfaces extending back to the Golden Highway near the Montrose Pit are expected to have FOS values nearer to or in excess of 2.

8.5 Sensitivity Analysis of Fault Shear Strengths for United Pit

In the analyses to date the thrust faults have been modelled as continuous, planar and at a residual strength with no cohesion. These shear strengths were based on the residual shear strengths recorded for open bedding defects derived from laboratory-scale, multi-stage, direct-shear testing.

Figure 19 show how the FOS varies with increasing angle of friction and cohesion. Even a modest increase in the angle of friction of only 3° increases the FOS from 1.9 to 2.1. Adding cohesion of 100 kPa has a similar magnitude effect.

8.6 Comments on 3-D Effects

All stability analyses were conducted using 2-D models. This does not account for addition shear resistance mobilised along the side release planes, and implicitly assumes that the section and failure surface are infinitely long, and their geometry does not change along strike. This often leads to conservative FOS values, particularly when the "worst-case" sections are selected for 2-D analysis, as was done for the stability analyses for the United Project.

By adopting the 2-D approach for the stability analyses at United, this has also ignored the favourable buttressing effects that the in-pit waste dumps will have on stability.

Although there will always be a small strike length of unbuttressed highway all the way down to the pit floor at any one time, the lengths are small enough such that they would inhibit the development of large failures capable of extending back to the Golden Highway.

However the other real benefit for stability due to 3-D effects is the ability to map and monitor the pit walls as they advance.

9 ONGOING PIT SLOPE MANAGEMENT

The following are considered as integral parts of the ongoing pit slope management:

1. During mining, the location, orientation and continuity of structural features such as dykes and faults are mapped and then be updated into a 3-D geological model.
2. The effect of any structures or variation of existing structural orientations on pit slope stability is re-assessed as new information is made available.
3. The tuff bands and thrust faults represent key structural features which are expected to govern the stability of the final pit walls. The shear strengths and characteristics of these structures will be better characterised as exposure become available in the highwalls as mining progresses.
4. Depressurisation of the northern and eastern walls of the United Pit is required.
5. Additional groundwater monitoring using VWPs should be installed on the northern and southern walls of the United Pit, and around the Montrose Pit to ensure that sufficient pore pressure reduction is occurring ahead of mining.
6. Pit slope deformation monitoring shall be undertaken in order to determine "normal" pit slope behaviour and assist with early detection of potential slope movements.

For and on behalf of
PELLS SULLIVAN MEYNINK

TIM SULLIVAN

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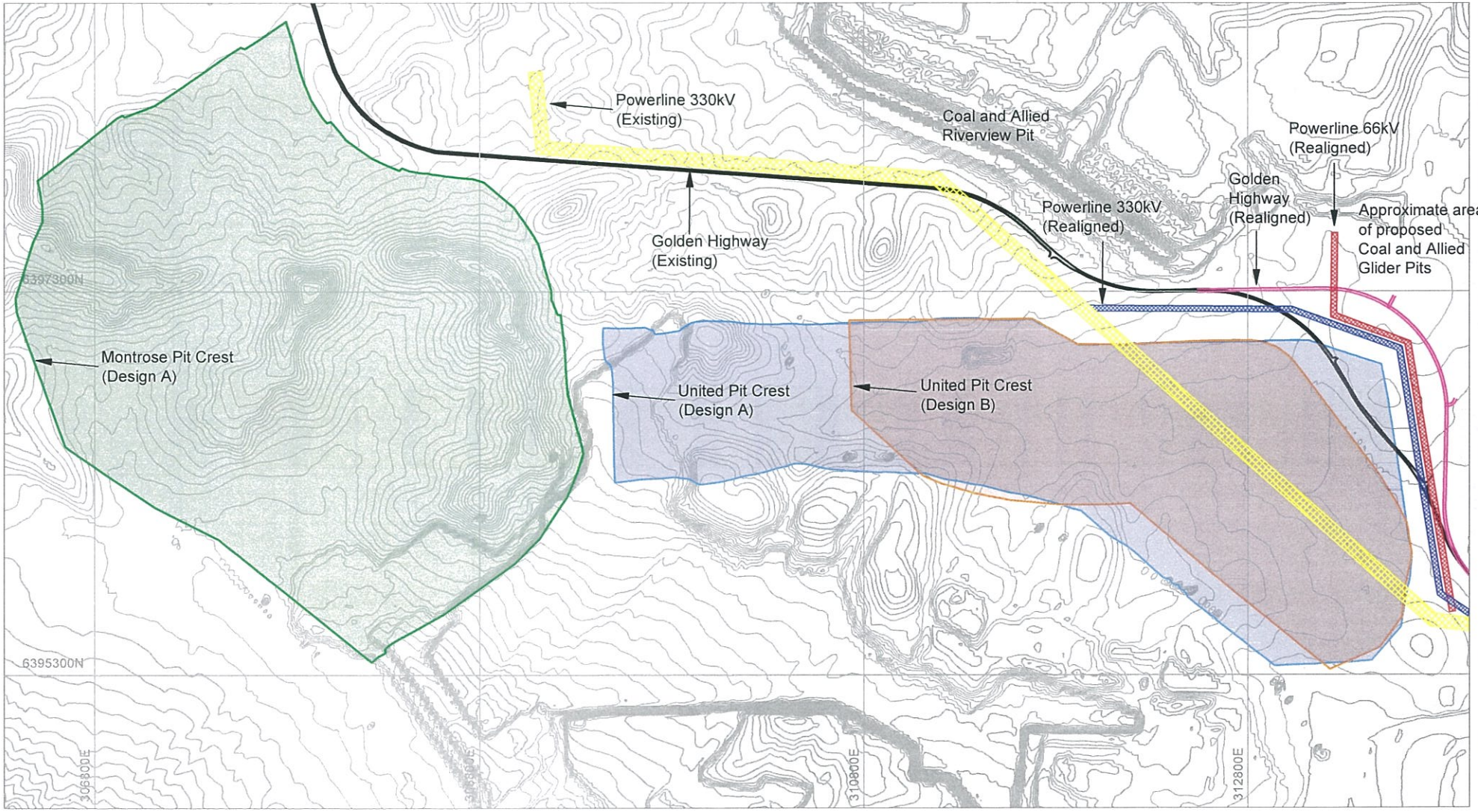
1. Read, J and Stacey, P (2009). Guidelines for open-pit slope design. Published by CRC Press, Taylor & Francis Group.

2. Hoek, E. (2012). Blast damage factor D. Technical note for RocNews, February 2, 2012.



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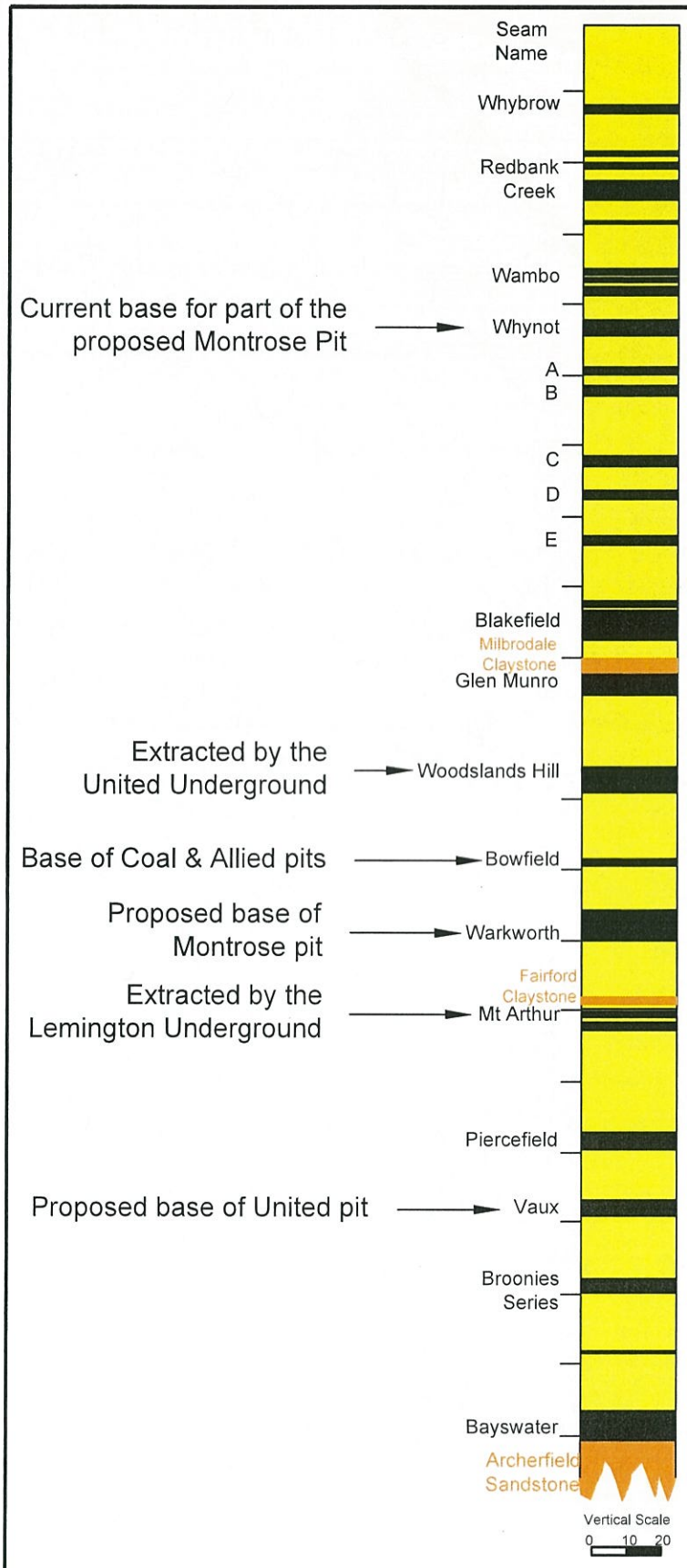
United Collieries
United Wambo Project
Golden Highway

FOOTPRINTS OF THE
UNITED AND MONTROSE PITS

PSM1448-141R | Figure 1



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STRATIGRAPHIC COLUMN
AND MINING HORIZONS

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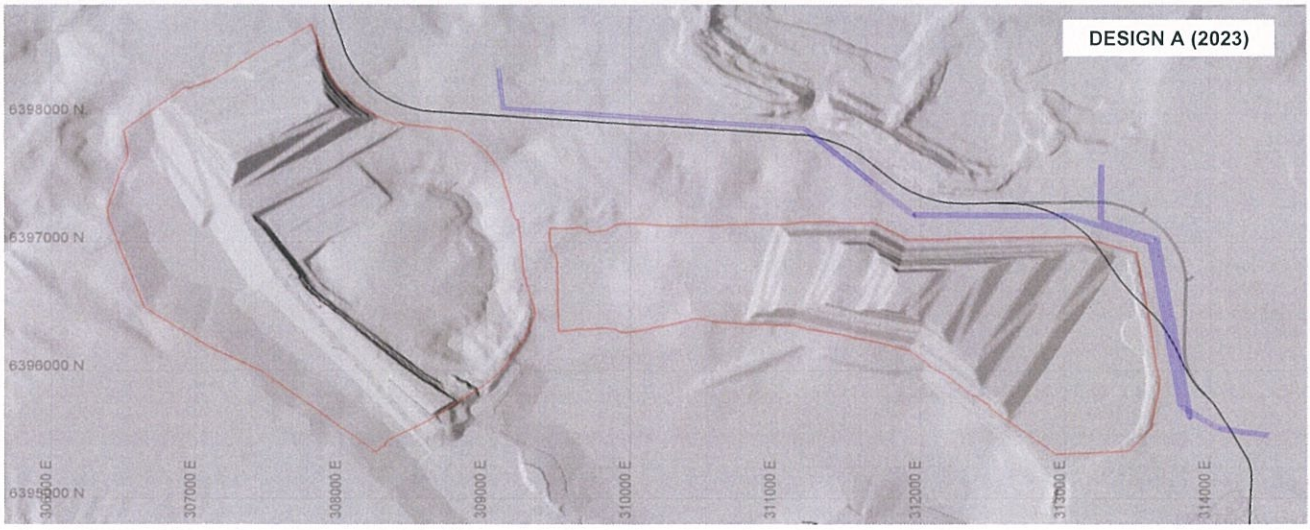
Figure 2



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Golden Highway Rock Pillar Stability

STAGED PIT DESIGNS FOR
DESIGN A (1 OF 2)

PSM1448-141R	Figure 3

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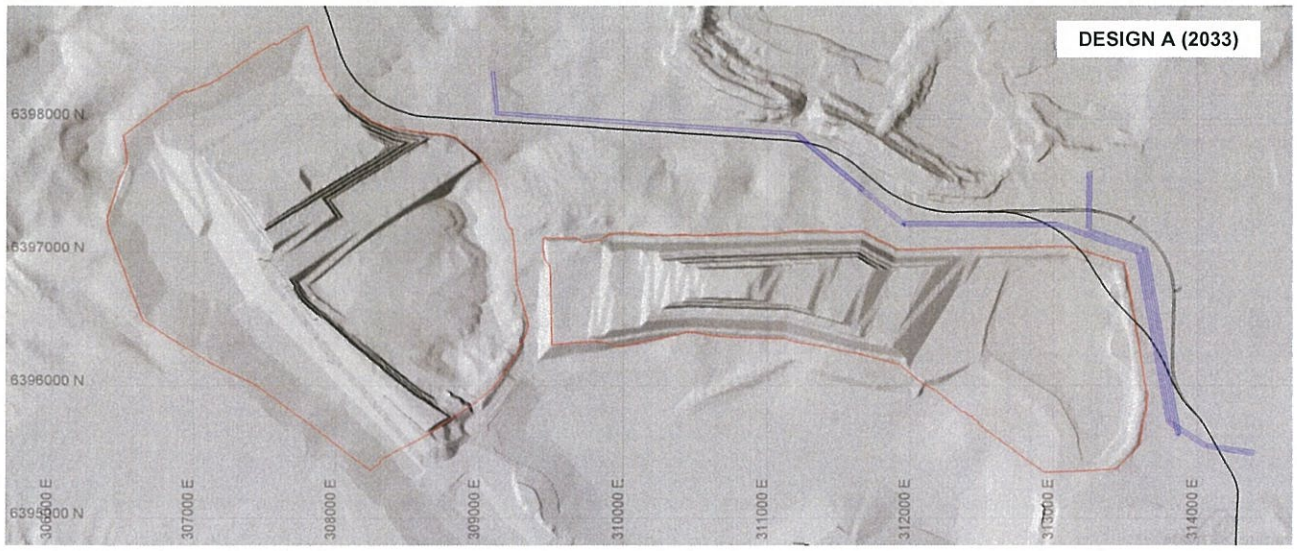

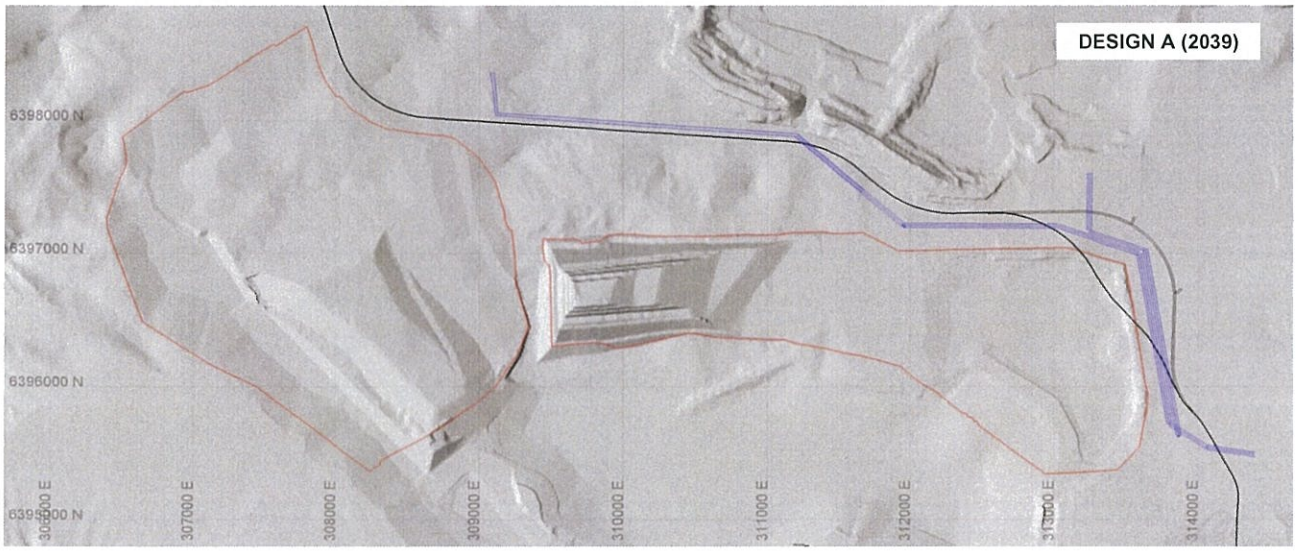

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Golden Highway Rock Pillar Stability

STAGED PIT DESIGNS FOR
DESIGN A (2 OF 2)

PSM1448-141R	Figure 4

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Golden Highway Rock Pillar Stability

STAGED PIT DESIGNS FOR
DESIGN B (1 OF 2)

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PSM1448-141R | Figure 5

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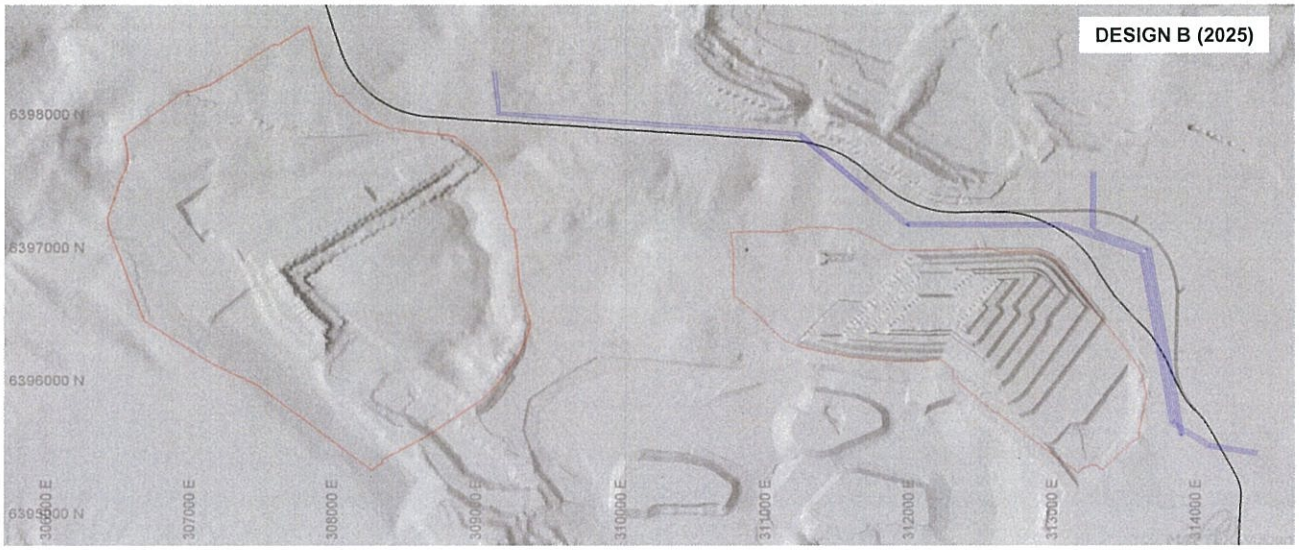

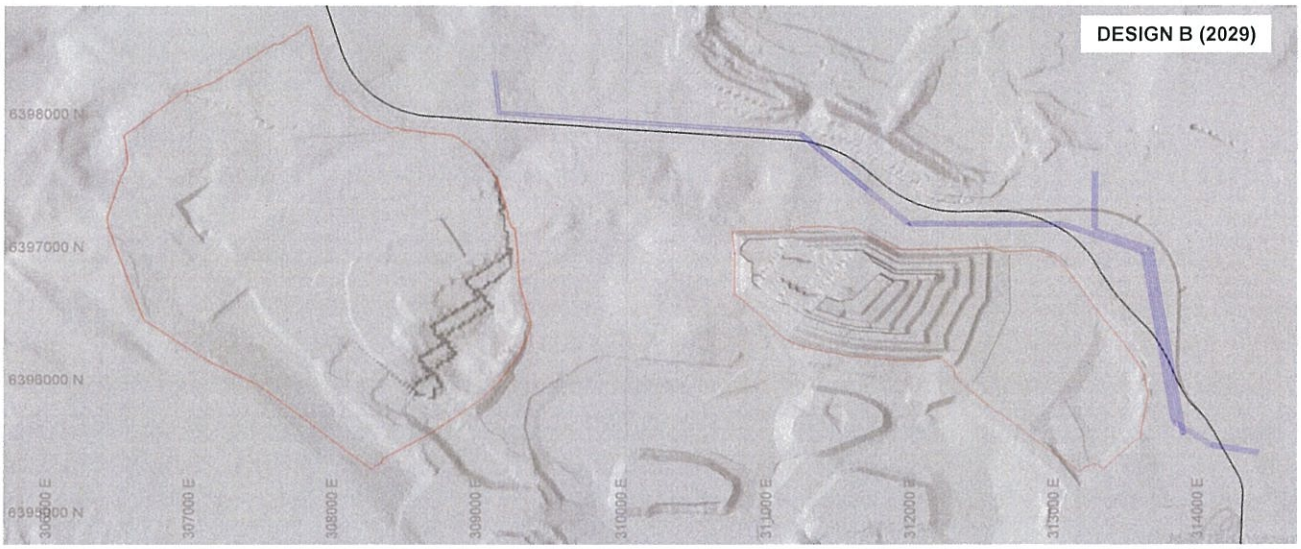

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STAGED PIT DESIGNS FOR
DESIGN B (2 OF 2)

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PSM

PSM1448-141R	Figure 6

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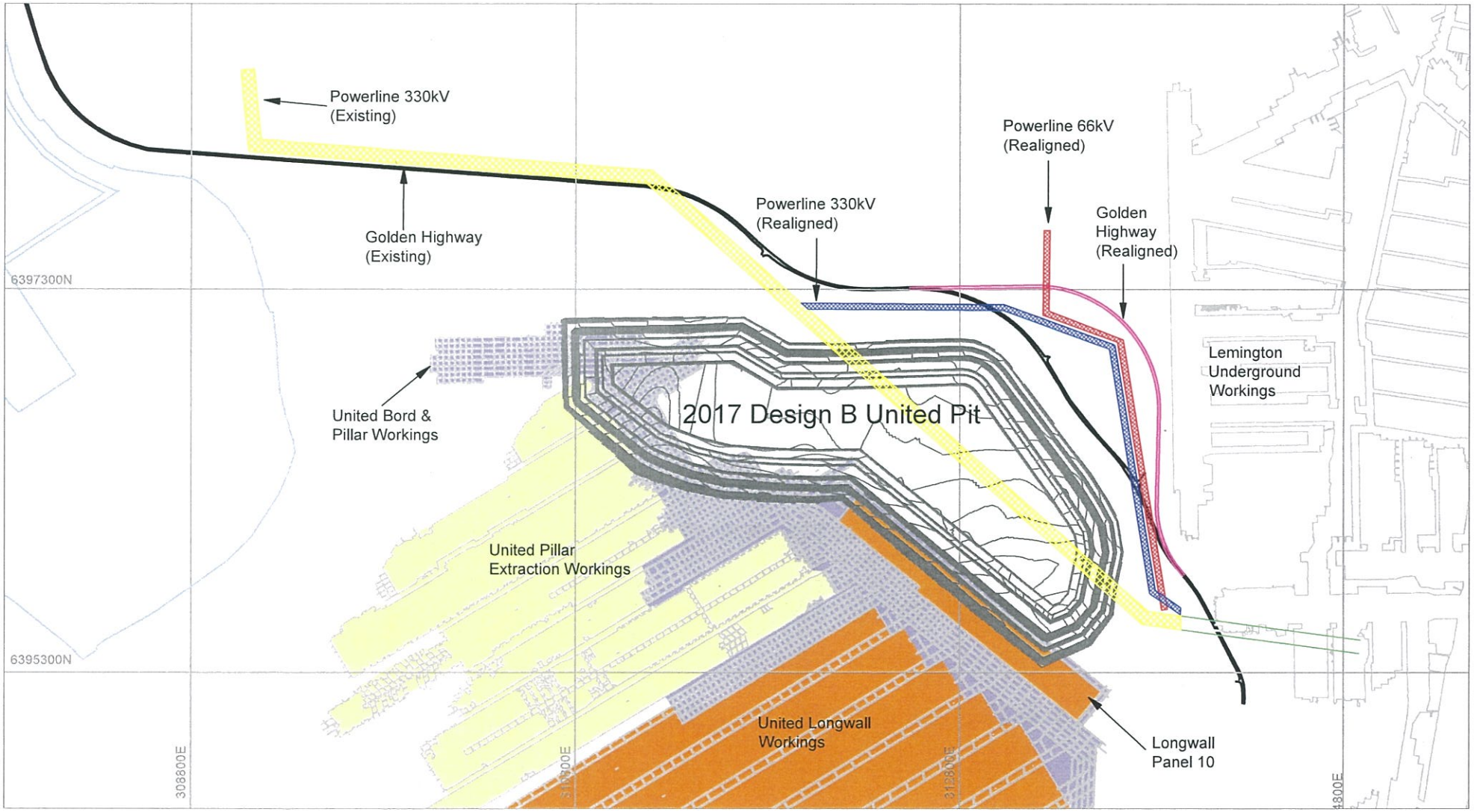

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Scale (m)

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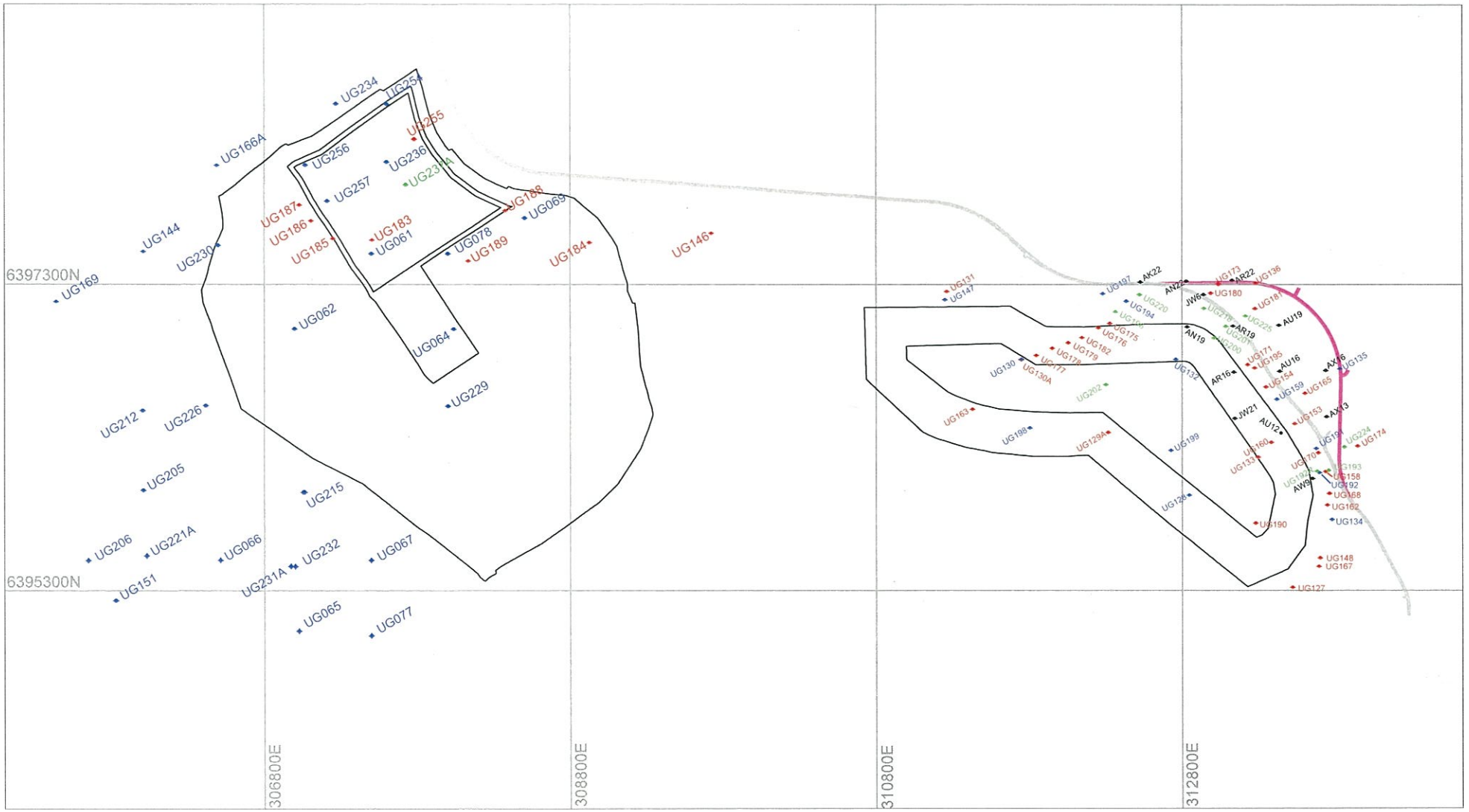
United Collieries
United Wambo Project
Golden Highway

LOCATION OF UNDERGROUND WORKINGS
IN RELATION TO PROPOSED UNITED PIT

PSM1448-141R | Figure 7



LEGEND

- Borehole with ATV Data + Identified Thrust Faulting
- Borehole with ATV Data
- Borehole with no ATV Data
- Borehole with only Geological Logs

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Scale (m)

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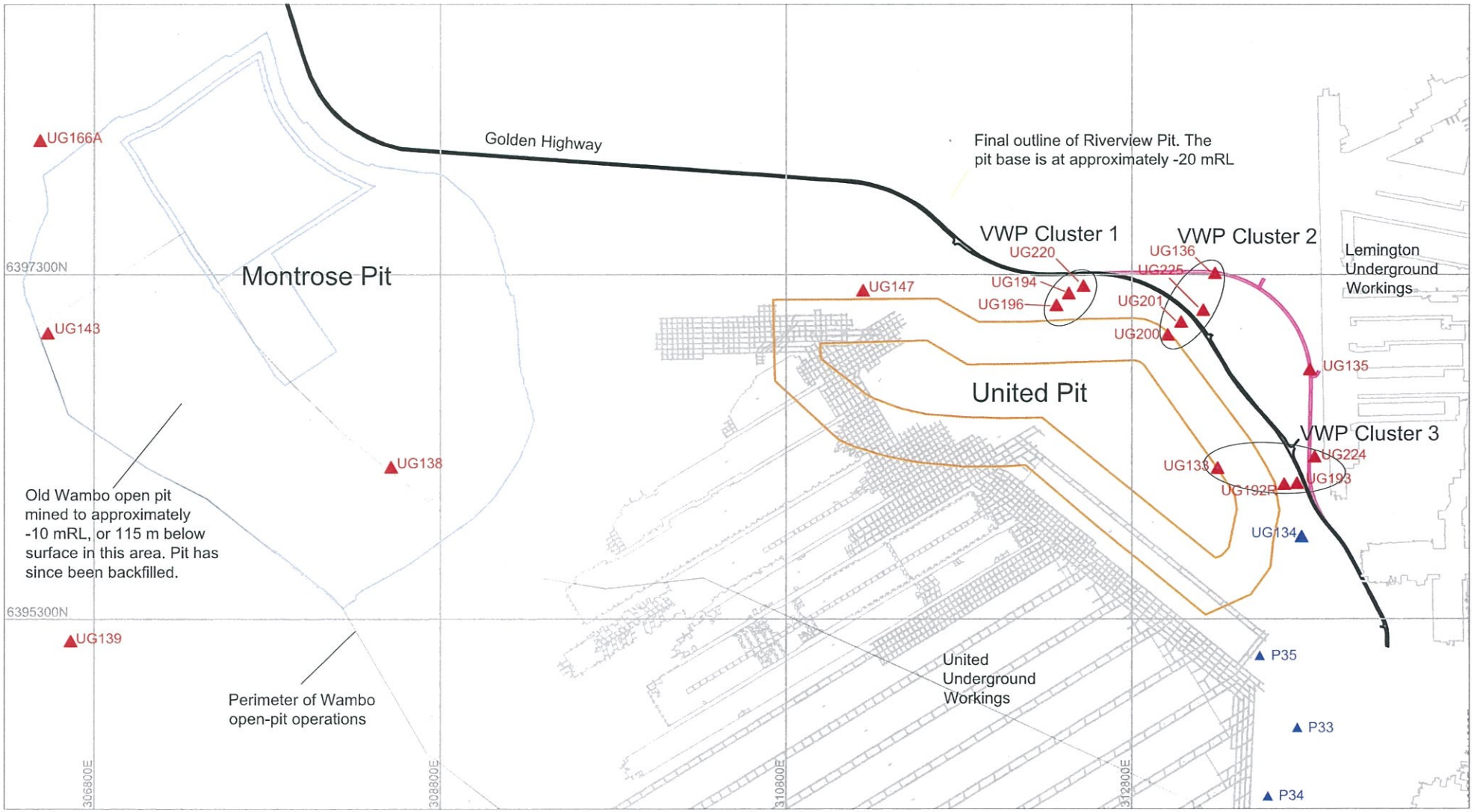
Golden Highway

BOREHOLE LOCATIONS

PSM1448-141R | Figure 8



LEGEND

- Underground workings
- VWP - New data supplied by Glencore (16 Nov 2015)
- VWP - No new data obtained

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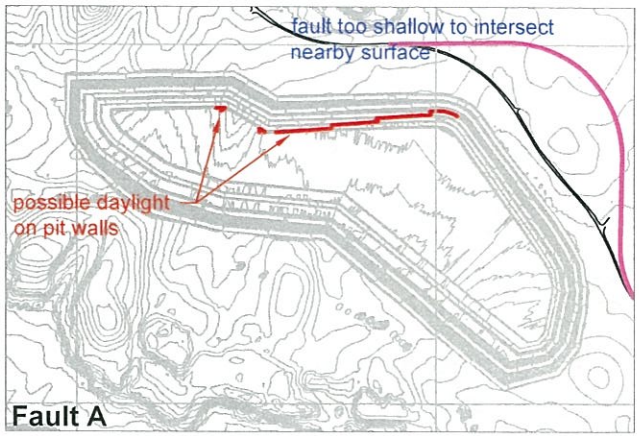
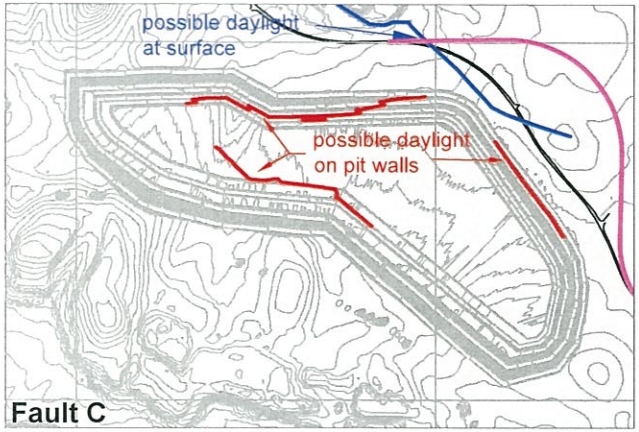
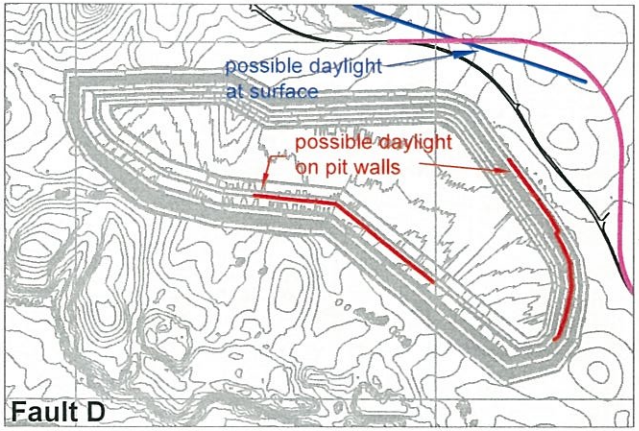
United Wambo Project
Golden Highway

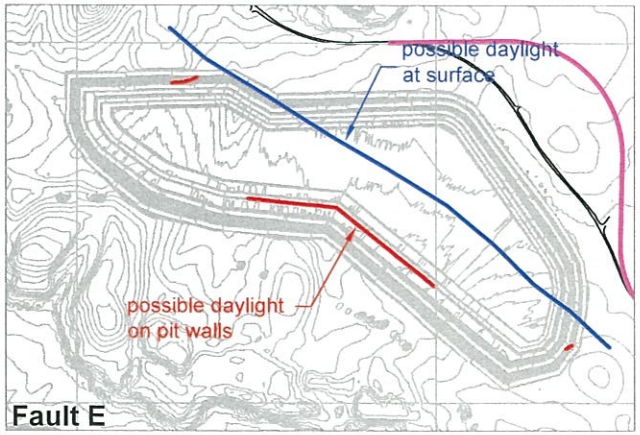
PIEZOMETER LOCATIONS

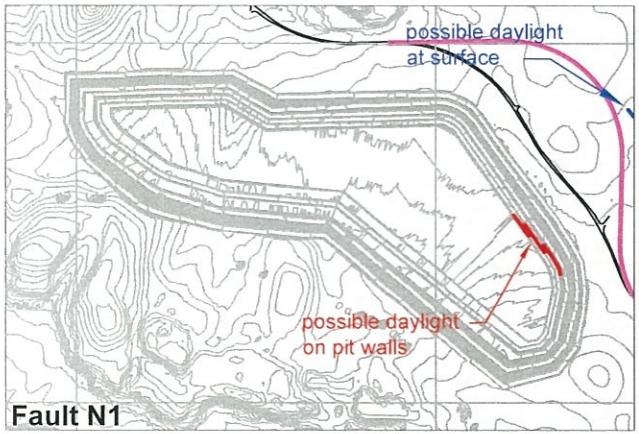
PSM1448-141R | Figure 9

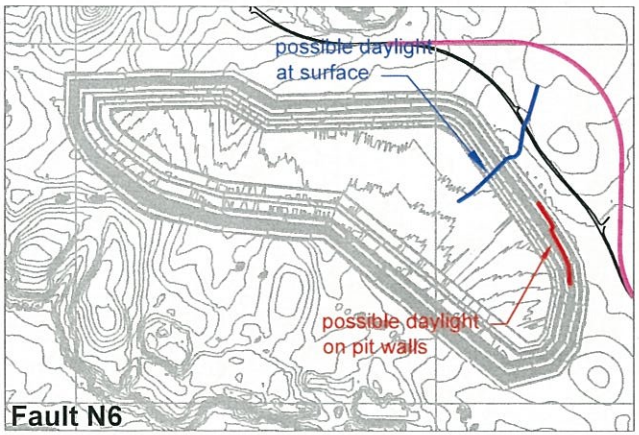


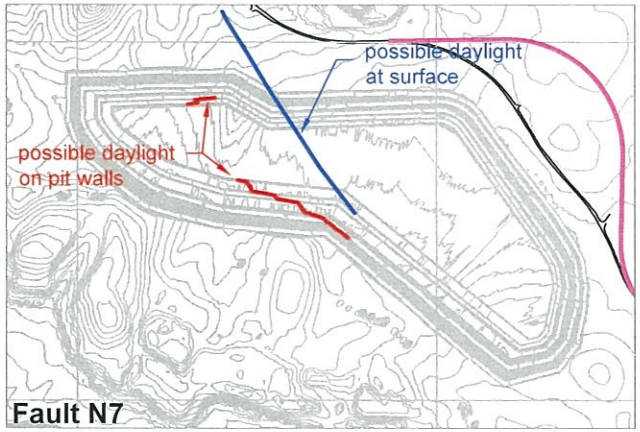












Extrapolation of fault surface to intersect topography

Intersection of fault surface with pit design

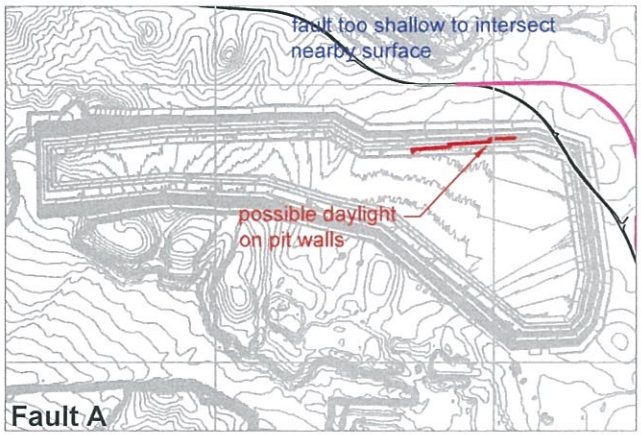
(Pit intersection is within the zone of drill hole intercepts and interpretations)

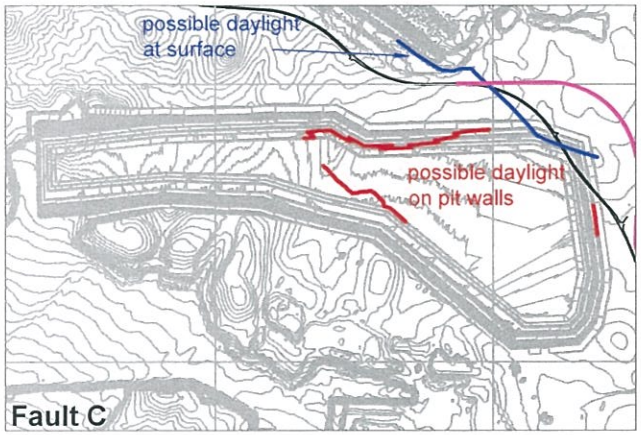
Pells Sullivan Meynink

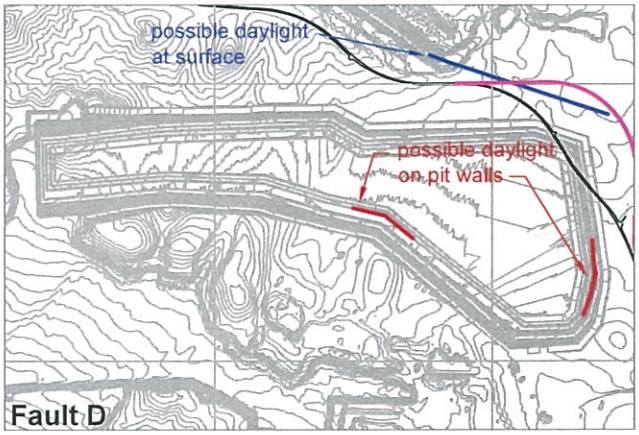
United collieries
Wambo United Project
Golden Highway

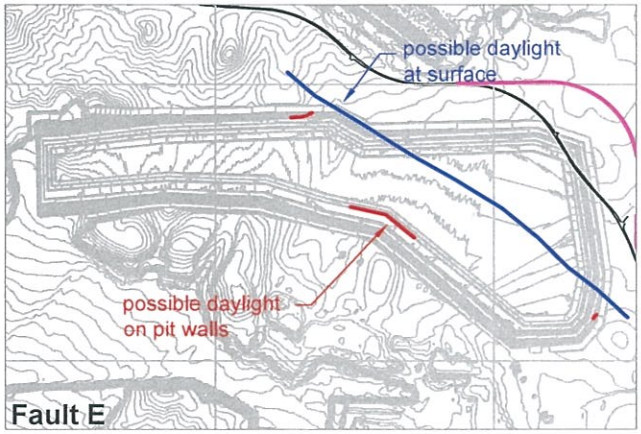
INTERPRETED FAULT LOCATIONS
UNITED PIT DESIGN B

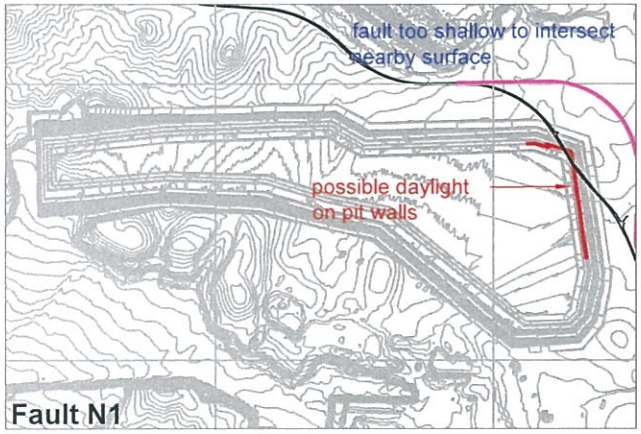
PSM1448-141R | Figure 10

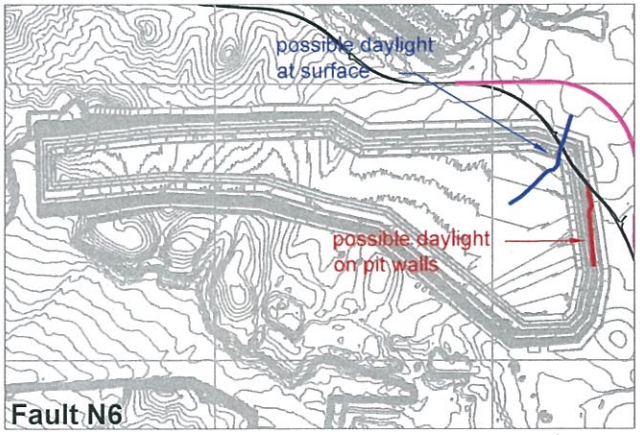


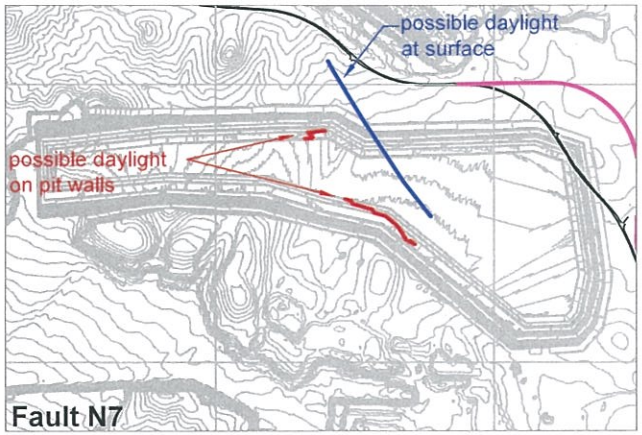












Extrapolation of fault surface to intersect topography

Intersection of fault surface with pit design

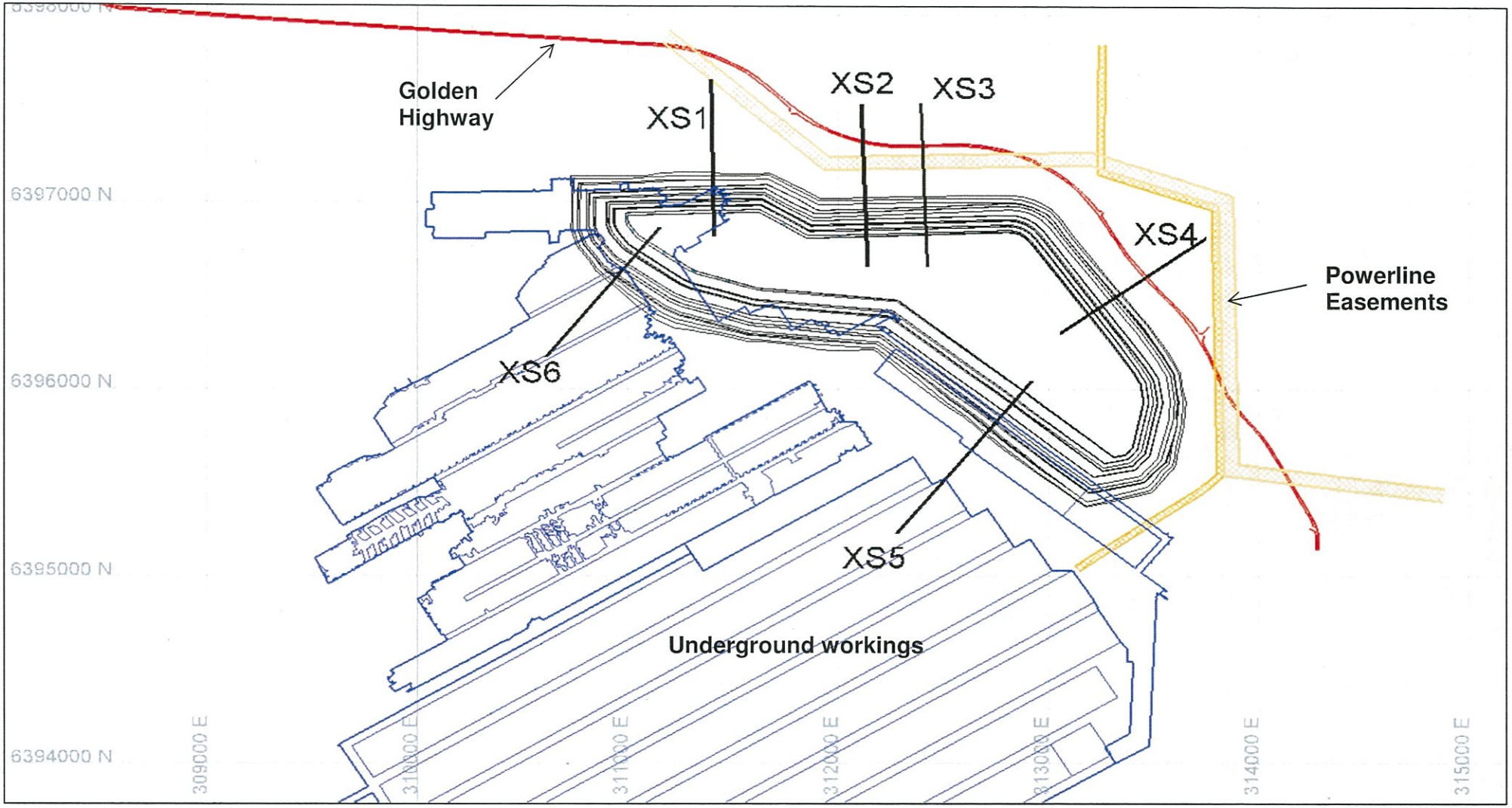
(Pit intersection is within the zone of drill hole intercepts and interpretations)

Pells Sullivan Meynink

United collieries
Wambo United Project
Golden Highway

INTERPRETED FAULT LOCATIONS
UNITED PIT DESIGN A

PSM1448-141R | Figure 11



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United Wambo Project

Golden Highway

UNITED PIT

SLOPE STABILITY ANALYSIS SECTIONS

PSM1448-141R	Figure 12

Pells Sullivan Meynink

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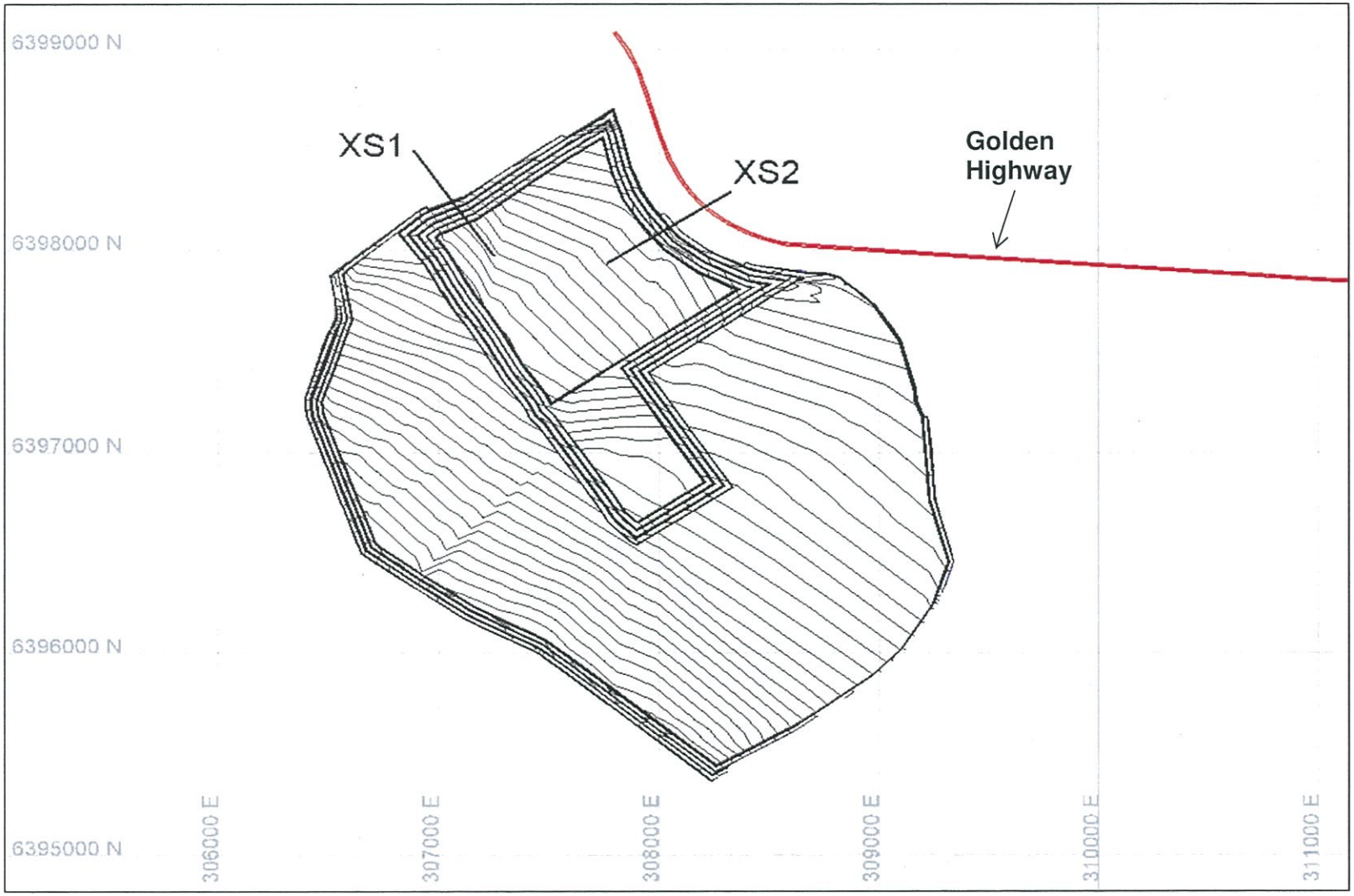

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United Wambo Project

Golden Highway

MONTROSE PIT

SLOPE STABILITY ANALYSIS SECTIONS

Pells Sullivan Meynink

PSM1448-141R | Figure 13

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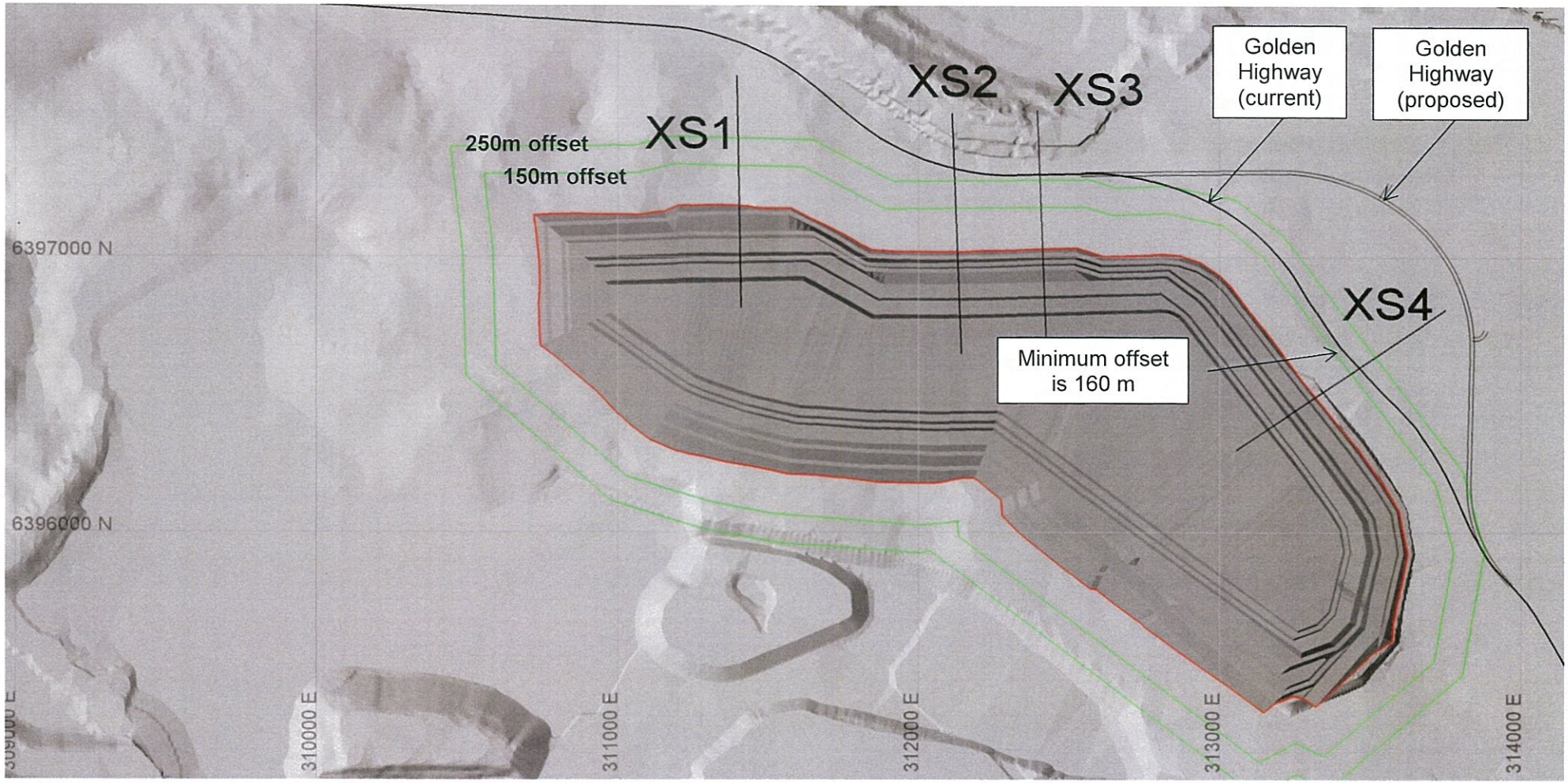

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Golden Highway

LOCATION OF GOLDEN HIGHWAY FROM CREST OF UNITED PIT - DESIGN B

PSM1448-141R	**Figure 14**

Pells Sullivan Meynink

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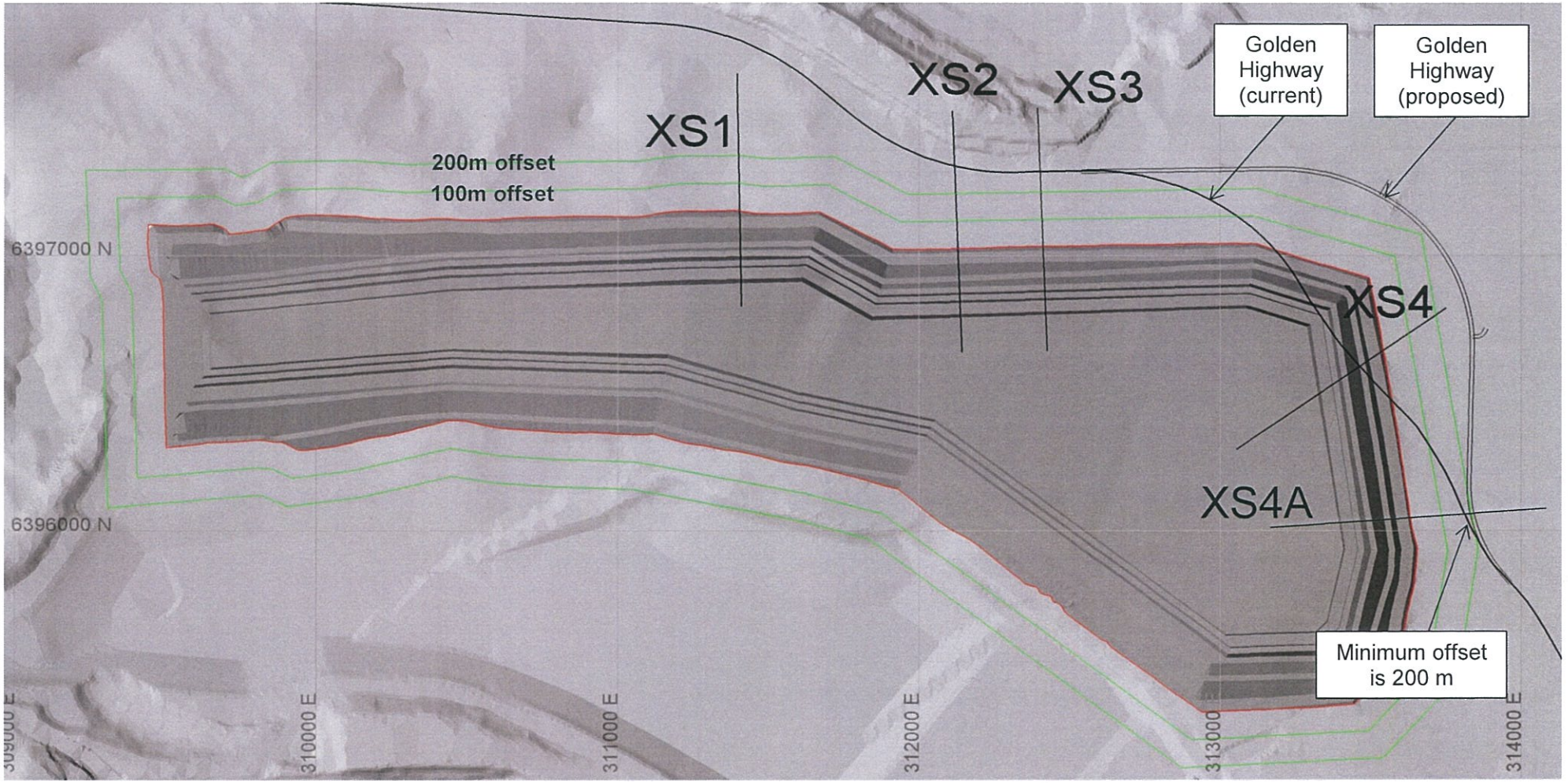

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Golden Highway

LOCATION OF GOLDEN HIGHWAY FROM CREST OF UNITED PIT - DESIGN A

PSM1448-141R	**Figure 15**

PSM

Pells Sullivan Meynink

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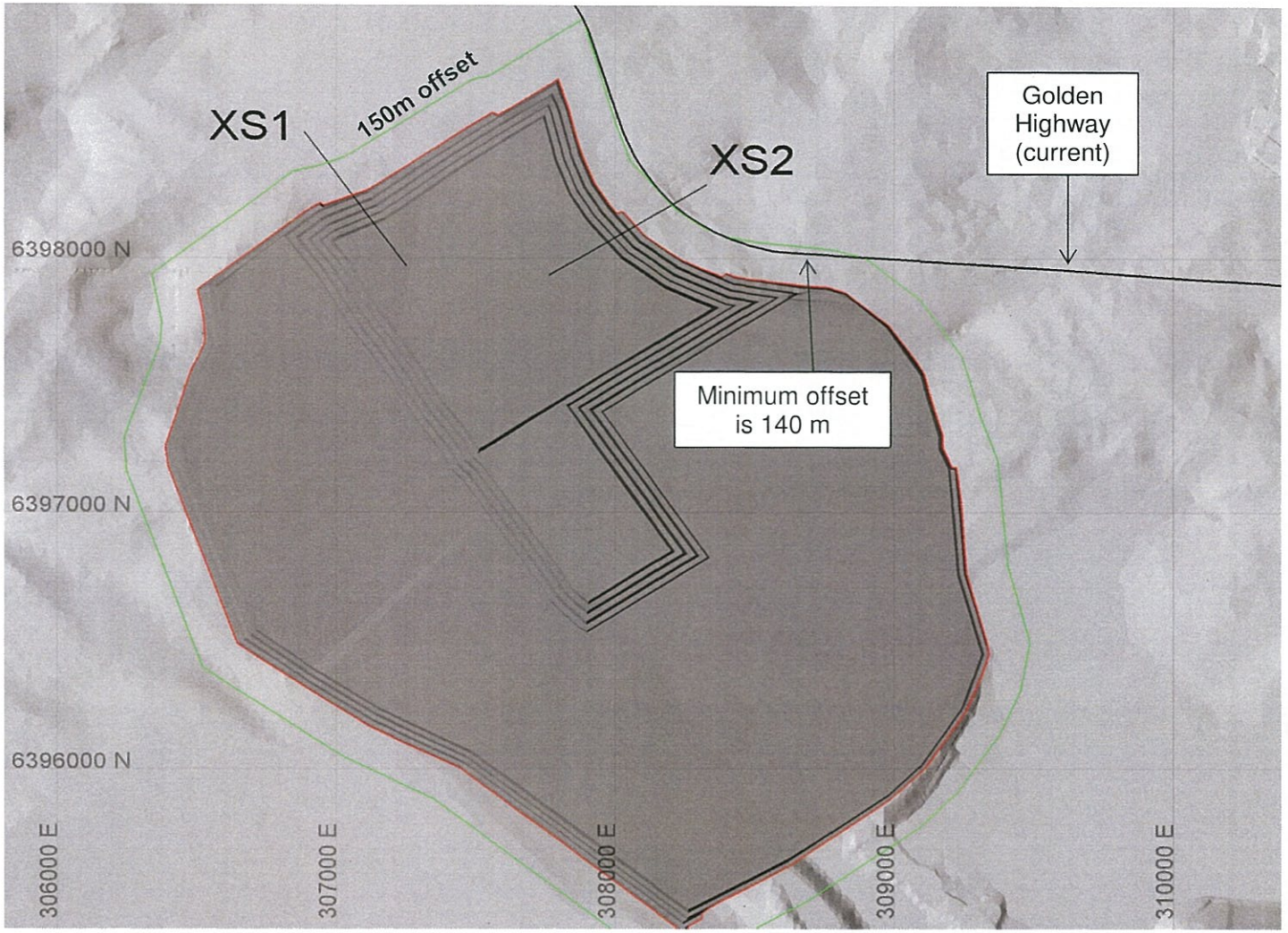

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United Wambo Project

Golden Highway

LOCATION OF GOLDEN HIGHWAY FROM CREST OF MONTROSE PIT

Pells Sullivan Meynink

PSM1448-141R	Figure 16

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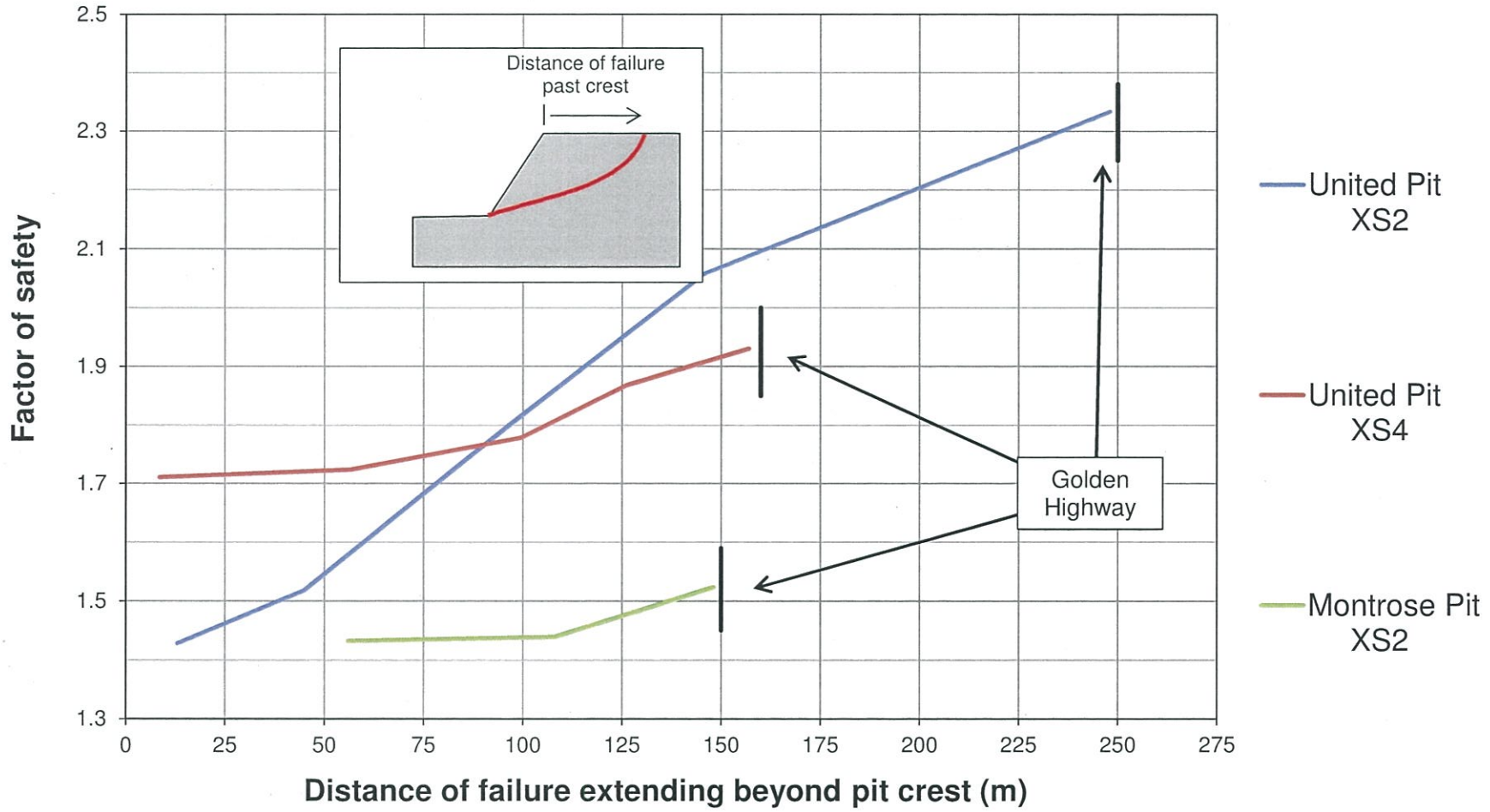

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United Wambo Project
Golden Highway

FOS AS A FUNCTION OF DISTANCE FROM PIT CREST

PSM1448-141R	**Figure 17**

Pells Sullivan Meynink

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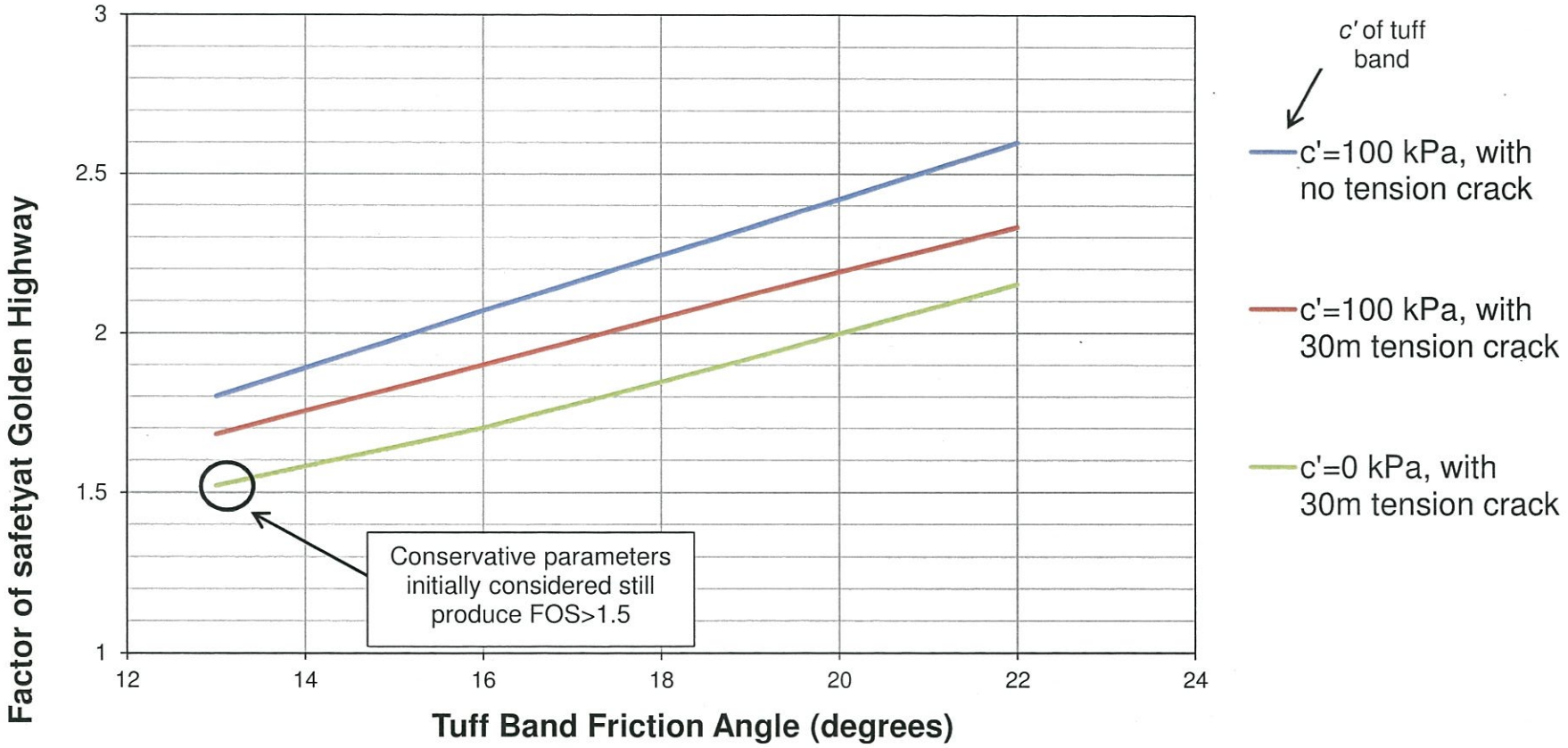

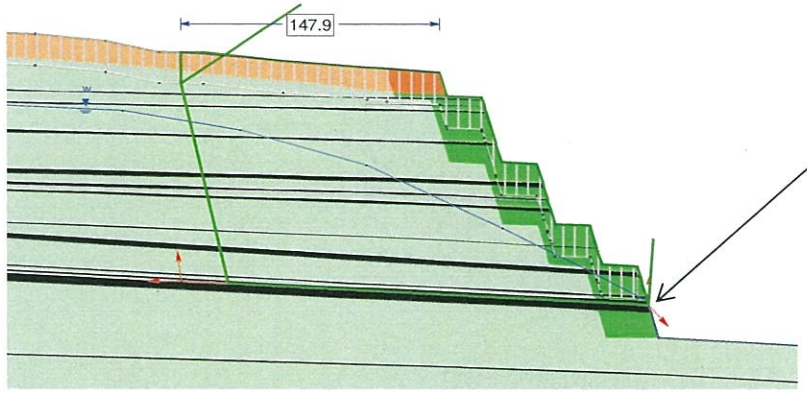

Pells Sullivan Meynink

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Golden Highway

SENSITIVITY ANALAYSIS FOR MONTROSE PIT XS2

PSM1448-141R	Figure 18

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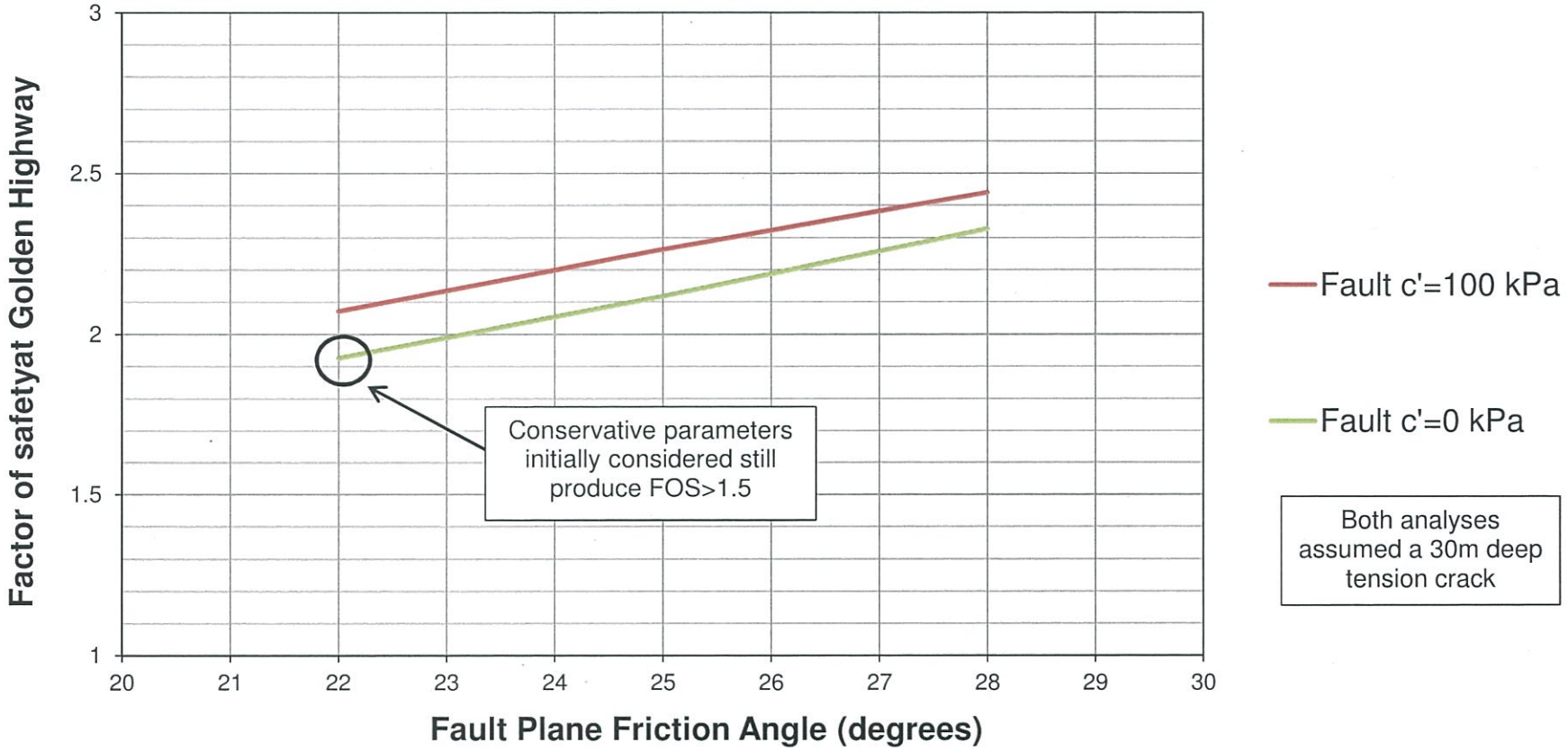

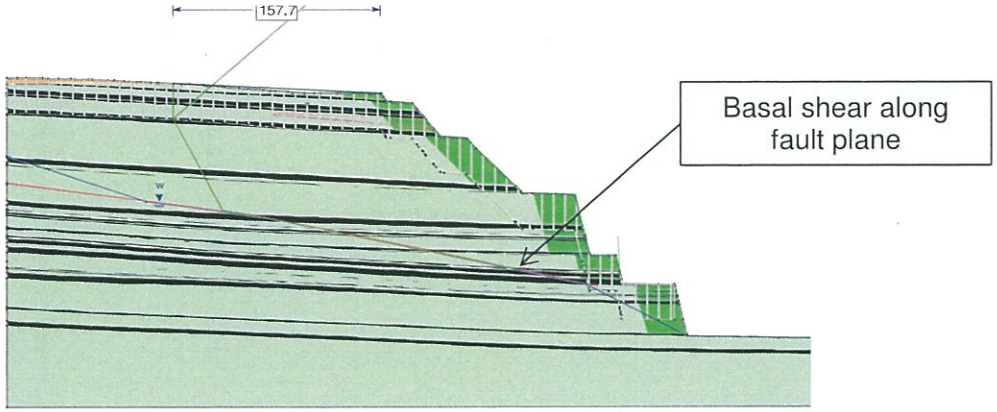

Pells Sullivan Meynink

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Golden Highway

SENSITIVITY ANALAYSIS FOR UNITED PIT XS2

PSM1448-141R	Figure 19

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APPENDIX A

PIEZOMETER DATA

APPENDIX B

BOREHOLE IMAGING INTERPRETATIONS

APPENDIX C

BOREHOLE IMAGING CROSS SECTIONS

APPENDIX D

STRUCTURAL MAPPING DATA

APPENDIX E

INTERPRETATION OF LABORATORY DATA

APPENDIX F

ROCKMASS STRENGTH ESTIMATES

APPENDIX G

SLOPE STABILITY ANALYSIS RESULTS FOR THE UNITED PIT

APPENDIX H

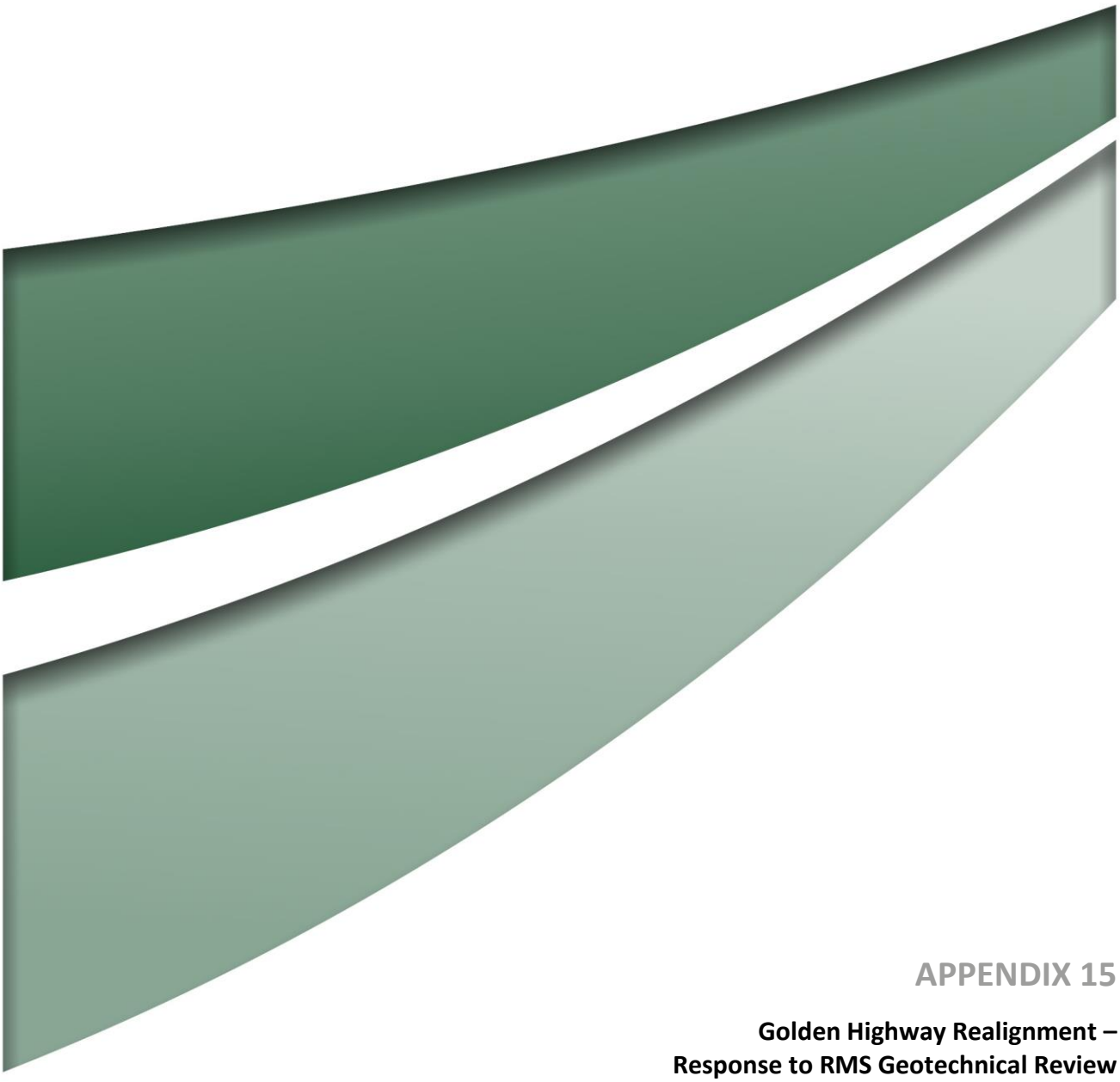
SLOPE STABILITY ANALYSIS RESULTS FOR THE MONTROSE PIT

APPENDIX I

POSSIBLE EFFECTS ON THE GOLDEN HIGHWAY

APPENDIX J

TUFF BANDS



APPENDIX 15

Golden Highway Realignment –
Response to RMS Geotechnical Review Questions

Transport Roads & Maritime Services Infrastructure Development Project Development Newcastle	Project title: **United Wambo JV Project - Golden Highway**			**DOCUMENT REVIEW**		
	Road No.	**Design Organisation**	**RMS Drawing No. / Report**	**INFRASTRUCTURE DEVELOPMENT**		
	HW27	PSM	PSM1448-141R/Stability of the Rock Pillar Beneath the Golden Highway	This design review by the Roads & Maritime Services (hereafter referred to as "RMS") covers an examination of the provided drawings and report to determine if they conform to RMS policy and practice. The review is not a proof check or a dimensional check and may not be complete..		
Review requested by:	**Review performed by:**			**Project Status**	**Issue No**	**Review Issue Date**
N/A	RMS: Arthur Li (AL)			Concept	01	15/08/2016
Statement by reviewer: N/A						

Item	Date (DD/MM/YY)	Reviewer	Page / Section	Review Comment	Response & Action (to be completed by design team)	Response & Action By (Disciple & Initials)	Response date (DD/MM/YY)	Status (I-N-O--P-)	Closeout (Initial & DD/MM/YY)
1.	26/09/16	AL	Subvertical dykes/(normal) faults/sheared zones	Subvertical dykes/(normal) faults/sheared zones sub-parallel to the highwall adjacent to the Golden Highway were not considered in the stability analysis mainly because they were not encountered by the boreholes drilled by PSM. It is noted that all boreholes drilled by PSM as shown in Fig.8 were apparently vertical. The presence of subvertical dykes/faults/sheared zones, if any and depending on their location, extent and shear strengths, may adversely affect the stability of the highwall adjacent to the Golden Highway. Drilling inclined boreholes at strategic locations may provide better information to assess whether these subvertical geological structures may need to be considered in the stability analysis in the pre-mining stage. RMS comments in this item pointed out that drilling inclined boreholes would have better chance to intercept sub-vertical dykes/fault which, depending on their location, extent and shear strengths, may adversely affect the stability of the highwall adjacent to the Golden Highway. PSM's comments have concluded that based on their assessment, "sub-vertical structures do not pose a significant risk to the Golden Highway". RMS has no further comment.	RMS state that sub vertical structures were not considered in the stability analysis. This is incorrect as all stability analyses considered a 30m deep tension crack to account for any potential structures that may occur in the rock pillar. Furthermore, we note the following: • Sub-vertical structures are only problematic for slope stability if they strike sub parallel and within close proximity to the highwall face. • The current structural model indicates that there are no sub parallel structures to the Golden Highway. This model is based on a combination of borehole drilling, airborne geophysics and face mapping from the surrounding underground and open pit exposures. • The proposed Golden Highway alignment is a minimum of 200m from the crest of the United Pit and 140m from the crest of the Montrose Pit (Figures 15 and 16 of PSM1448-141R). Additional to the above, the mining plan is such that if any potentially adverse structures are encountered during mining of the upper benches, then targeted drilling could be undertaken, and a design change could be implemented prior to advancing the pit to full depth. Identification of potentially adverse structures will form part of the ongoing pit slope management strategy. Progressive backfilling of the void will also minimize the length of highwall that is exposed to full pit depth. Minimizing exposed highwall lengths, will reduce or eliminate the likelihood that sub parallel structures will extend from the pit slope back to the Golden Highway (see attachment 1). In summary, for sub vertical structures to affect the Golden Highway: • The structures must be present and sub parallel to the pit slopes. • The structures will need to be continuous, and extend long distances back from the pit slope back to the Golden Highway, • The structures will need to go unrecognized, or not be appropriately managed despite implementation of the pit slope management plan, • A long section of unexposed highwall, parallel to the Golden Highway, will be required between the advancing highway and backfill dump section. Based on the above, PSM have assessed that sub-vertical structures do not pose a significant risk to the Golden Highway.			N	21/12/16

Resolved by: (to be completed by reviewer)	ACTION "I" = Incorporated into design or documentation (item can be closed-out) ACTION "O" = Issue/Comment remains outstanding ACTION "P" = Pending ACTION "N" – No action required (item can be closed-out)	Response & Action	To be completed by design team	Closeout:	Record date of closeout by Reviewer/Approver. Responsible designer to seek closeout of all comments prior to submission of revised design.

Transport Roads & Maritime Services

Project title: United Wambo JV Project - Golden Highway

Item	Date (DD/MM/YY)	Reviewer	Page / Section	Review Comment	Response & Action (to be completed by design team)	Response & Action By (Disciple & Initials)	Response date (DD/MM/YY)	Status (I-N-O--P-)	Closeout (Initial & DD/MM/YY)
2.	26/09/16	AL		PSM included a 30m deep tension crack (5th bullet point in Sec. 8.1) in all slope stability models as a substitute for dykes and normal faults (last para in Sec.5.3.4 and last para in Sec.5.3.5). RMS consider that in the mining stage if subvertical dykes/faults/sheared zones were encountered, they should replace the 30m tension crack model and the slope stability be checked again. This is in line with the ongoing pit slope management strategy proposed by PSM (para 1and 2 in Sec.9). PSM to implement ongoing geological assessment of the pit slope and update the geological/geotechnical model using new information available. RMS has no further comment.	PSM agrees that if major sub-vertical structures are encountered, they should replace the 30m tension cracks and the slope stability models should be re-run. This will be undertaken as part of the pit slope management strategy, which will include: • Ongoing structural mapping for identification of potential structures, • Updating of the structural model, as required, and • Assessing the effect that newly identified structures have on slope stability. However, given the response to item 1, it is reiterated that sub-vertical structures do not pose a significant risk to the Golden Highway, based on the favorable distribution and orientations of known structures, the ongoing pit slope management and monitoring plan, the large offsets between the pit and the Golden Highway, and the progressive backfilling of the mine.			N	21/12/16
3.	26/09/16	AL	Residual shear strength parameters for thrust faults, tuff and coal	PSM reported that for conservative purposes, residual strengths were used for the thrust fault, tuff bands and coal bands in slope stability analysis (Table 5.4). The major tuff bands were inspected using core photos and geophysics and found little evidence of shearing and displacement (p.19). However, no petrographic examination of the tuff core was carried out to confirm the inspection results. RMS interprets that the residual strength for tuff (Table 5.4) is for unsheared tuff units. PSM's Sensitivity Analysis (Sec. 8.2 and 8.5) pointed out that a modest increase of angle of friction and cohesion will result in increases in FOS. It follows that a modest decrease of angle of friction in residual strength may also result in a decrease in FOS. If sheared tuff units are encountered in the mining stage, especially on the highwall side adjacent to the Golden Highway, it would be prudent to assume that the sheared tuff units may have lower shear strength than the unsheared tuff. PSM should consider its impact to the slope stability and the design of the highwall adjacent to the Golden Highway. In PSM's report, inspection of core photos and geophysics was undertaken to assess whether tuff bands have been subject to shearing or displacement (p.19). RMS consider that the inspection of tuff core, supplemented by petrographic analysis if necessary, would be fundamental for geologists to adopt in assessing whether a tuff band has been subject to shearing. Nevertheless, PSM have pointed out in their reply how the residual shear strength parameters (c'=0 kPa, ø' = 13°) was established – where cases for sheared tuff bands were also considered (1st bullet point). RMS has no further comment on the use of the residual shear strength parameters adopted by PSM.	Petrographic analysis is used for determination of mineralogy. It cannot be used to identify if the tuff bands are in a sheared or intact condition. Instead, sheared conditions are indicated by the recovery of fragmented or "disked" core samples which fall apart on handling. As was shown in Figure J1 of PSM1448-141R, tuff bands were observed to be intact and not sheared. As RMS point out, PSM adopted "residual" shear strength parameters for the tuff bands, with c'=0kPa and φ'=13 degrees. This strength: • Is based on back analysis of very large failures in the Hunter Valley on known sheared tuff bands at a number of mines including Hunter Valley Operations and Mt Owen. • It is has been generally accepted by the geotechnical fraternity in the Hunter Valley for more than two decades as being appropriate for sheared tuff bands. • Laboratory testing of tuff samples collected from Hunter Valley mines, including Bulga, Wambo, and Mt Owen indicate suggest the adopted strengths are a lower bound for sheared tuff bands. This is in agreement with published values from various literature. Thus PSM consider that the adopted shear strength represents the residual strength of a sheared tuff band, and that the adopted parameters are conservative given that tuff bands were observed to be intact.			N	21/12/16

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Item	Date (DD/MM/YY)	Reviewer	Page / Section	Review Comment	Response & Action (to be completed by design team)	Response & Action By (Disciple & Initials)	Response date (DD/MM/YY)	Status (I-N-O--P-)	Closeout (Initial & DD/MM/YY)
4.	26/09/16	AL	Grouping of the rock strata into weathered rock domain and fresh rock domain and assigning averaged rock mass strength parameters for slope stability analysis	Fig.2 indicates that drilling from the ground surface to the bottom of Montrose pit or United pit would encounter many rock units where each would have their respective shear strengths. PSM's approach is to apply the Generalised Hoek-Brown failure criterion and averaged UCS to derive the rock mass shear strength parameters for weathered rock and fresh rock (Tables 5.7 and 5.8). Note that some rock strata (e.g. claystone and siltstone) may be relatively weaker and more vulnerable to weathering when exposed. Hence more vigorous slope stability analysis would be based on the shear strength parameters pertinent to the rock units. RMS has no further comment.	The following questions are raised upon reviewing RMS's comment: 1. Is it appropriate to model the weathered zone separate? 2. Is it appropriate to model every single bed/material interval? 3. Will the material deteriorate over time and compromise slope stability? PSM note the following points with regards to the local conditions: • The overburden stratigraphy is comprised of typical coal measure rocks dominated by siltstone and sandstone lithologies (typically more than 80%), with lesser amounts of conglomerates and claystone units. • The sandstone, siltstone and interbedded sandstone/siltstone units have reasonably similar UCS distributions (Figure E1 of PSM1448-141R) • Individual units generally range in thickness from 0.05m to 5m, • Significant deterioration of rocks was not observed during the field campaigns, and is not observed in similar exposure at other mines in the area. Addressing the above questions: 1. The depth of the weathered zone was based on the depth of weathering provided to PSM by United. This was observed at variable depths across site and was based on results from resource drilling. Appendix F of PSM1448-141R shows that the weathered zone was assumed to have poorer geotechnical characteristics than the fresh zone. Weathered zones have also been designed with shallower slope angles (see Figure G11). 2. In order to address question 2, the large scale of the pit slope and large scale potential failure surface required to impact the Golden Highway must be appreciated with respect to the scale of the bed thicknesses. In some areas the pit slope will be more than 200m high, whilst the bed thicknesses typically range from 0.05m up to 5m thick. Thus, for a failure to extend the large distance back to the Golden Highway, it would need to extend to a significant depth and intersect many different rock units. Thus, an "averaged" approach to assessing the shear strength is deemed appropriate, particularly given that the sandstone and siltstone lithologies have similar strengths (Figure E1) and dominate composition of the overburden. It is also noted that the lower quartile UCS was used when estimating the GHB parameters. 3. PSM agree that siltstone and claystones may be more susceptible to slaking and degradation than sandstones and conglomerate units. In coal measure rocks, this typically takes many years to develop and manifests as surficial damage to highwall exposures as weaker beds erode and cause minor cantilevering of stronger beds. However, this process only affects a thin "skin" on the highwall face, and the rockmass more than 1m from the face is left unaffected. Thus degradation of weaker units will not affect the Golden Highway as degradation and slaking will not trigger large scale slope instability. Furthermore, progressive backfilling of the pit will bury the highwall faces and limit degradation potential.			N	21/12/16
5.	26/09/16	AL	In-pit dumping to serve as buttressing of the highwall adjacent to the Golden Highway (Sec.3.2)	The in-pit dumps must not become a barrier blocking the natural ground water flow outlet on the highwall side (e.g. the northeastern wall in the Montrose pit, the northern and the eastern wall of the Approval Case in the United pit). This is to avoid ground water pressure build-up in the rock pillar. RMS has no further comment.	RMS are concerned with the in pit waste dumps impeding depressurization, as this may increase pore pressure in the rock pillar. Presumably there is concern that the elevated pore pressures may then trigger slope instability. Spoil permeability is an important consideration in the design, operation and management of all coal mine waste dumps. Mine waste is typically a granular rock fill material, formed by blasting and excavating the parent in situ rock. Waste dumps are then formed by loose-tipping the rock fill, at a lower density and higher void ratio the in situ density prior to blasting and excavation. As a result mine spoil is generally considered to be "free draining". PSMs experience in the Hunter Valley, and in particular Coal and Allied's Riverview Pit approximately 500m to the North, where the same units are mined, indicates that the excavated rock waste at United will be free draining. There is no body of evidence, either in the Hunter Valley or generally in coal mining, that suggests loosely placed mine spoil, comprised predominantly of sandstone and siltstone, will form a groundwater barrier. Thus, it is considered that backfilling the pit will not stop dewatering and promote pore pressure build up within the rock pillar. Notwithstanding the above, we also note that stability of the rock pillar is only a concern if there is an exposed highwall, and void into which the rock pillar can fail. Hence the buildup of pore pressure in the rock pillar behind the backfilled void would not be a concern for stability. We reiterate however, that we do not expect pore pressure buildup in the rock pillar after backfilling.			N	21/12/16

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6.	26/09/16	AL	Hydrogeological model for Montrose pit (Sec.5.2)	The 4 piezometers (UG138, 139, 143 and 166A) as shown in Fig.A2 were installed in the southern and western side of the proposed pit whereas the Golden Hwy is on the north eastern side. The nearest piezometer UG166A (2nd para, Sec.5.2 and 6.3.2) is about 1600m (measured horizontally) from the Golden Hwy (Fig.9). Note that three VWP clusters were installed between the United pit and the Golden Highway to provide site specific ground water information (Fig.9). It follows that piezometers should be installed between the Montrose pit and the Golden Hwy (e.g. on XS2) so as to provide site specific ground water information for hydrogeological assessment for the highwall at Montrose pit in relation to the Golden Highway. PSM have acknowledged RMS comments about the need to provide site specific ground water information for the area between the Golden Highway and the Montrose pit. This will be carried out as part of the ongoing pit slope management. RMS has no further comment.	PSM have recommended, as part of the ongoing pit slope management that *"additional groundwater monitoring using VWPs should be installed…. around the Montrose Pit to ensure that sufficient pore pressure reduction is occurring ahead of mining"* (Section 9, Point 5 of PSM1448-141R). It is intended that this monitoring will include the area between the Highway and the Montrose Pit.			N	21/12/16
7.	26/09/16	AL	Stress release of the geological materials caused by open pit mining	The design for the highwall/rock pillar stability appears to be based on FOS. PSM's report did not mention the effect of stress release to the geological materials as a result of the open pit mining to a depth of about 250m. Slope forming materials and geological structures, under stress release, will deteriorate in strengths and may be subject to ongoing ground deformation (e.g. slope creep). RMS road pavements and other subsurface utilities have limited tolerance to ground movement. Pavement cracks caused by ground deformation often result in abrupt changes in pavement profile and may cause safety concern to road users travelling in highway speed. RMS has no further comment. RMS has no further comment.	The technical issues that RMS raise in this item are: 1. The effect of "stress-relation" due to mining to 250m depth is not mentioned in the report. 2. If significant stresses exist then changes to the stress regime may cause deterioration of rock strengths and ongoing deformation. 3. The Golden Highway is sensitive to deformation. PSM accepts that excavation can cause a "stress relaxation" phenomena in the intact highwall. However, the following points are noted: • The stress regime in the immediate area has already been affected by nearby open cut and underground mining for many decades. • Significant stress relief has already occurred, as proven by the groundwater depressurization due to that mining. • Induced systematic strains from open cut mining are typically small, and diminish with distance from the pit crest. • Concentrated tensile or shear strains along geological structures may cause notable changes in pavement profile along the Highway but for reasons cited in response 1, strains of this nature are not expected to occur as far back as the Golden Highway. • The pit slope management plan incorporates monitoring of displacements during open cut mining, and results will be used to confirm that significant pit slope displacements are not occurring. Based on the above points, stress relaxation and associated strains within the rock pillar will not affect traffic movements along the Golden Highway. This is reinforced by PSMs experience with the Golden Highway and Coal & Allied's Riverview Pit (offset ~100m), and from ongoing modelling and displacement monitoring of the Northern rail line at the Liddell mine where pits are excavated on both sides of a rock pillar.			N	21/12/16

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8.	26/09/16	AL		Para 6 in Sec.9 briefly mentions the need to undertake pit slope deformation monitoring as part of the ongoing pit slope management. RMS would further advise that implementation of ground deformation monitoring with respect to the Golden Highway is recommended. In response to RMS comment (8), PSM have agreed to "assist with design and implementation of an appropriate monitoring regime". RMS has no further comment.	PSM will continue to work with United, as requested, to assist with design and implementation of an appropriate monitoring regime.			N	21/12/16
9.	26/09/16	AL	Mine blasting and vibration monitoring	Blasting and vibration monitoring are not addressed in PSM's report. Two issues are of RMS concern : (i). If blasting cracks are found between the crest of the final highwall and the Golden Highway, that indicates that the rock mass forming the rock pillar may have been disturbed by blasting. Hence their impact on slope stability must be assessed. (ii). Vibration monitoring should be implemented on the Golden Highway for RMS reference. (i), PSM will update their slope stability models if cracks are observed to be more extensive. Pit slope management program will also implement ongoing crack and deformation monitoring visually and using instrumentation. RMS has no further comment. (ii), RMS request PSM to implement blast/vibration monitoring for the Golden Highway as part of the blast management plan.	(i) To an extent, cracking of the highwall crest has already been addressed during design by including a 30m deep tension crack in slope stability models. If cracks are observed to be more extensive, then models can be updated to reassess stability. Ongoing crack and deformation monitoring will be undertaken both visually and using instrumentation as part of the pit slope management plan. (ii) PSM consider that a blast management plan should include blast monitoring, and establishment of suitable peak particle velocity limits. If requested, PSM will work with United to address these items.			P	21/12/16
10.	26/09/16	AL	Post-mining slope stability and monitoring for ground water, slope movement (e.g.creep) and ground deformation	The staged pit design for the Approval Case is up to 2039 (Fig.4). The Golden Highway would likely still to be in use long after 2039. RMS would like to raise the following issues related to post mining ground water condition, slope movement and ground deformation: (i). Depressurisation is only briefly mentioned in Sec.4.5 for the United pit. Would cessation of mining activities render depressurisation not necessary? (ii). Ground water modelling should address the post mining long term ground water condition for the rock pillar for post mining slope stability analysis. The post mining ground water condition should also be monitored to check against the modelling results. (iii). Stress release caused by open pit mining will continue for a long period of time even after the cessation of mining. It is envisaged that continued stress release would induce deterioration of the rock mass strength and/or may produce slope creep. In view of this, long term monitoring for post mining slope and ground deformation is considered necessary. (i), RMS has no further comment. (ii), RMS has no further comment. (iii), RMS request instrumentation and monitoring for providing information/data to substantiate PSM's assessment.	PSM make the following comments in regards to the points that RMS raise: (i) Cessation of mining will see most of both pits backfilled with excavated rock waste. Ongoing depressurization will not be required to ensure highwall stability in backfilled areas, but will continue given high permeability Hence even if ground water does recover in the rock pillar, it will not impact stability. We reiterate however that we expected that depressurization will be ongoing after backfilling.the pits.. Figure 4 of PSM1448-141R shows that the proposed final voids, which will not be backfilled, are approximately 2km from the Golden Highway and will not affect rock pillar stability. (ii) Because the final voids are 2km from the Golden Highway, and the void immediately adjacent to the Golden highway will be backfilled with free-draining waste rock, there is no likelihood of groundwater recovery in the rock pillar. Notwithstanding this, groundwater monitoring in the rock pillar will be maintained after mining. (iii) Backfilling will effectively buttress the highwall sections near to the highway and limit deformation potential. Ongoing creep deformations in the final voids 2km away will not impact the Golden Highway. Once backfilled there is effectively no likelihood that pit slope movements will impact the Golden Highway.			P	21/12/16

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11.	06/10/16	AL	General	In the stability analysis of the highwalls adjacent to the Golden Highway, PSM used results based on the investigations carried out for the Montrose and the United pit. There is no mention of the Riverview pit in PSM's stability analysis of the rock pillar. Planning of some smaller pits (Glider pits) east of the Riverview pit has been proposed but it appears no information is available at the time when the stability analysis for the rock pillar was carried out (Sec.3.3). Can PSM confirm whether the existing Riverview pit and the proposed Glider pits have been considered in PSM's stability analysis of the rock pillar? RMS requests PMS explanation of not including the existing Riverview pit in their slope stability analysis of the rock pillar. RMS has no further comment.	For items 11 and 12, it appears that RMS are concerned that an excavation on one side of the pillar may trigger instability on the other side, and this instability may then impact the Golden Highway. The rock pillar between the United Pit and the Riverview Pit is approximately 300m wide at the surface, and estimated to be nearly 500m wide near to the pit base. Mining of the Glider Pit has not yet been commenced, but similar or greater pillar widths are expected. PSM have not analyzed the stability of the Riverview or Glider Pit high walls on the premise that the rock pillar is of sufficient width such that pit slope behavior on one side of the pillar will be decoupled from pit slope behavior on the other side of the pillar. This is evident from Figures 18 and 19 of PSMs report which highlight how failure surfaces extending great distances back into the rock pillar will have high FOS values, which will increase at greater distances than those shown in the Figures. Furthermore, any possible "destressing" effects in the pillar associated with excavation of the United Pit will not affect the Riverview Highwall, as this rock mass is already significantly destressed due to excavation of the Riverview Pit.			N	21/12/16
12.	06/10/16	AL		If proposals come in the future for the planning of the Glider pits, the stability analysis of the highwalls of the proposed Glider pits should consider the possible impact, if any, of the mining at the Montrose and the United pit. PSM need to review their stability analysis of the highwalls adjacent to the Golden Highway with reference to the design of the proposed Glider pits. RMS has no further comment.				N	21/12/16
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