HVO NORTH - FINE REJECT EMPLACEMENT MODIFICATION

Section 75W Modification to DA 450-10-2003 - Environmental Assessment

Prepared for Coal & Allied Operations Pty Limited
June 2013

COAL & ALLIED

Managed by Rio Tinto Coal Australia

EMM
EMGA Mitchell McLennan

www.emgamm.com

HVO North - Fine reject emplacement

Environmental Assessment

Section 75W Modification to DA 450-10-2003

Prepared for Coal & Allied Operations Pty Limited | 7 June 2013

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

emgamm.com

HVO North - Fine reject emplacement

Final

Report J12046RP1 | Prepared for Coal & Allied Operations Pty Limited | 7 June 2013

Prepared by	**Andrew Wiltshire**	Approved by	**Luke Stewart**
Position	Environmental Scientist	Position	Director
Signature		Signature	
Date	7 June 2013	Date	7 June 2013

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

Document Control

Version	Date	Prepared by	Reviewed by
1	7 June 2013	Andrew Wiltshire	Luke Stewart

EMM
EMGA Mitchell McLennan

T +61 (0)2 9493 9500 | F +61 (0)2 9493 9599

Ground Floor | Suite 01 | 20 Chandos Street | St Leonards | New South Wales | 2065 | Australia

emgamm.com

Table of Contents

Table of Contents *(Cont'd)*

Table of Contents *(Cont'd)*

Table of Contents *(Cont'd)*

Table of Contents *(Cont'd)*

Appendices

Tables

Figures

Photographs

1 Introduction

1.1 Modification overview

Hunter Valley Operations (HVO) is located approximately 24 kilometres (km) north-west of Singleton, New South Wales (NSW) (Figure 1.1). The mining and processing activities at HVO are geographically divided by the Hunter River into HVO North and HVO South. While HVO is managed as one operation, HVO North and HVO South each have separate planning approvals.

HVO North operates under Development Consent No. DA 450-10-2003 (DA 450-10-2003), which was issued by the then Minister for Infrastructure, Planning and Natural Resources in 2004, under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The original consent has since been modified a number of times, the most recent being in March 2013 following the assessment of the Carrington West Wing project.

The HVO North complex comprises the Carrington, North, West and Mitchell Pits and all related mining activities and infrastructure such as overburden emplacement areas.

Coal & Allied is proposing to modify DA 450-10-2003 under section 75W of the EP&A Act, to allow for:

- the construction and operation of a fine reject emplacement to the north of the existing Carrington Pit; and
- fine reject emplacement in the Cumnock void 3, located to the north-east of West Pit.

A minor amendment to the HVO North development consent boundary is also proposed to encompass Cumnock void 3.

Figure 1.2 shows the location of the two proposed modification elements, in the context of the HVO North mining operations and surrounds. The proposed modification elements are referred to collectively as 'HVO North – Fine reject emplacement'. The 'project area' comprises the fine reject emplacement, Cumnock void 3, fine reject pipelines and areas of associated disturbance. Further detail on the proposed modification is provided in Chapter 3.

1.2 The proponent

The proponent is Coal & Allied Operations Pty Limited (Coal & Allied). Rio Tinto is a major shareholder in Coal & Allied. Coal & Allied owns and operates HVO with management services provided by Rio Tinto Coal Australia. Further information on Coal & Allied and its operations can be found at:

http://www.riotintocoalaustralia.com.au/

1.3 Site and surrounds

The majority of HVO North is located within the Singleton Local Government Area (LGA) with the exception of the northern most section, containing part of the rail loading facilities, which is located within the Muswellbrook LGA.

Dominant features of the HVO North landscape comprise the existing open cut pits, mine-related infrastructure and rehabilitated former mining areas, to the north, east and south. Topography is generally undulating and ranges from RL 130 to RL 200 to the north of West Pit and from RL 50 to RL 120 to its south.

Mine operations and related infrastructure in the surrounding area include Ravensworth Operations, HVO South, Warkworth Mine, Wambo Mine and United Colliery. Bayswater Power Station is situated to the north. Grazing and cropping land dominates areas to the west. A large ridgeline, approximately RL 220, is located between HVO North and the village of Jerrys Plains found to the south-west.

Of particular relevance to the proposed modification is Ravensworth Operations, located immediately adjacent to the north-east of the HVO North development consent boundary. Ravensworth Operations comprise the existing Ravensworth West Mine, including Cumnock No.1 Colliery, and Narama Mine approved under Project Approval DA 09_0176. As mentioned in Section 1.1, the proposed modification includes the emplacement of fine reject in the Cumnock void 3 which is part of the Ravensworth Operations. Interactions with the Ravensworth Operations are discussed in Section 2.4 below.

The majority of the proposed fine reject emplacement will take place on land that has been previously disturbed at HVO North for mining activities and rehabilitated. The rehabilitated areas within its footprint consist of areas planted with native overstorey species and pasture areas. The vegetation within this area cannot be assigned a formal vegetation type in the Biometric database (DECCW 2008), as it is not a naturally occurring community and does not conform to any known vegetation type or ecological community.

The closest privately owned residences are over 4 km to the west, south-west and south of the proposed fine reject emplacement and are located within the village of Jerrys Plains and along the Golden Highway.

1.4 Need for the modification

Reject material is produced as a by-product of the coal washing process. Run-of-mine (ROM) coal often contains part of the rock strata above and below the coal seam together with thin rock bands within the seam. The rock is removed from the product through the washing process in the coal handling and preparation plant (CHPP). As a result, two forms of reject are produced: coarse reject and fine reject. Coarse reject, together with waste rock, is hauled to active overburden emplacement areas. The fine reject is pumped as slurry from the CHPP to fine reject emplacement facilities via pipeline.

Mine planning has identified that fine reject capacity will soon be reached at HVO North, estimated to be approximately quarter one 2015. Additional storage is required by the end of approximately 2014 to enable ongoing mining operations at HVO North. The proposed fine reject emplacements will provide an additional six years of fine reject capacity and are, therefore, critical to the viability of HVO North and HVO as a whole. A strategy for fine reject storage beyond the additional six years afforded by the proposed modification will be developed, assessed and approval sought at the appropriate time.

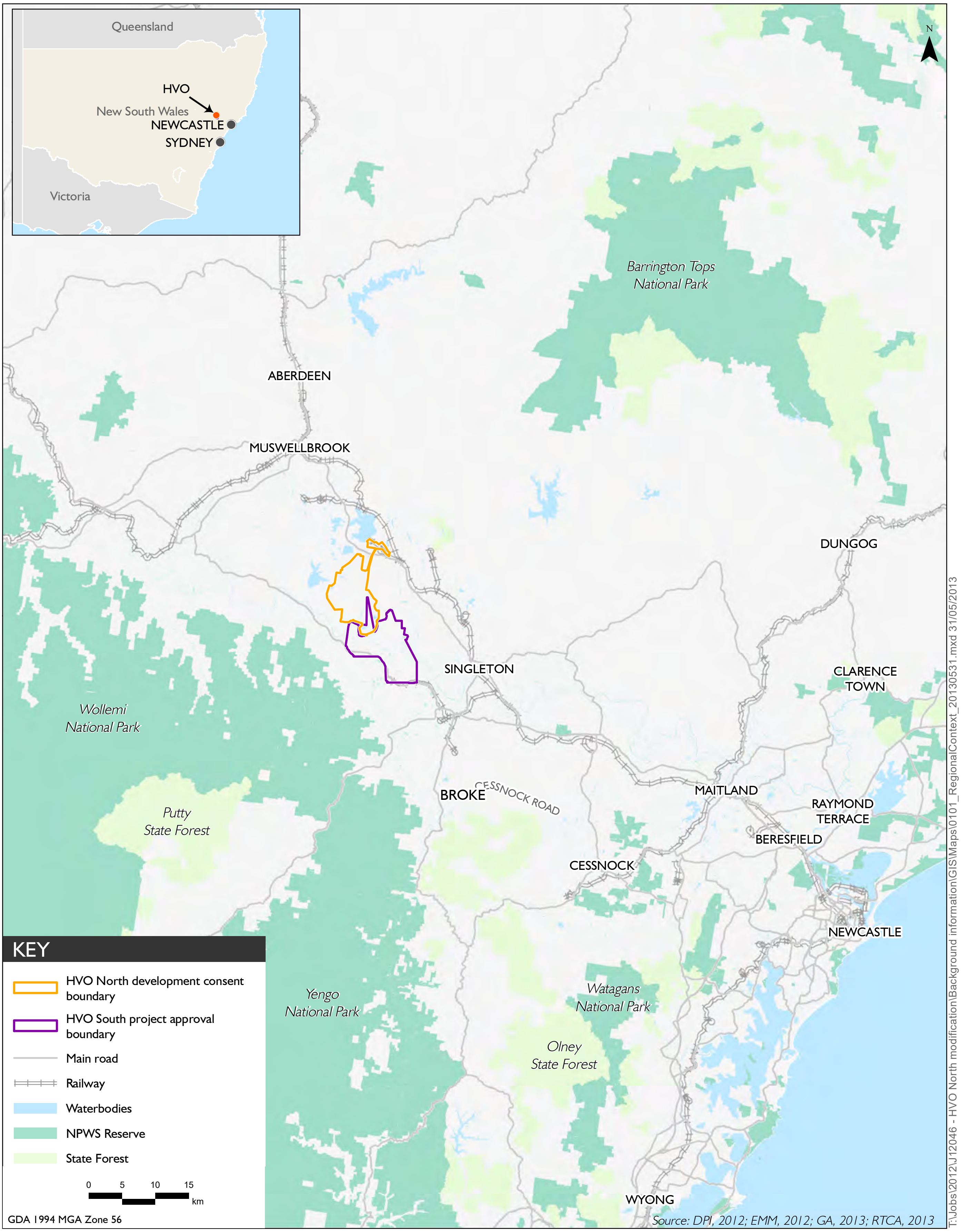
The proposed modification will enable the ongoing substantial regional and local economic benefits to be realised from HVO, such as continued employment at HVO. At present HVO directly employees 1,160 permanent staff.

As substantiated in Chapters 7 to 16, potential environmental impacts from the operation of the fine reject emplacement will be generally indiscernible from approved operations. Similarly, only minor short term impacts will result during construction and again, these will be generally indiscernible from approved operations. The design of the proposed modification therefore achieves the objective of providing critical fine reject storage capacity whilst minimising adverse environmental impacts.

1.5 Purpose of this report

The purpose of this Environmental Assessment (EA) is to accompany an application by Coal & Allied for the proposed modification, in accordance with Section 75W of the EP&A Act to modify DA 450-10-2003. This document provides a description of the existing environment, an assessment of the potential impacts resulting from the proposed modification and details measures that would be implemented, subject to approval, to avoid and/or minimise potential impacts. The EA provides information to allow NSW government authorities to assess the merits of the proposed modification and make a determination as to whether or not to grant approval.

This EA was prepared by EMGA Mitchell McLennan Pty Limited (EMM), with input from a number of external technical specialists. The study team is presented in Appendix A.

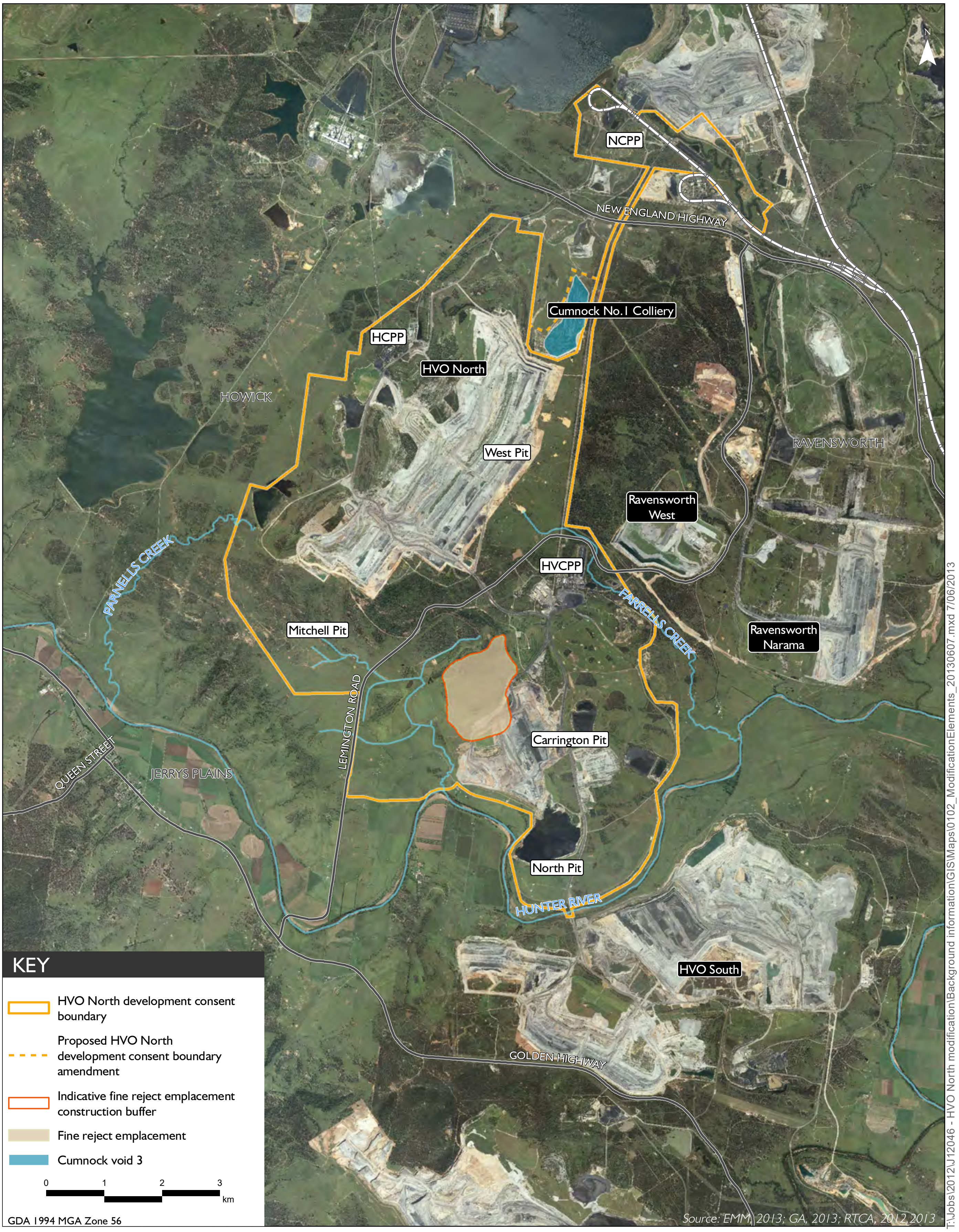


EMM

Regional context

HVO North - Fine reject emplacement modification

Figure 1.1



Modification elements

HVO North - Fine reject emplacement modification

Figure 1.2

2 Existing development consent

2.1 Overview of existing development consent

The current development consent at HVO North is DA 450 10 2003. There have been three modifications to DA 450-10-2003, as detailed in Table 2.1 below. In addition, an access road was consented to in 2005 by Singleton Council. A high level summary of the consents and modifications is provided in Table 2.1. A copy of DA 450-10-2003, as modified, constitutes Appendix B.

Table 2.1 High level summary of approvals for HVO North

Approval No.	Approval Type	Issue Date	Consent Authority	Summary of Approved Activity
450-10-2003	Consent	12/6/2004	Department of Planning and Infrastructure (DP&I)	Extension of open cut mining to the east of existing development. Production rate of 12Mt per annum (Mtpa) ROM coal from West Pit, 10Mtpa ROM coal from Carrington Pit and 4Mtpa from North Pit. Coal haulage of 16Mtpa from HVO South to the Hunter Valley CHPP. Total processing capacity of 20Mtpa at Hunter Valley CHPP, 6Mtpa at Howick CHPP and 4.5Mtpa at Newdell CHPP. Movement of coal and rejects between areas of HVO, including between HVO South and HVO North. Temporary crossings of the Hunter River for heavy equipment too heavy for the existing bridge. Consolidation of 15 existing development approvals applying to HVO North, into a single consent.
884/2004	Consent	02/2/2005	Singleton Council	Construction and use of an access road to the former EnergyAustralia (now Ausgrid) substation.
450-10-2003 M1	Mod 1[(1)] of DA 450-10-2003	16/8/2005	DP&I	Upgrade of Hunter Valley Load Point to increase the loading rate from 4,000 tonnes per hour (tph) to an average rate of approximately 5,100tph with a peak load of up to 7,200tph.
450-10-2003 M2	Mod 2[(1)] of DA 450-10-2003	25/6/2006	DP&I	Extension of open cut mining to the south and east of Carrington Pit to access approximately 19Mt of ROM coal. Construction of up to three levees and potential construction of groundwater barrier walls. Diversion of an existing drainage channel. Construction of a service corridor and modification of the development consent boundary.

Table 2.1 Summary of approvals for HVO North *(Cont'd)*

Approval No.	Approval Type	Issue Date	Consent Authority	Summary of Approved Activity
450-10-2003 M3	Mod 3 of DA 450-10-2003	19/3/2013	DP&I	Extension of the Carrington Pit to the west (in an area known as the Carrington West Wing) to allow an additional 17 million tonnes of ROM coal to be extracted over a period of 6 years. Development of an out-of-pit overburden emplacement area to the north of the extension area. Construction of flood levees, a groundwater barrier wall, a temporary watercourse diversion and a service corridor to the south of the extension area. Rehabilitation the site. Modification of the development consent boundary to include the extension area.

Due to the long history of operations at HVO, a significant volume of environmental baseline data has been obtained. Numerous environmental assessments have been undertaken for the activities that have occurred across the site and, as such, the regional and local social, physical and economic environments are well understood. An overview of HVO's approach to environmental management is provided in Section 2.3.

As the proposed modification relates to the management of fine reject, additional information on this element of HVO North is provided below.

2.2 Processing and reject management

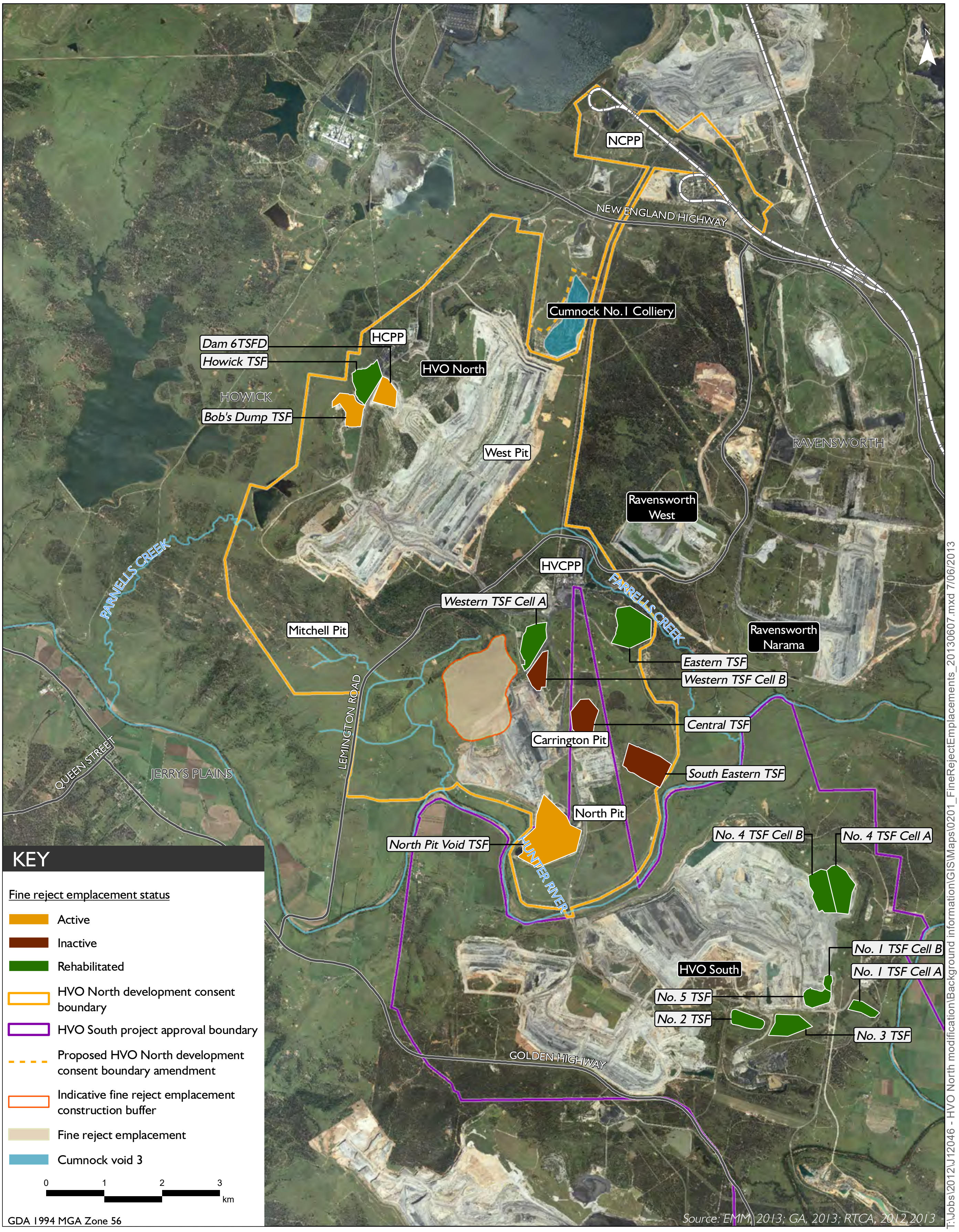
Coarse reject from HVO North can be transported between any pit, CHPP and overburden emplacements within HVO, as required, on existing private haul roads. Similarly, fine reject is approved to be pumped from any CHPP to any fine reject storage facility within HVO, as required. There are a number of fine reject storage emplacements located across HVO as shown on Figure 2.1 (referred to as TSFs - tailings storage facilities, in the figure). These emplacements are in various stages of development including rehabilitated, closed and drying and active. Active fine reject emplacements located within HVO North are in North Pit (North Pit Void Tailings Storage Facility) and West Pit (Bob's Dump Tailings Storage Facility). These emplacements are nearing capacity. Additional fine reject capacity has recently become available with the construction of Dam 6W in April 2012, however, this will only provide a limited amount of capacity for the Howick CHPP.

The ROM coal from the active pits within HVO North is trucked via internal haul roads to either the Hunter Valley CHPP or the Howick CHPP for processing. Product coal from the Hunter Valley CHPP is then transported by overland conveyor to the Hunter Valley Load Point where it is loaded onto trains for transport to Port Waratah at Newcastle. Product coal from the Howick CHPP is trucked to the Newdell Load Point for rail transport to Port Waratah. There is also infrastructure in place that allows coal to be transported by conveyor directly from the Howick CHPP to local power stations; however this is currently not in use.

The site produced around 2.66 million tonnes of coarse washery rejects and around 912,000 tonnes of fine washery rejects during the 2012 calendar year.

Visual inspections of the active fine reject emplacements and associated pipelines are carried out frequently, in accordance with relevant procedures and operation and maintenance manuals.

A programme of regular inspections is undertaken to include fine reject emplacements. The programme includes regular surveillance inspections and reporting by the fine reject emplacement design engineers who receive regular inspection reports. Operation and maintenance manuals have been developed for all active fine reject emplacements. Additionally, where fine reject emplacements are prescribed by the NSW Dams Safety Committee, further surveillance reporting is also undertaken and submitted to the Committee.



EMM EMGA Mitchell McLennan

Location and status of fine reject emplacements at HVO

HVO North - Fine reject emplacement modification

Figure 2.1

2.3 Environmental management

All of Coal & Allied's Hunter Valley mining operations operate under an Environmental Management System (EMS) which is certified to the international standard ISO 14001 (2004). The EMS relies upon an environmental policy, a series of regulatory required management plans, a monitoring programme and environmental standards and procedures. The EMS forms the basis for rigorous and consistent environmental management. It is regularly internally and externally audited to assess environmental performance. The effectiveness of the system has been demonstrated through these audits, which have shown a consistent trend of environmental improvement throughout the business.

The Coal & Allied EMS is integrated with the Rio Tinto Health, Safety, Environment & Quality Management System (HSEQ MS). The framework of the HSEQ MS aligns with the requirements of the standard AS/NZ 4804:2001, in addition to the requirements of section 25 of the *Coal Mine Health and Safety Act 2002* (NSW) and clause 22 of the *Coal Mine Health and Safety Regulation 2006* (NSW).

The HSEQ MS is a management tool implemented by Rio Tinto Coal Australia rather than it being a statutory requirement.

The HSEQ MS ensures all Rio Tinto operations uniformly work within a robust management framework and meet various certifications and internal and external reporting requirements. The HSEQ MS provides a systematic approach for sound hazard and risk identification, evaluation and management, ongoing verification and review of performance.

Environmental management at HVO North is undertaken in accordance with a number of approvals, licences, policies and procedures, including, but not limited to:

- development consent DA 450-10-2003;
- Environment Protection Licence (EPL 640);
- water licences;
- various mining authorities;
- Mining Operations Plans (MOPs);
- various environmental management plans; and
- dam licences.

As per existing policies and procedures, an extensive air quality, noise and vibration, surface and groundwater monitoring network supports environmental management at HVO. Two real time meteorological stations are also located at HVO: HVO Corporate Meteorological Station and the Cheshunt Meteorological Station. Data obtained from this monitoring network provided important information for the assessments presented in this report.

2.4 Existing interactions with Ravensworth Operations

The Ravensworth Operations complex comprises several mining areas that were consolidated under Project Approval DA 09_0176 for the Ravensworth Operations Project (ROP). The *Ravensworth Operations Project Environmental Assessment* (Umwelt, 2010) outlines the use of the Cumnock void 3 for the emplacement of fine reject. As Coal & Allied own land on which the Cumnock void 3 encroaches, a draft joint use agreement is being finalised between Coal & Allied and Cumnock No.1 Colliery Pty Limited, ICRA Cumnock Pty Limited and Xstrata Coal (NSW) Processing Pty Limited (Cumnock Joint Venture) for fine reject disposal within the void. The environmental assessments that were presented in the Umwelt (2010) EA and subsequent approvals are based on this premise.

The conceptual fine reject emplacement design for the Cumnock void 3 includes the construction of a dam wall for the emplacement of the fine reject on Cumnock Joint Venture-owned land.

2.5 Environmental assessment of the proposed use of Cumnock void 3

Planning approval for the use of Cumnock void 3 has been obtained for the emplacement of fine reject, including material originating from HVO (refer to Condition 6.14.3 of DA 09_0176). Therefore, this EA does not address the environmental impacts of the proposed modification in respect of the use of Cumnock void 3, except for those elements of the proposed modification that were not covered in the Umwelt EA (2010), for example the proposed installation of the fine reject pipeline from HVO to the void. Such exceptions are addressed in this document.

Hereinafter, references to the ’fine reject emplacement’, or simply the ‘emplacement’, refer to proposed fine reject emplacement in the northern section of the Carrington Pit, unless stated otherwise.

3 Proposed modification

3.1 Introduction

This chapter describes the proposed modification of DA 450-10-2003 which will provide HVO North with an anticipated additional six years of fine reject storage capacity. The construction and commissioning of the proposed emplacement will be completed within the existing development consent period, which is currently to 2025. Section 3.2 describes the fine reject emplacement and Section 3.3 describes the Cumnock void 3.

As shown in Table 3.1, there are no other changes to DA 450-10-2003 under the proposed modification.

Table 3.1 Overview of the proposed modification

Project aspect	Current approval	Proposed modification
ROM coal extraction limit	22 Mtpa ROM coal	No change
Project approval term	Until 12 June 2025	No change
Operating hours	Seven days per week, 24 hours per day	No change
Number of employees	Up to 1,246 full time positions (HVO in its entirety)	No change
Mining methods	Dragline and truck and shovel	No change
Mining areas	Within approved project disturbance boundary	No change
Infrastructure	As detailed in original EIS and subsequent modifications	The following alterations to infrastructure are sought under the proposed modification: • the construction and operation of a fine reject emplacement; and • fine reject emplacement in the Cumnock void 3.
External coal transport	Transport of coal via rail	No change

3.2 Fine reject emplacement

3.2.1 Overview

The proposed fine reject emplacement will be constructed in the northern section of the Carrington Pit. It will occupy an area of approximately 161 ha, including a 13 ha construction disturbance buffer, and will be on land that has been mined and is cleared of remnant native vegetation. Figure 3.1 depicts the emplacement's conceptual design and Figure 3.2 an indicative cross-section. Based on the conceptual design, the facility would have a capacity of approximately 14.4 million cubic metres.

Fine reject will be transported to the emplacement via an overland pipeline direct from the HVO North CHPPs. A separate return water pipeline will also be constructed.

The life of the fine reject emplacement, in conjunction with the use of Cumnock void 3, is anticipated to be six years. After this time, the emplacement will be decommissioned and the affected land rehabilitated in accordance with the rehabilitation planning for the Carrington Pit.

3.2.2 Construction

The NSW Dams Safety Committee (DSC) has issued guidelines in respect of the design, construction and operation of fine reject dams to assist dam owners and other stakeholders in the consideration of general and specific issues relating to the safety management of dams, namely the DSC3F guidelines. The subject emplacement will be designed, constructed and operated in accordance with the DSC3F guidelines. These guidelines cover such issues as consequence assessment of dam failure, flood criteria, seismic capacity, freeboard, operational requirements, surveillance and decommissioning.

The detailed design of the fine reject emplacement is yet to be undertaken but a preliminary design has been developed by experienced engineers based on the results of the geotechnical analysis and risk assessment. The indicative configuration is shown in Figure 3.1. At completion of design, a design report would be prepared and submitted to the NSW Dams Safety Committee for its consideration.

The proponent will liaise with the DSC to fulfil its requirements.

The emplacement will be built from mine spoil and will be located within the mine's approved disturbance footprint. As far as practical, equipment associated with the operation of adjacent pits will be utilised in the construction of the emplacement. As a result, limited additional equipment is anticipated to be required for its construction. To provide a conservative assessment approach, plant and equipment associated with the construction of the fine reject emplacement have been modelled separately as additional plant items and incrementally added to past modelling results for HVO North. This approach is detailed in the noise and air quality studies in Chapters 11 and 12, respectively.

HVO has an existing network of pipelines and the fine reject pipelines required to and from the fine reject emplacements will be constructed, as necessary to form part of the larger network. All pipelines will be overland, minimising the requirement for excavation. Pipeline construction will generally be restricted to areas that:

- have been previously disturbed by mining and related activities;
- are adjacent to existing infrastructure such as haul roads and existing pipelines; and
- will disturb no more than remnant isolated trees if they cannot be avoided.

A site survey of the preferred alignment will be completed before any activities start at each location. This information will be used to complete a Coal & Allied Ground Disturbance Permit (GDP) application. This is an internal application, subject to Coal & Allied's assessment. The GDP will ensure that the sites meet the above criteria and appropriate environmental management is assigned to each site.

3.2.3 Operation

The emplacement will operate as a settling pond under the principle of gravity settlement. A slurry mixture of coal fines and water will be fed from either CHPP to the emplacement via a pipeline. The pipeline's discharge location will be moved regularly, to promote beaching and fine reject settlement whilst minimising the extent of water pooling against the emplacement wall. The water will then be decanted from the fine reject emplacement and re-used in the CHPPs. Over the life of the emplacement the volume of coal fines will accumulate until no further space is available. After this time the remaining water will be decanted from the emplacement leaving the coal fines to air dry. Ongoing monitoring will determine when the emplacement is dry and stable. Following this, the emplacement will be capped with suitable material and the land rehabilitated.

3.2.4 Rehabilitation

A MOP (August 2012) is in place for the Carrington Pit. The proposed emplacement will be located within the area covered by the MOP, and accordingly, its rehabilitation needs to be considered in the context of the MOP. The pre-cursor to the actual rehabilitation of the area will be the drying and capping of the emplacement area, as indicated in Section 3.2.3 above. The Carrington Pit MOP reinforces the conditions of consent in DA 450-10-2003 regarding rehabilitation.

As set out in the MOP for the Carrington Pit, the final landform is planned to comprise an undulating landscape with minor valley systems designed to be consistent with the surrounding pre-mining environment. Final landform slopes vary according to erosion hazard, stability and drainage requirements. The rehabilitated land will have a mix of pasture and native habitat areas. The emplacement area will be rehabilitated in accordance with these concepts.

3.3 Cumnock void 3

3.3.1 Overview

The Cumnock void 3 is located outside of the HVO North development consent boundary on freehold land substantially owned by Cumnock Joint Venture, however it encroaches on land owned by Coal & Allied. The majority of the void is located within a mining lease held by Cumnock Joint Venture with the remainder within an area proposed to be included in a mining lease applied for by Coal & Allied. Fine reject emplacement within the void was assessed by Umwelt (2010) and approved under Project Approval 09_0176. This modification is to allow for Coal & Allied to transport and emplace fine reject in Cumnock void 3.

3.3.2 Construction

Cumnock void 3 is an existing void and requires no substantial construction works to enable the emplacement of fine reject from HVO North.

Fine reject will be transported to the Cumnock void 3 emplacement via an overland pipeline from either the Howick or Hunter Valley CHPP.

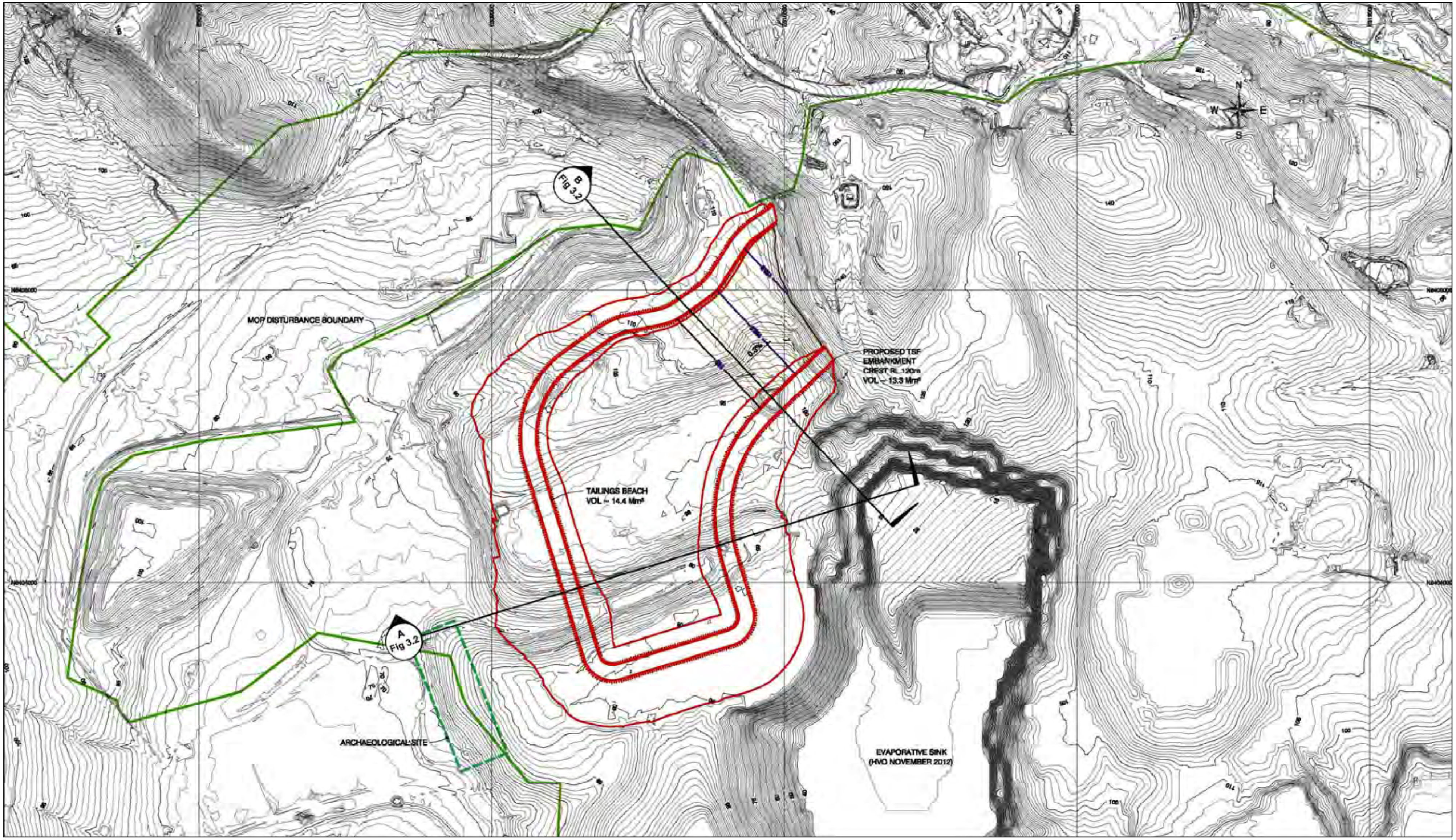
3.3.3 Operation

The operation of the fine reject emplacement in the Cumnock void 3 will be managed by an appointed Manager in accordance with the Project Approval DA 09_0176 and is described in Umwelt 2010.

3.3.4 Rehabilitation

Rehabilitation of the Cumnock void 3 will be undertaken by Cumnock Joint Venture in accordance with rehabilitation objectives and management plans, as required in the Project Approval DA 09_0176. The proposed modification is consistent with Project Approval DA 09_0176 and will have no bearing on the rehabilitation and final landform of Cumnock void 3.

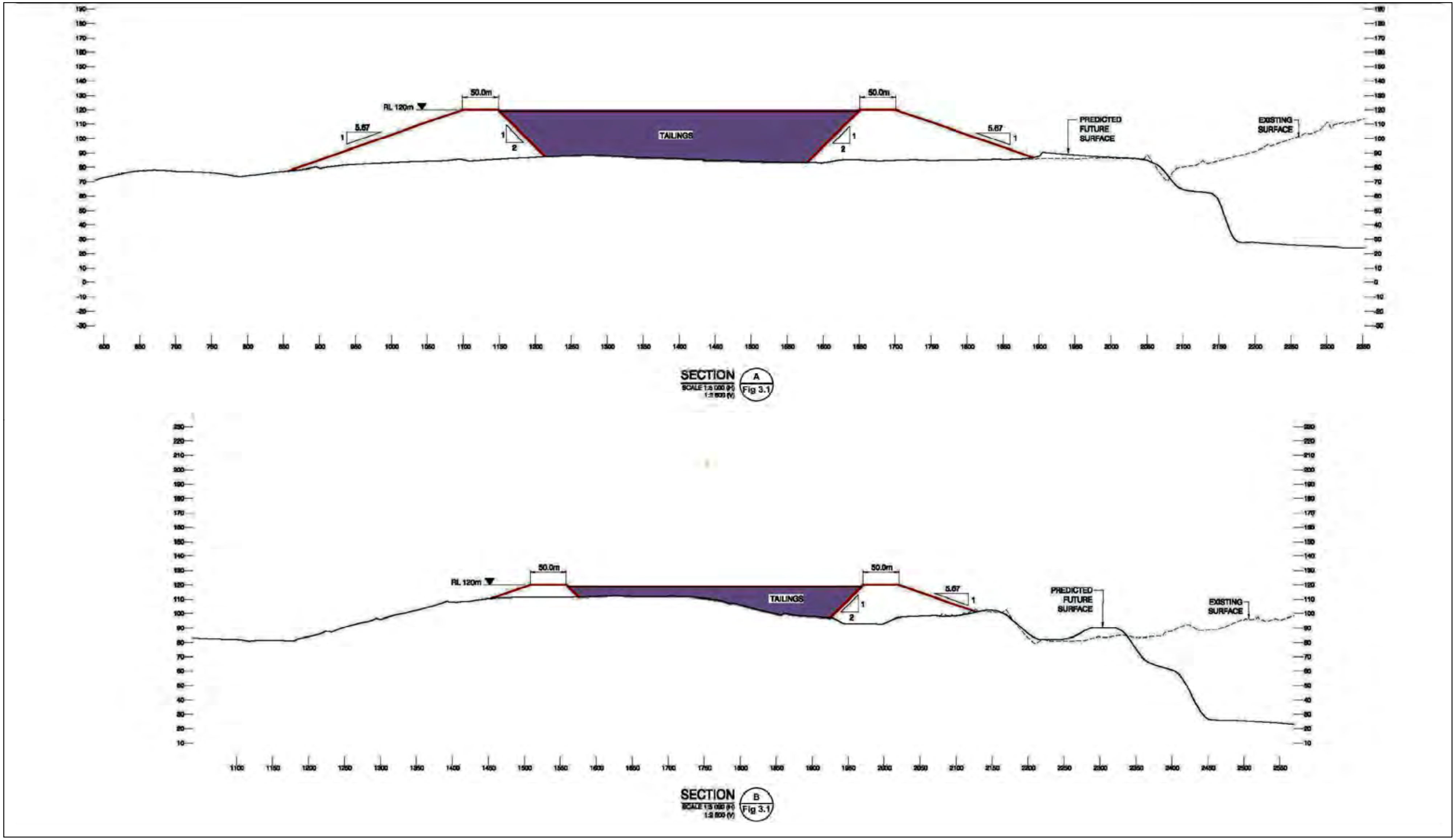
The draft joint use agreement proposes that Cumnock Joint Venture will be responsible for the rehabilitation of the Cumnock void 3 and associated disturbed land and for the costs of rehabilitation to be shared with Coal & Allied. The rehabilitation of the pipeline route will be undertaken in accordance with an approved MOP.



Indicative fine reject emplacement configuration

HVO North - Fine reject emplacement modification

Figure 3.1



Indicative fine reject emplacement cross section

HVO North - Fine reject emplacement modification

Figure 3.2

3.4 Modification to development consent boundary

To accommodate Cumnock void 3 and the proposed pipeline that will connect the Howick and/or Hunter Valley CHPPs to the void, the existing development consent boundary will be extended. The development consent boundary amendment is shown on Figure 1.2.

3.5 Proposed interactions with Ravensworth Operations

Existing interactions between HVO North and Ravensworth Operations are described in Section 2.4. As stated, the Umwelt (2010) EA and Project Approval DA 09_0176 have been based on the premise that Cumnock void 3 will be utilised for fine reject emplacement from both operations. Accordingly, no modification to Project Approval DA 09_0176 is required as a result of the proposed modification.

A joint use agreement between the Cumnock Joint Venture and Coal & Allied will be finalised in respect of each company's use of the void. The draft joint use agreement states that each party is responsible for the recovery of return water from the emplacement of fine reject in Cumnock void 3 to their nominated facility.

In the unlikely event of an incident occurring at the proposed fine reject emplacement or pipelines leading to and from the proposed fine reject emplacement and Cumnock void 3, remediation would take place in accordance with the applicable management procedures to ensure compliance with the applicable EPL.

3.6 Alternatives considered

A number of options for the management of fine reject were considered during the development of the proposed modification, including the 'do nothing' option. As can be seen in Table 3.2, options were excluded for various reasons that included economics, construction or development time delays and geotechnical risk. The preferred option provides the greatest increase in fine reject storage capacity with the least environmental footprint.

i Fine reject management options

Considerations in arriving at the proposed modification included:

- examination of alternative in-pit and out-of-pit locations throughout HVO North and HVO South. These were rejected on environmental and safety grounds, practicality and timing of their availability;
- reduction of the northern extent of the fine reject emplacement to avoid the remnant vegetation located beyond the approved 20 year mine plan disturbance area; and
- the free-draining design of the fine reject emplacement to minimise the loss of catchment.

A summary of fine reject management options assessed is provided in Table 3.2.

Table 3.2 Summary of fine reject management options assessed

Option	Advantages	Disadvantages	Outcome
Cumnock void 3	• Secure location • Short timeframe to implement • Approved for construction and operation under DA 09_0176	• Subject to agreement with Ravensworth Operations • Limited capacity	Preferred and proposed under this modification
Carrington fine reject emplacement	• Within existing approved area of disturbance • Upstream of voids • Close to existing infrastructure	• Additional haulage costs • Additional water management required • Potential impact on future mining - underground resource sterilisation	Preferred and proposed under this modification
West Pit North Void	• Contained in established void	• Would require revision of existing mine plan • Impacts to dragline operation and, hence, productivity • Long timeframe to implement • Option only possible after mining of the northern end of West Pit is exhausted	Not currently suitable
Raise Bob's Dump fine reject storage facility	• Within existing mining footprint	• Limited capacity • High cost • Not cost effective due to limited room to raise embankment on haul road side	Rejected
Raise North Void and utilise paste thickening	• Extend life of North Void	• Surface area of void not conducive to paste thickening • Potential impact on future mining - underground resource sterilisation • Long timeframe to implement	Rejected
Dam 6 fine reject storage facility (Stage 3)	• Minimal	• Limited capacity • High cost • Water in pit impacting operations	Rejected

ii Do-nothing option

The 'do nothing' option would avoid the minor additional environmental impacts beyond those currently approved and the costs associated with construction of the fine reject emplacement. Fine reject emplacement capacity is, however, critical to the viability of the HVO North. The 'do nothing' option would force RTCA to adopt an alternative option, which as demonstrated in Table 3.2 above, would have increased potential for adverse environmental impacts, be less cost effective, reduce productivity and/or sterilise resources. Under this scenario, the social and economic benefits from HVO North that have been realised for over 50 years since commencement of operations may cease.

4 Planning and statutory framework

4.1 NSW legislation

4.1.1 Environmental Planning and Assessment Act 1979

While the development consent for the HVO North was a consent issued under Part 4 of the EP&A Act, transitional provisions within the *Environmental Planning and Assessment Regulation 2000* (NSW) (EP&A Regulation) allow for a consent to be modified under Section 75W of the EP&A Act as if the consent were an approval under the now repealed Part 3A.

Pursuant to the transitional provisions under clause 12 to Schedule 6A of the EP&A Act, Section 75W of Part 3A continues to apply to modifications of certain development consents provided for under Clause 8J(8) of the EP&A Regulation.

Clause 8J(8)(c) of the EP&A Regulation states:

> *For the purposes only of modification, the following development consents are taken to be approvals under Part 3A of the Act and section 75W of the Act applies to any modification of such a consent:*
>
> *c) a development consent granted by the Minister under Part 4 of the Act (relating to State significant development) before 1 August 2005 or under clause 89 of Schedule 6 to the Act,*

DA 450-10-2003 was issued by the then Minster for Infrastructure, Planning and Natural Resources in 2004, under Part 4 of EP&A Act, and therefore, Clause 8J(8)(c) applies.

The main elements of the approved development and operations at HVO North will not be affected by the proposed modification. It is contended that the proposed modification does not represent a radical transformation of the previously approved project. Further, as demonstrated by the assessments in Chapters 7 to 16, the proposed modification will not result in significant environmental consequences beyond those covered in the current development consent. Accordingly, Coal & Allied seeks to have the proposal approved as a modification of DA 450-10-2003, as provided for under Clause 8J (8)(c) of the EP&A Regulation and Section 75W of the EP&A Act.

A political donations disclosure statement has been provided, in accordance with Section 147 of the EP&A Act.

4.1.2 Other state legislation

Table 4.1 summarises other NSW legislation that is of relevance to the proposed modification.

Table 4.1 Summary of other applicable legislation

Legislation	Requirement	Comment
Protection of the Environment Operations Act 1997 (NSW) (POEO Act)	Section 48 of the POEO Act requires that a premises-based Environment Protection Licence (EPL) be held for the activities listed in Schedule 1.	A premises-based EPL, EPL 640, applies across HVO as a whole. No update to the EPL will be required as a consequence of the proposed modification.
Mining Act 1992 (NSW)	This Act regulates the granting of Mining Leases and mining activities generally and, amongst other legislative instruments, places controls on methods of exploration and mining, the disposal of mining waste, and rehabilitation and environmental management activities.	The following titles are held by HVO and covers the project area: CML4, ML1474, ML1482. The Cumnock Joint Venture owns ML1669 which covers the Cumnock void 3. In line with Section 6 of the Mining Act, the proposed modification will be undertaken in accordance with authorisations in force in respect of the land where the proposed modification will occur. The Carrington Pit MOP will be reviewed and updated as required to incorporate the proposed modification (see Section 3.2.4).
Water Management Act 2000 (NSW) *(WM Act)*	The WM Act governs the issue of new water licences and the trade of water licences and allocations for those water sources (rivers, lakes and groundwater) in NSW where water sharing plans have commenced, such as within the project area.	The proposed modification will not affect any water source regulated by a Water Sharing Plan in force under the WM Act 2000.
National Parks and Wildlife Act 1974 (NSW) (NPW Act)	A permit under Section 87 or a consent under Section 90 of the Act is required to disturb or destroy an Aboriginal object.	No Aboriginal objects are assessed to be disturbed or destroyed under the proposed modification (Chapter 10).
Threatened Species Conservation Act 1995 (NSW) (TSC Act)	If a planned development or activity will have an impact on a threatened species, population or ecological community listed under the Act, this must be taken into account in the development approval process.	The species protected under this Act have been considered in this assessment (Chapter 9) and with the implementation of management measures, the proposed modification will not adversely affect species prescribed in the schedules to the TSC Act.
Dams Safety Act 1978 (NSW)	The Act requires that the NSW DSC periodically review large dams that may constitute a hazard to human life and property. These dams are prescribed dams and are to be designed to the satisfaction of the DSC.	Consultation with DSC will be undertaken as part of the approvals process to determine if the fine reject emplacement will be a prescribed dam (Section 3.2.2)
Coal Mines Health and Safety Act 2002 (NSW)	Section 100 (1) requires the approval of the Minister for Primary Industries for the establishment of an emplacement area at a coal mine.	The approval required under S 100 (1) will be sought in respect of the emplacement area.

4.1.3 State Environmental Planning Policies

State environmental planning policies (SEPPs) are environmental planning instruments that address issues significant to NSW. The following SEPPs will be considered in the assessment of the proposed modification:

- *SEPP (Mining, Petroleum Production and Extractive Industries) 2007*;
- *SEPP (Major Development) 2005*;
- *SEPP (State and Regional Development) 2011*;
- *SEPP 33 – Offensive and Hazardous Development;*
- *SEPP 44 – Koala Habitat Protection*; and
- *SEPP 55 – Remediation of Land.*

The *SEPP (Mining, Petroleum Production and Extractive Industries) 2007* aims to provide for the proper management and development of mineral, petroleum and extractive material resources for the social and economic welfare of the State. The policy establishes appropriate planning controls to encourage Ecologically Sustainable Development (ESD). The proposed modification is consistent with the aims and controls of this policy.

The *SEPP (Mining, Petroleum Production and Extractive Industries) 2007* also defines mining developments that are prohibited, exempt or complying developments. As discussed in Section 4.1.4, the proposed modification is permissible under the provisions of the Singleton LEP. The permissibility of the proposed modification is not affected by this SEPP.

SEPP (Major Development) 2005 previously defined classes of development to which Part 3A of the EP&A Act applied. This SEPP was amended by *SEPP (State and Regional Development) 2011* in accordance with the repeal of Part 3A, though it is still relevant to the proposed modifications as it continues to apply to transitional Part 3A projects. Prior to the repeal of Part 3A of the EP&A Act, Clause 6 of *SEPP (Major Development) 2005* stated:

> *(1) Development that, in the opinion of the Minister, is development of a kind:*
>
> *(a) that is described in Schedule 1 or 2, or*
>
> *…*
>
> *is declared to be a project to which Part 3A of the Act applies.*

Coal mining was a form of development described in Schedule 1 of SEPP (Major Development) 2005 and, therefore, Part 3A of the EP&A Act applies to DA 450-10-2003.

SEPP 33 requires the consent authority to consider whether a proposal is a potentially hazardous or offensive industry. The existing operations at HVO North are not classed as hazardous or offensive development under SEPP 33. The proposed modification proposes only minor changes to current operations. It is not considered potentially hazardous or offensive. Therefore, SEPP 33 does not apply to the proposed modification.

SEPP 44 applies to the extent that a consent authority is restricted from granting approval for a development proposal on land identified as core koala habitat without the preparation of a plan of management. The ecological assessment found that no areas of core koala habitat exist and, therefore, SEPP 44 does not place any constraints on the proposed modification.

SEPP 55 requires that a consent authority not consent to the carrying out of development on land unless it has considered any potential contamination issues. Technical assessments for the proposed modification did not identify any potential contamination issues. Therefore, SEPP 55 does not place any constraints on the proposed modification.

4.1.4 Singleton Local Environmental Plan

The proposed modification elements are located within the Singleton LGA. Under the provisions of the *Singleton Local Environmental Plan 1996* (NSW) (Singleton LEP), the affected area is zoned No.1 (a) Rural. Mining is a permissible land use within this zone with development consent. The proposed modification is consistent with the provisions of the Singleton LEP.

The Draft Singleton Local Environmental Plan 2013 is currently being finalised. Under the Draft LEP, the project site is Zoned RU1 – Primary Production. Open cut mining is permissible with consent within this zone.

4.1.5 Upper Hunter Strategic Regional Land Use Plan

The Upper Hunter Strategic Regional Land Use Plan (DP&I 2012) (the Plan) aims to minimise potential land use conflict between mining and coal seam gas proposals and key land values such as strategic agricultural land. The Plan includes a gateway process for State significant development applications for mining on biophysical strategic agricultural land. This gateway process takes place prior to submission of development applications to the consent authority and is conducted by an independent panel of experts (Mining and Coal Seam Gas Gateway Panel). The Plan excludes the requirement for gateway certification provided the project area is entirely within an existing mining lease. As the entire project area is within existing lease areas (refer to Table 4.1), the proposed modification is exempt from the gateway process.

In accordance with the Plan, an Agricultural Impact Statement (AIS) is required for all State significant development applications for mining proposals in the region that would potentially impact on agricultural resources or industries. The proposed modification will not impact on agricultural resources or industries and, accordingly, an AIS has not been prepared for the proposal.

4.1.6 NSW Aquifer Interference Policy – Stage 1

The NSW Aquifer Interference Policy – Stage 1 explains the role and requirements of the Minister administering the WM Act in the water licensing and assessment processes for aquifer interference activities under the WM Act and other relevant legislative frameworks.

State significant development applications that have been granted consent will be exempt from requiring an Aquifer Interference Approval. Accordingly, assuming that the proposed modification is approved, it will be exempt from requiring an Aquifer Interference Approval.

4.2 Commonwealth legislation

The *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) aims to protect matters deemed to be of Matters of National Environmental Significance (MNES).

If an action (or proposed modification) will, or is likely to, have a significant impact on any of the MNES, it is deemed to be a Controlled Action and requires approval from the Commonwealth Environment Minister or the Minister's delegate. To determine whether a proposed action will or is likely to be a Controlled Action, an action may be referred to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC). The ecology assessment, Chapter 9, concluded that the proposed modification would not significantly impact any MNES. Accordingly, a referral under the EPBC Act is not required.

5 Stakeholder engagement

5.1 Consultation principles and process

Coal & Allied aims to build enduring relationships with the communities in which it operates, characterised by mutual respect, active partnership and long term commitment.

Coal & Allied adheres to a set of engagement tools. These tools are:

- shopfronts in Singleton and Muswellbrook, freecall information line (1800 727 745) and Coal & Allied website that includes information on the proposal (www.riotintocoalaustralia.com.au);
- quarterly newsletters distributed to all residents within the Singleton LGA which provide information on Coal & Allied mining operations in the LGA, including upcoming projects;
- the Hunter Valley Operations Community Consultative Committee (CCC) which meets regularly to discuss mining operations and environmental performance, and comprises representatives of the community, Singleton and Coal & Allied; and
- Upper Hunter Cultural Heritage Working Group which meets regularly to discuss heritage aspects of Coal & Allied operations, and is comprised of representatives of Coal & Allied and the Upper Hunter Valley Aboriginal community.

These tools were supplemented by activities undertaken specifically for the proposed modification, as detailed in the following.

5.2 Project specific stakeholder engagement

5.2.1 Stakeholder engagement strategy

Coal & Allied prepared and is implementing a stakeholder engagement strategy for the proposed modification. The strategy involves:

- informing stakeholders about the proposed modification through the CCC and quarterly newsletters; and
- the continued option for stakeholders to contact Coal & Allied about the proposed modification via the shopfronts, free call information line and the website.

The level of stakeholder engagement detailed in the strategy is considered appropriate, given the relatively minor nature of the proposed modification.

5.2.2 Government

Consultation was undertaken with DP&I and the DRE. The outcomes of consultation with DRE are reflected in the preferred approach to the management of fine reject in the fine reject emplacement. A summary of consultation undertaken with these government agencies is provided in Table 5.1.

Table 5.1 Summary of consultation undertaken with government agencies

Agency	Date consulted	Description
DP&I	17 July 2012	Project briefing; discussion of the need to document alternatives considered and additional key matters requiring consideration.
DRE	18 July 2012	Project briefing; DRE identified a need for an innovative approach to fine reject management at HVO.
DRE	13 December 2012	Additional information was provided to DRE following a request from DRE for further information regarding the management of fine reject, including the preparation of a fine reject management and rehabilitation strategy and innovation in HVO's approach to fine reject management.

5.2.3 Community

Coal & Allied prepared and is implementing the stakeholder engagement strategy referred to in Section 5.2.1 above.

A summary of community consultation for the proposed modification, matters raised and where these have been addressed in the EA is provided in Table 5.2. A more in depth description of consultation undertaken with the local Aboriginal community is provided in Chapter 10.

Table 5.2 Summary of consultation with community

Stakeholder	Date consulted	Description	Matter raised	Reference
CCC members	19 July 2012	Proposal was presented as part of CCC meeting.	None raised	-
Jerrys Plains BBQ	23 August 2012	Community BBQ – operational staff and factsheets were on hand to provide details.	Noise and air quality impacts from HVO.	Chapters 11 and 12
Singleton Local Government Area	24 September 2012	Newsletter sent on 24 September to all residents in the 2330 postcode, and was also available on Rio Tinto Coal Australia's website.	Noise and air quality impacts from HVO.	Chapters 11 and 12
Singleton	Ongoing	Factsheet and Rio Tinto Coal Australia Community Relations team staff available at shopfront for people to drop in for information.	None raised	-

6 Environmental risk assessment

6.1 Methodology

An environmental risk assessment was undertaken for the proposed fine reject emplacements, using two variables, namely:

- the potential severity or consequences of the environmental impact; and
- the likelihood of that impact occurring.

The variables were evaluated for the construction and operation of the proposed fine reject emplacement and pipelines leading to and from the proposed fine reject emplacement and Cumnock void 3, assuming that appropriate mitigation measures would be in place.

The following definitions were applied.

- Severity or consequences of impact:
  - **Minor:** Near-source confined and promptly reversible impact on-site with little or no off-site impact expected.
  - **Medium:** Near source confined and short-term reversible impact on-site with little, promptly reversible, off-site impact.
  - **Serious:** Near-source confined and medium-term recovery impact on-site with near-source and short-term reversible off-site impact.
  - **Major:** Impact that is unconfined and requiring long-term recovery, leaving residual damage on-site with near-source confined and medium-term recovery of off-site impacts.
  - **Catastrophic:** Impact that is widespread and unconfined and requiring long-term recovery, leaving major residual damage on-site with off-site impact that is unconfined and requiring long-term recovery and leaving residual damage.
- Likelihood of impact:
  - **Rare:** Impact that is very unlikely to occur during the lifetime of the project.
  - **Unlikely:** Impact that is unlikely to occur during the lifetime of the project.
  - **Possible:** Impact that may occur during the lifetime of the project.
  - **Likely:** Impact that may occur frequently during the lifetime of the project.
  - **Almost Certain:** Recurring event during the lifetime of the project.

Table 6.1 below shows the risk matrix used to identify environmental risks associated with the emplacements. In each case, a score of 1 to 5 is given for the consequence and likelihood of impact and the scores are added to determine the environmental risk rating. There are four classes of environmental risk utilised in this assessment, as indicated below.

- **Low:** Risks that are below the risk acceptance threshold and do not require active management. Certain risks could require additional monitoring.
- **Moderate:** Risks that lie on the risk acceptance threshold and require active monitoring. The implementation of additional measures could be used to reduce the risk further.
- **High:** Risks that exceed the risk acceptance threshold and require proactive management. Includes risk for which proactive actions have been taken, but further risk reduction is impractical.
- **Critical:** Risks that significantly exceed the risk acceptance threshold and need urgent and immediate action.

Table 6.1 Environmental assessment matrix

		Consequence				
		1 Minor	2 Medium	3 Serious	4 Major	5 Catastrophic
Likelihood of Impact	5 Almost Certain	6 (Moderate)	7 (High)	8 (Critical)	9 (Critical)	10 (Critical)
	4 Likely	5 (Moderate)	6 (High)	7 (High)	8 (Critical)	9 (Critical)
	3 Possible	4 (Low)	5 (Moderate)	6 (High)	7 (Critical)	8 (Critical)
	2 Unlikely	3 (Low)	4 (Low)	5 (Moderate)	6 (High)	7 (Critical)
	1 Rare	2 (Low)	3 (Low)	4 (Moderate)	5 (High)	6 (High)

6.2 Risk ratings

The results of the risk assessment for the proposed emplacement are provided in Table 6.2. The risk ratings were derived by considering the proposed emplacement and how it would affect the environmental attributes listed in the table in terms of the likelihood and consequences of its impacts on those attributes.

Table 6.2 Environmental risk rating

Environmental Attribute	Consequence	Likelihood	Rating
Groundwater			
Seepage into groundwater system	2	3	5 (Moderate)
Surface water			
Impact on local watercourses and the Hunter River	1	1	2 (Low)
Biodiversity			
Impact on threatened flora species and their habitat	2	1	3 (Low)
Reduction of threatened fauna habitat	2	1	3 (Low)
Aboriginal heritage			
Impact on Aboriginal artefacts	1	1	2 (Low)
Impact on cultural heritage	1	1	2 (Low)
Acoustics			
Incremental noise impacts on residential receptors	2	1	3 (Low)
Cumulative noise impacts	2	1	3 (Low)
Air quality and greenhouse gases			
Incremental air quality impacts on residential receptors	2	1	3 (Low)
Cumulative air quality impacts	2	1	3 (Low)
Greenhouse gas impacts	1	3	4 (Low)
Soils and land capability			
Erosion and soil disturbance	1	1	2 (Low)
Impact on agricultural land	1	1	2 (Low)
Rehabilitation			
Changes to landform	2	3	5 (Moderate)
Visual amenity			
Impact on surrounding receptors from modified landform	1	3	4 (Low)
Socio-economic			
Impact on general amenity of residential receptors	1	1	2 (Low)
Economic impacts of proposed emplacements	3	2	5 (Moderate)
Historic heritage			
Impact on historic heritage	1	1	2 (Low)
Traffic and transport			
Impact on local and regional road networks	1	1	2 (Low)

As shown in Table 6.2, all environmental risks from the proposed modification were considered low, with the exception of potential groundwater, rehabilitation and socio-economic impacts. Environmental assessments of these moderate risk environmental aspects have been undertaken commensurate with their risks. The assessments are provided in Chapters 7 (Groundwater) and 15 (Socio-economic). Rehabilitation and final landform are described in Chapter 3.

Where appropriate, management and monitoring measures are proposed in the subsequent chapters to prevent and/or mitigate the potential for adverse impacts to the attributes identified in Table 6.2.

7 Groundwater

This chapter provides a summary of the groundwater assessment prepared by Australasian Groundwater & Environmental Consultants, which is presented in full in Appendix C. The key findings are summarised below.

7.1 Existing environment

The hydrogeological regime at HVO North consists of:

- palaeochannel alluvium;
- spoil placed in mined areas; and
- permian formations, comprising coal seams and interburden.

The fine reject emplacement will be located on an area that has been mined and filled with spoil. Prior to mining, the topmost 10 to 20 m of the subject area was part of a former meander of the Hunter River, known as a paleochannel. A remnant of paleochannel alluvium remains to the north of the backfilled Carrington Pit which is effectively isolated from the remainder of the paleochannel alluvium to the south. The spoil that has been used to backfill the Carrington Pit hydraulically connects the dissected alluvium to the north and the in-situ alluvium to the south.

Existing groundwater monitoring data indicates that groundwater within the paleochannel alluvium is generally poor quality in its natural state. Groundwater is moderately saline, with a measured electrical conductivity (EC) range of 2,000 to more than 8,500 µS/cm. The pH levels typically range from about 6.8 to 8.5 pH units.

The Permian formations and coal seams outcrop in the elevated terrain of HVO North and dip to the south-west below the Hunter River. They are generally low yielding and contain poor quality brackish to slightly saline water. The water table / potentiometric surface of the Permian formations and coal seams is locally depressurised due to seepage to the Carrington Pit. The depressurisation of the coal seams has resulted in a downward vertical gradient from the alluvium to the Permian.

An impermeable barrier wall has been constructed across the eastern arm of the paleochannel to isolate groundwater connectivity between the Hunter River and the mining area. Another barrier wall will be constructed for the Carrington West Wing project on the western arm of the paleochannel. An enlarged evaporative sink which also formed part of the Carrington West Wing project will stop saline water overtopping the barrier wall and, conversely, the barrier wall stops fresh water from the Hunter River and alluvials from reaching the mining operations.

7.2 Assessment

7.2.1 Approach

The proposed fine reject emplacement will seep water from the emplaced fine reject slurry and from rainwater recharge through the emplacement. Modelling has been undertaken to assess the potential for seepage from the proposed fine reject emplacement to interact with the Hunter River and the surrounding alluvium.

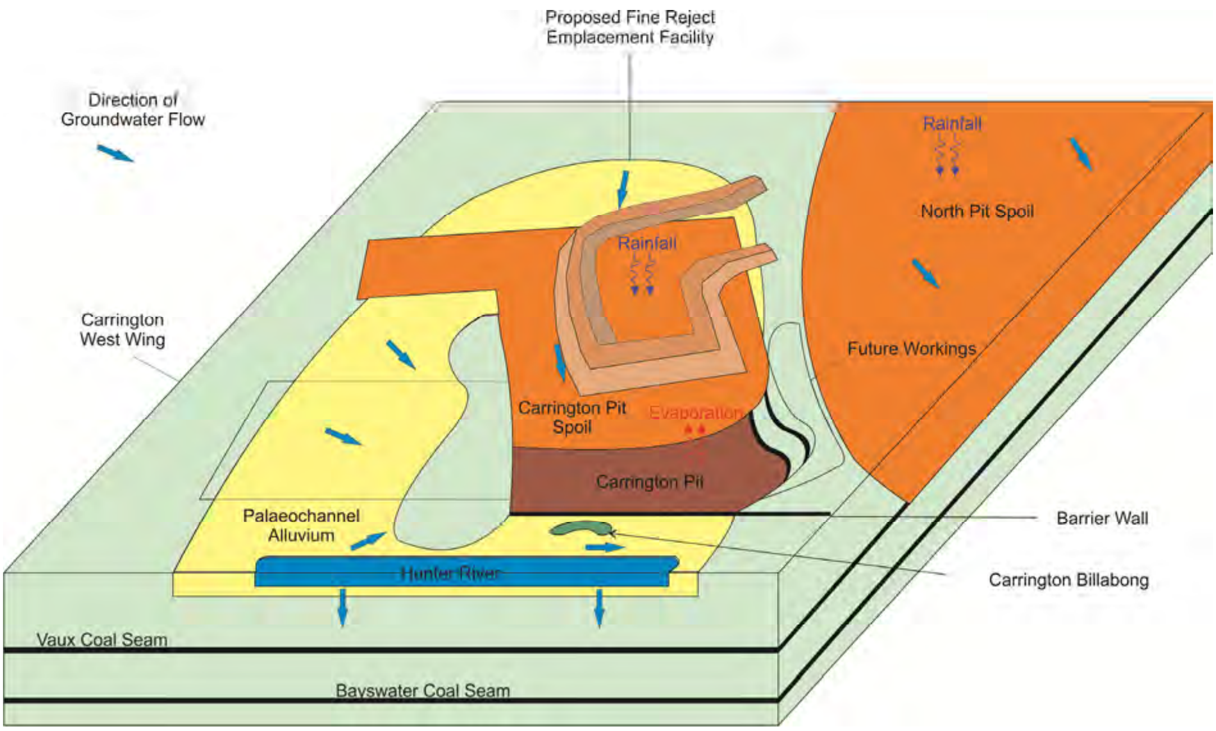
Three different models were involved:

1. An analytical seepage model which is based on water balances that take account of rainfall, evaporation and water in the fine reject slurry;

2. A two dimensional (2D) model known as SEEP/W. It is an industry standard, two dimensional, finite element, numerical seeping modelling package which is used extensively in the mining industry for assessing seepage through artificial embankments, fine reject emplacement facilities and water impoundments; and

3. A three dimensional (3D) model based on the SURFACT software package. A finite difference numerical model was developed to predict groundwater impacts for the Carrington West Wing project using this package. This model was adapted to include the proposed modification. It consists of seven layers. The upper layer represents the alluvium and weathered bedrock. The other layers, except for Layer 6, represent the Permian coal measures and associated interburden. Layer 6 represents the Bayswater Seam. Figure 7.1 illustrates the concepts that underpin the 3D model.

Figure 7.1 Conceptual groundwater model



The analytical seepage model was used as a check against the results from the 2D Model and supported the 2D model results. Outputs from the 2D model were fed into the 3D model which produced predicted spatial and temporal groundwater impacts attributable to the proposed fine reject emplacement.

The 3D model includes the existing approved activities associated with the Carrington Pit, the Carrington West Wing project, and the fine reject emplacement.

Results of the analytical, 2D and 3D modelling are summarised below:

- predictions using the analytical seepage model indicate that the fine reject emplacement could produce up to 703 m^3/day of seepage after accounting for rainfall and evaporative loss. This steady state solution considers a 'conservative' or 'worst case' estimate. The calculations are based on the maximum hydraulic head within the emplacement which will only occur during the final stages of fine reject deposition; and

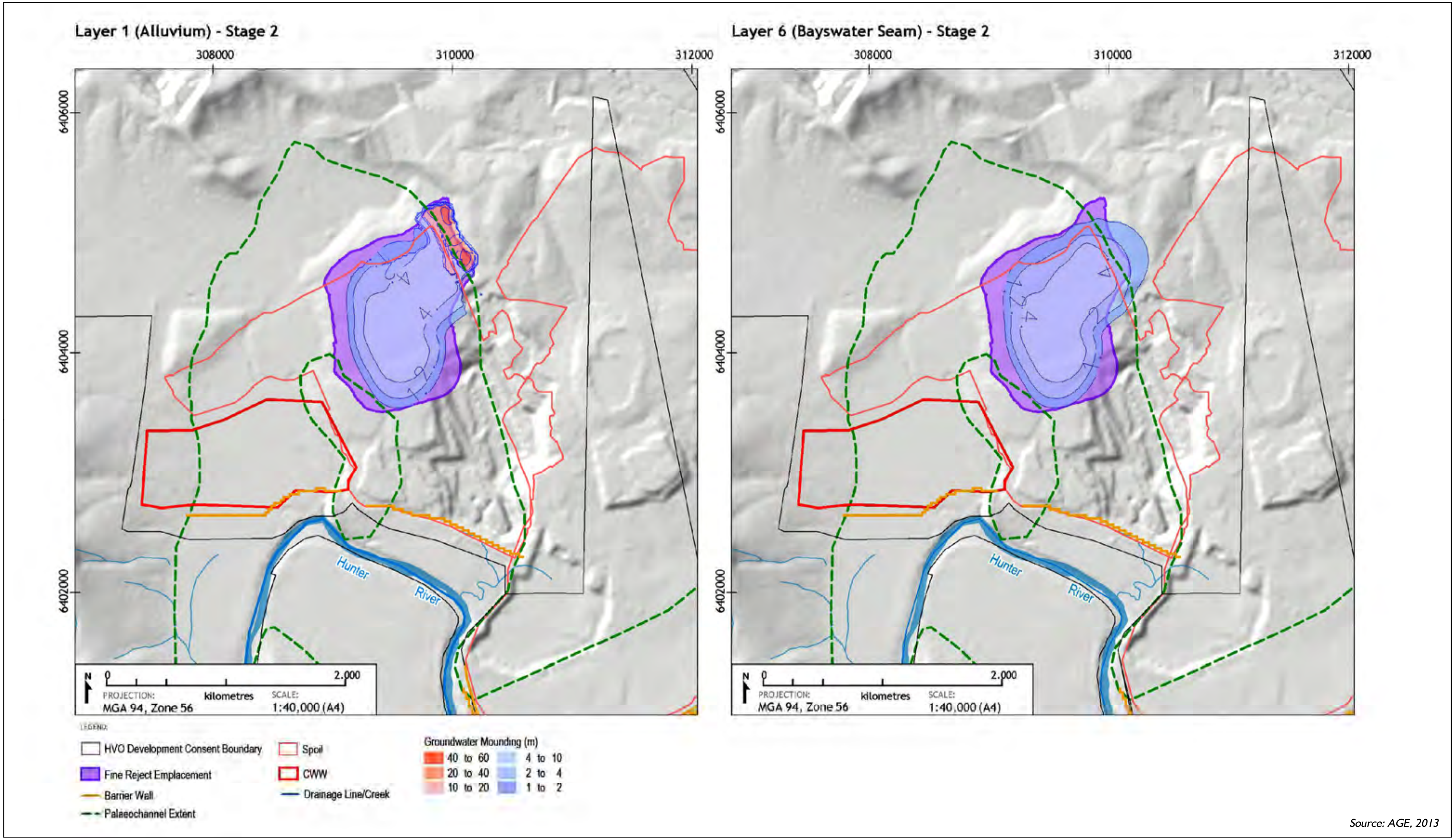
- the 2D modelling provides a steady state solution for seepage through the floor of the original fine reject emplacement design. Two sectional models of this model were developed. Seepage rates of 859 m^3/day and 777 m^3/day were predicted from these sectional models. As per the analytical seepage model, the SEEP/W modelling is a steady state solution that considers a 'conservative' or 'worst case' scenario whereby the calculations are based on the maximum hydraulic head within the fine reject emplacement, which will only occur during the final stages of fine reject deposition. The seepage rates predicted from the SEEP/W modelling, confirmed with site data and analytical calculations, were applied in the 3D numerical model.

7.2.2 Projections

The projections based on conservative modelling and assumptions and represent the worst case.

i Mounding

The 3D modelling predicts mounding as a result of the fine reject seepage which will occur in the immediate vicinity of the fine reject emplacement. This water level change is predicted to occur within all model layers, with the 1 m mounding contour extending a maximum distance of 500 m to 600 m from the emplacement's footprint. The mounding will be more prominent to the south-east as the seepage migrates toward the open cut pit and final void. Two typical mound projections are shown in Figure 7.2. These projections are for mounding in Layers 1 (alluvium) and 6 (Bayswater Seam) after six years of fine reject emplacement (referred to as Stage 2 in the figure) and with Carrington Pit operating.



Carrington Pit mounding after Stage 2 - Layers 1 and 6 based on indicative emplacement cross-sections

HVO North - Fine reject emplacement modification

Figure 7.2

ii Mine inflow

Modelling predicts that the seepage from the proposed emplacement would be unlikely to reach the open cut within the active mining period, and there will be no appreciable change in mine inflow water quality during mining.

iii Depressurisation

The application of fine reject results in a net change in flow (0.002 ML/day) from the regolith (loose material that sits on the geological layer below it) back to the adjoining alluvium. This is likely to be due from slightly elevated heads in the regolith forcing groundwater back into the alluvium under a higher hydraulic gradient. The proposed modification results in a net change in flow of 0.09 ML/day from the alluvium to the spoil. Once the fine reject emplacement is decommissioned, the net change in flow steadily reduces to 0.05 ML/day. There is no appreciable change in flux from the alluvium to the Permian strata. The total seepage rate applied to the fine reject emplacement is 859 m^3/day. It has been demonstrated that a large component of this seepage will not flow far from the footprint area, and will result in a change in storage in both the alluvium and spoil beneath the fine reject. This change in storage is expressed as localised mounding of the water table.

iv Groundwater dependent ecosystems (GDEs) and other users

As described above, the model predicts very localised mounding in response to fine reject seepage. As the groundwater level changes are very much constrained to their areal extent, it is considered highly unlikely that the proposed emplacement will impact the Carrington Billabong GDE. Furthermore, the closest privately owned bores are located approximately 2.5 km south of Carrington Pit and the Hunter River, and given the localised effect of mounding due to fine reject seepage, it is highly unlikely that the proposed modification would impact these bores.

v Hunter River base flow

The net change in leakage to the Hunter River as a result of the proposed modification is predicted to be negligible. In the model, the fine reject emplacement provides additional recharge to the groundwater system, which ultimately increases groundwater levels. This increase in groundwater levels reduces the hydraulic gradient from the river and will reduce the rate of loss from the Hunter River.

vi Post-closure

Seepage from the fine reject emplacement will not occur in perpetuity. After the emplacement is decommissioned and active deposition and decant stops, rainfall recharge will be the only input. The output from the fine reject emplacement will be drainage under gravity and evaporation from the surface and embankments. After decommissioning, recharge to groundwater within the fine reject footprint is highly likely to reduce to rates approaching those occurring pre-mining. As a result of this, fine reject seepage is unlikely to influence either the final void water level or the approximate time taken to stabilise.

After decommissioning of the emplacement and in the longer term, the final void water quality predictions presented for the Carrington West Wing project are still considered valid, that is “most likely to exhibit a pH range from 7.5 to 9.5, a TDS range from 1,000 mg/L increasing to about 3,000-4,000 mg/L, with a speciated signature Na>Mg>Ca and HCO^3>Cl>SO^4”. However, it is expected that final void water quality will be more sulphate dominant as a result of the fine reject seepage.

vii Licensing

Licensing under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* is required to account for any reduction of flow to the alluvium. The current Carrington operations already have approvals to account for any water take and Mackie Environmental Research (2010) presents any additional licensing required for Carrington West Wing (CWW).

The modelling for the proposed modification predicts that there is no additional alluvial loss or river leakage, and as a result, there is no additional licensing required as part of the approval process. The proposed modification does not incur any licence obligations under the *Water Sharing Plan for the Hunter Regulated River Water Source 2003*.

7.3 Management and monitoring

Groundwater is currently managed and monitored in accordance with the existing Water Management Plan for HVO. The monitoring is undertaken as a strategy to assess potential impacts relating to:

- open cut depressurisation;
- continuing loss of coal measures aquifer pressures;
- change in groundwater quality in coal measures; and
- leakage of groundwater from shallow aquifers.

As the impact of the proposed modification is predicted to be limited to localised mounding of groundwater beneath and adjacent to the fine reject emplacement, there are no specific groundwater management measures put forward for the proposed modification.

However the monitoring bores and vibrating wire piezometers that were installed as part of this assessment will be included in the groundwater monitoring plan for the Carrington Pit. The purpose of these bores will be to monitor the water levels beneath the fine reject emplacement to ensure that the localised water level mounding that will occur as a result of seepage is consistent with model predictions. No additional monitoring bores need to be installed.

7.4 Conclusions

The operation of the fine reject emplacement will lead to seepage. The 2D seepage model predicts a worst case seepage rate in the order of 800 to 900 m^3/day over the life of the emplacement. The 3D model projects that this seepage will lead to localised mounding of the groundwater in the geological layers below the emplacement. However, the seepage is projected to raise the water level by no more than a metre in any geological layer at a distance of 500 to 600 m from the emplacement's footprint.

Due to the predicted highly localised changes in groundwater levels, in the form of groundwater mounding, it is considered highly unlikely that the emplacement will affect the Carrington Billabong, the nearest bore owners, or the Hunter River, where net change in leakage to the river as a result of the proposed emplacement is predicted to be negligible, at 3 L/day.

After decommissioning, recharge to groundwater within the fine reject footprint is highly likely to reduce to rates approaching those occurring pre-mining. Accordingly, long term seepage is unlikely to influence either the final void water level or the approximate time taken to stabilise, for the approved Carrington operations. The final void water quality will be more sulphate dominant as a result of the fine reject seepage.

Modelling indicates that no additional water access licensing as a result of the emplacement should be required under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* or the *Water Sharing Plan for the Hunter Regulated River Water Source 2003* as sufficient licences are already in place.

The groundwater monitoring infrastructure installed as part of the assessment together with existing bores and piezometers will be suitable for monitoring groundwater impacts from the emplacement.

8 Surface water

This chapter provides a summary of the surface water assessment prepared WRM Water & Environment (WRM), which is presented in full in Appendix D. The key findings are summarised below.

8.1 Existing environment

8.1.1 Regional drainage network

There are approximately 13,400 km^2 of Hunter River catchment upstream of HVO. The Hunter River is a regulated river supplying water from Glenbawn Dam to a range of industrial and agricultural users as well as town water supplies. Glenbawn Dam is located on the upper headwaters of the Hunter River. Two major tributaries, Glennies Creek and Wollombi Brook, drain into the Hunter River some 10 km downstream of the mine.

An area of HVO North is located on the Hunter River floodplain, however, it is mostly on the adjoining hill slopes. Levees are currently used to prevent Hunter River floodwater from entering areas of the mine.

8.1.2 Local drainage network

A local catchment of 13.75 km^2 drains the south-western side of HVO North via an Unnamed Tributary to the Hunter River, as shown in Figure 8.1. The tributary is ephemeral. The upstream reach of the tributary has been constructed across previously mined areas and has been substantially realigned from pre-mining conditions. The realigned Unnamed Tributary consists of a small channel that is about 10 m wide and 1 m to 2 m deep and is well grassed. Adjacent to the existing Carrington Pit, the tributary drains along an ill-defined paleochannel to the Hunter River. The tributary will be diverted during mining of the CWW.

Farrells Creek is a minor tributary of the Hunter River that drains the catchment north-east of Carrington Pit. Parnells Creek is a minor tributary of the Hunter River that drains the catchment to the west of West Pit.

8.1.3 Flooding and levees

A levee currently extends along the Hunter River, adjacent to the mine area to the south-east of the Unnamed Tributary. The purpose of this levee is to protect the mine workings from Hunter River flooding.

A flood impact assessment was undertaken for the CWW project, including an assessment of predicted flooding levels around the Unnamed Tributary for existing conditions. The assessment found that the 2 year Average Recurrence Interval (ARI) Hunter River design flood is generally confined to the main channel. The Hunter River flood flows exceed the capacity of the channel and inundate the floodplain in the vicinity of the proposed fine reject emplacement for the 5 year ARI design event. The Hunter River dominates flood levels in the vicinity of the proposed fine reject emplacement for floods greater than and equal to the 10 year ARI event. Local catchment flows from the Unnamed Tributary dominate for the more frequent floods.

8.1.4 Rainfall and evaporation

The weather stations that provide useful rainfall and evaporation data for the proposal are located at Jerrys Plains Post Office, Singleton Post Office and Broke. Relevant data from these stations are summarised below.

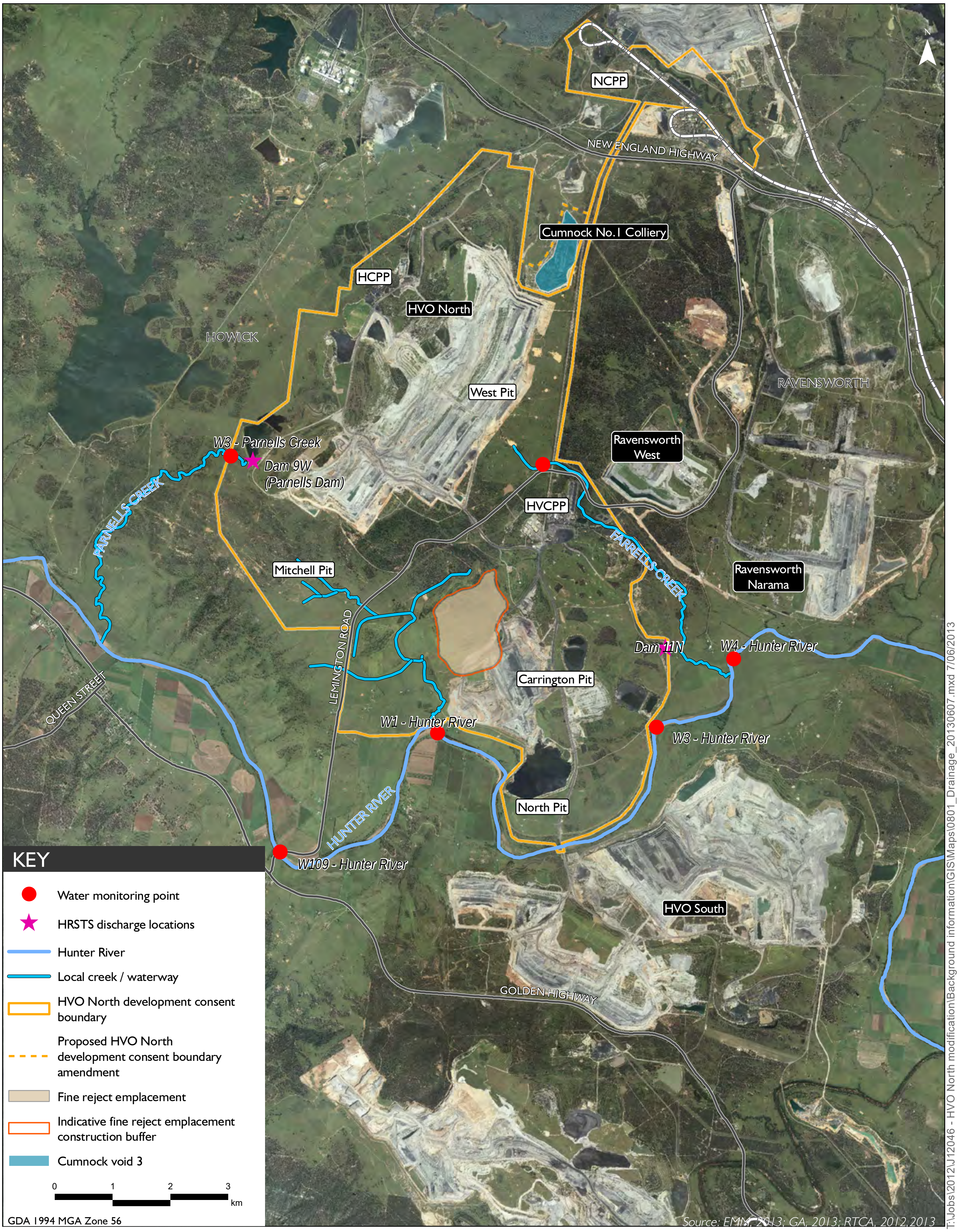
The mean annual rainfall ranges from 644 mm to 698 mm, with maximum monthly rainfalls occurring during the summer months.

Mean annual evaporation recorded at Jerrys Plains Post Office, located some 7 km to the west of HVO North, is 1,641 mm, which is more than double mean annual rainfall. Mean evaporation is similar to mean rainfall in the winter months, but substantially exceeds rainfall for the remainder of the year.

8.1.5 Streamflow

The flows measured for the Hunter River at the Liddell gauge indicate that flow is non-zero almost 100% of the time. This is characteristic of regulated river systems.

Very little runoff is generated by the catchment when annual rainfall is less than about 400 mm. Once annual rainfall exceeds this value, the volume of surface runoff increases substantially. The average annual run-off volume, as measured at the Liddell gauge, is 419 GL for the years 1971 to 2011.



EMM EMGA Mitchell McLennan

Local drainage and key surface water monitoring locations

HVO North - Fine reject emplacement modification

Figure 8.1

8.1.6 Surface water quality

Surface water quality is monitored at HVO in on-site dams and surrounding natural watercourses (including Wollombi Brook and the Hunter River) at 25 locations. The key monitoring locations considered in the assessment are shown in Figure 8.1.

Water quality sampling locations, W1 and W4, are located on the Hunter River upstream and downstream of the project area, respectively. A comparison of results between W1 and W4 indicates that there was no significant change in water quality between these stations in 2011. The parameters that were compared comprised pH, electrical conductivity (EC) and total suspended solids (TSS). The results are summarised in Table 8.1.

Table 8.1 Comparison of upstream and downstream water quality

Monitoring point	Location	Annual average 2011		
		pH	EC (µS/cm)	TSS (mg/L)
W1	Hunter River upstream	8.3	730	28
W4	Hunter River downstream	8.4	740	32

Source: 1. WRM 2012

Water quality sampling undertaken for the two minor waterways at HVO North, Parnells Creek (W3) and Farrells Creek (W11), shows that the water quality in these creeks is generally consistent with the Hunter River data for 2011, with the exception of somewhat elevated TSS for Farrells Creek.

8.1.7 Existing mine water management system

The WRM 2012 report provides considerable detail on the mine water management system, including the key environmental objectives of this system.

The assessment utilises the existing water management system configuration, with minor changes relating to the proposed modification. The existing fine reject management configuration is described in Section 2.2 and shown on Figure 2.1.

8.1.8 Hunter River Salinity Trading Scheme (HRSTS)

The HRSTS uses economic instruments to achieve desired water quality in the Hunter River. The scheme operates on the premise that salty water can only be discharged into the Hunter River during high river flows. When the river is in low flow, no discharges are allowed. When the river is in high flow, limited discharge is allowed, controlled by a system of salt credits. The amount of discharge allowed depends on the ambient salinity in the river, so it can change daily. The total allowable discharge is calculated so that the salt concentration does not go above 900 EC in the middle and lower sectors of the river, or above 600 EC in the upper sector. When the river is in flood, unlimited discharges are allowed as long as the salt concentration does not go above 900 EC. Members of the scheme coordinate their discharges.

HVO participates in the HRSTS and is allowed to discharge from Dam 11N (to Farrells Creek), and Dam 9W (to Parnells Creek) during periods of 'high' or 'flood' flows in accordance with the scheme rules. Discharge to the Hunter River is also permitted at HVO South from Dam 15S (Lake James), under the HRSTS. Table 8.2 summarises the discharges from these dams under the HRSTS for 2011.

Table 8.2 HRSTS Discharges 2011

Location	Number of discharge blocks	Credits held	Allowable discharge (tonnes)		Total salt load discharged (tonnes)
			Total	At location	At location
Dam 9W	9	145	30,945	4,890	932
Dam 11N	3	145	21,744	3,153	215
Dam 15S	14	145	48,804	7,932	2,240

Source: 1. WRM 2012

8.2 Assessment

8.2.1 Overview

The potential changes to surface water and water management during the life of the proposed modification comprise changes to:

- surface water runoff from the fine reject emplacement;
- surface water runoff volume to receiving waters;
- runoff water quality;
- HRSTS discharges and Hunter River water quality; and
- HVO's water management system.

These changes are discussed in the following sections.

Note that as the use of Cumnock void 3 for fine reject disposal already has planning approval, potential impacts are only related to impacts on the site water balance associated with the fine reject disposal operations which are primarily associated with the return of decant water from Cumnock void 3 back to the HVO water management system. The decant return arrangement is currently subject to agreement between Coal & Allied and Cumnock Joint Venture. For the purposes of assessment it was assumed that the volume of decant water from Cumnock void 3 to HVO would be equal to the moisture in the emplaced HVO reject material minus losses, notionally 25% of the total emplaced fine reject material. The Cumnock Joint Venture would retain responsibility for the remaining 75%.

8.2.2 Surface water runoff

Additional surface water would be generated by the collection of runoff into the proposed fine reject emplacement and Cumnock void 3.

The management of water in the project area would essentially be the same as for the existing operations. All water accumulated in the fine reject emplacement would be transferred via pit dewatering pumps to Dam 9N and Dam 9W respectively, where it would be re-used and recycled in the HVO North mine water management system. As Cumnock void 3 is a joint fine reject facility to be operated by Ravensworth Operations, some water will be returned to HVO via pipelines based on the amount of fine reject being deposited (refer to Section 8.2.1). The water returned from the Cumnock void 3 will be regulated and reported in the HVO Annual Environmental Management Report (AEMR).

8.2.3 Change in surface water runoff volume to receiving waters

The expected removal of catchment due to the fine reject emplacement and associated average annual runoff volume draining to receiving waters associated with the proposed modification is presented in Table 8.3. The loss of catchment is confined to the Unnamed Tributary catchment. There are no licensed or unlicensed water users on the Unnamed Tributary.

The volume of surface water runoff from the various catchment areas on the mine site was estimated using the OPSIM model and long term rainfall data. For comparison, the average annual flow in the Hunter River at the closest gauging station has also been included.

Table 8.3 shows that the relative reduction in the Hunter River flows due to the proposed fine reject emplacement is small compared to the total flows in the Hunter River. It is proposed that the catchment removed due to mining would be largely reinstated to existing conditions through capping and rehabilitation of the emplacement at the end of the emplacement's life.

Note that the construction of the fine reject emplacement is required to prevent contamination of a water source and therefore would not require a water supply works approval. There is no requirement, therefore, for a Water Access licence to take and use water.

Table 8.3 Catchment diversion and loss of runoff

Catchment Loss (ha)	Average Annual Catchment Runoff Reduction (ML/annum)	Average Annual Hunter River Volume (ML/annum)
90	57	419,000

Source: 1. WRM 2012

8.2.4 Change in runoff water quality

Land disturbance associated with the fine reject emplacement has the potential to adversely affect the quality of surface runoff through increased sediment loads.

Management measures will ensure no measurable adverse impacts on riparian and ecological values of watercourses on the site and downstream of the proposed modification.

8.2.5 Hunter River water quality and HRSTS

Changes in the site water management system at HVO North due to the proposed modification may impact the frequency of discharges to the Hunter River under the HRSTS, as well as the availability of HRSTS credits for other areas of the mine.

Figure 8.2 shows the modelled annual discharge volumes for each stage of the proposed modification. The modelling results indicate, on average, 4.4 HRSTS discharge events per year from each discharge location. Based on the calculated discharge opportunities and the current HVO credit allocation of 145 credits, modelled controlled discharges from HVO North would be in compliance with the HRSTS.

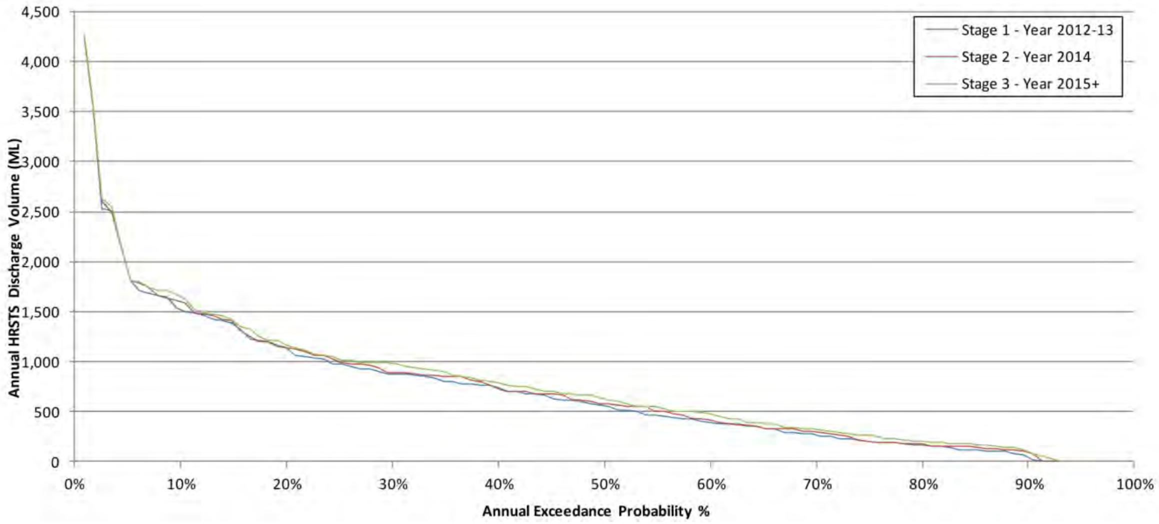
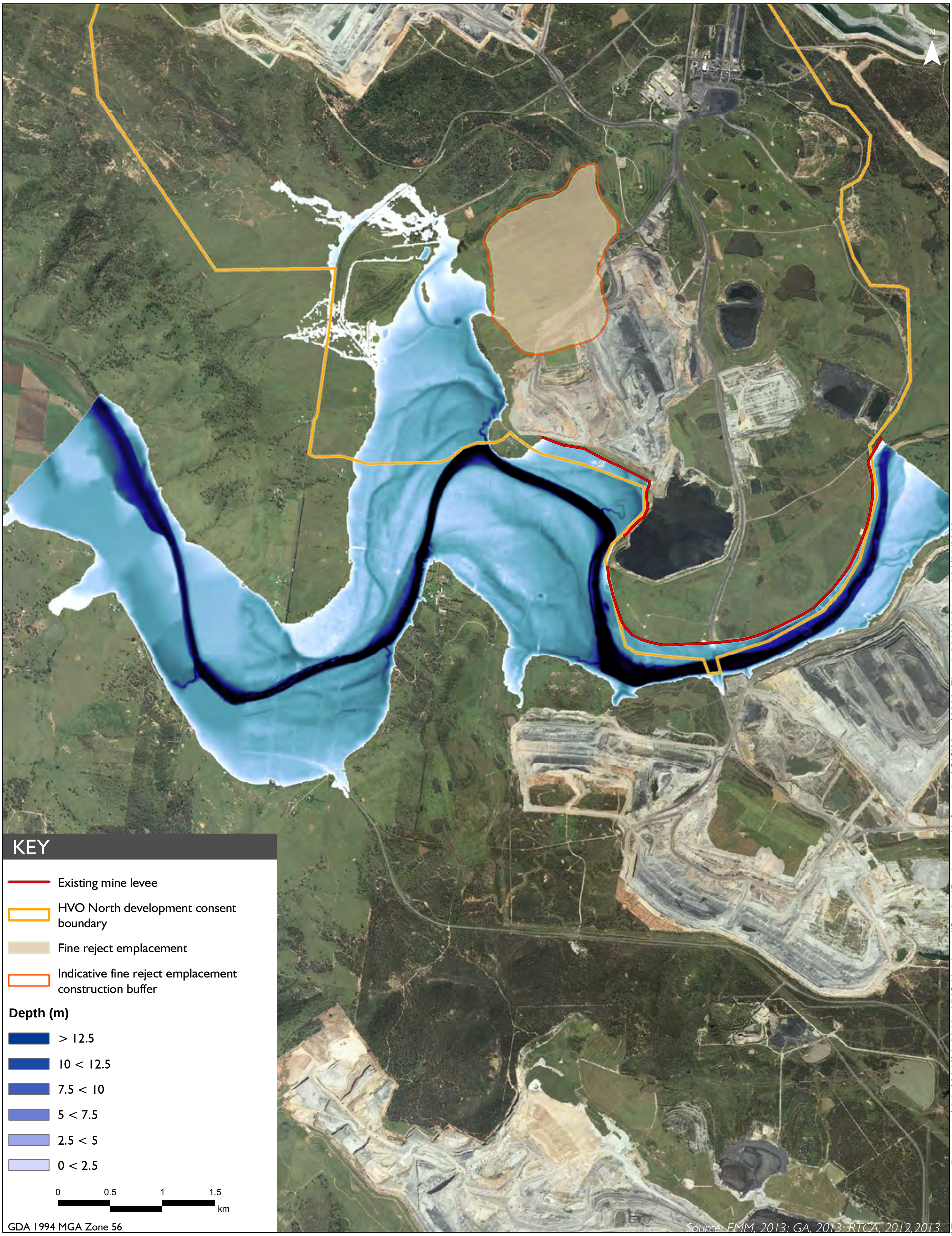


Figure 8.2 HRSTS discharge assessment

8.2.6 Hunter River flooding

Figure 8.3 shows the extent of the previously modelled 100 year ARI flood inundation for the Unnamed Tributary, overlain with the proposed fine reject emplacement footprint.

The figure shows that the proposed fine reject emplacement footprint only marginally encroaches into the 100 year ARI flood inundation extent. The flooding in this area is associated with backwater from the Hunter River (in the Unnamed Tributary), and the marginal encroachment of the proposed fine reject emplacement would have no impact on flood levels or velocities in the Hunter River.



\\Emgammsvr1\emgamm\Jobs\2012\J12046 - HVO North modification\Background information\GIS\Maps\0803_Flood_20130531.mxd 31/05/2013

Existing conditions Q100 flood depths - (with emplacement overlay)

HVO North - Fine reject emplacement modification

Figure 8.3

8.2.7 Impacts on the mine's water management system

An assessment of the potential impacts of the proposed modification on the HVO North mine water management system has been undertaken using the HVO North OPSIM Model. The findings of this assessment can be summarised as follows:

- the proposed modification does not have any significant impact on expected pit inundation at HVO North;
- the proposed modification does not have any significant impact on accumulation or reduction in overall site inventory volumes;
- the proposed modification has no impact on site raw water requirements; and
- there is an increase in the risk of discharge from Dam 15N, that has the ability to discharge via a spillway into receiving waters (Hunter River via Farrells Creek). The maximum modelled discharge is only around 70 ML, at an estimated EC of 700-800 µs/cm. Given that the discharge only occurs during a HRSTS discharge window and at a low salinity, the proposed modification should have no impact on Farrells Creek or Hunter River water quality.

The water balance modelling indicates that the proposed modification would have little impact on the existing HVO North water management system.

There are no substantial changes proposed to the HVO North water management system to accommodate the proposed modification.

8.3 Management and monitoring

Surface water is currently managed and monitored in accordance with the existing Water Management Plan for HVO North.

The following measures will be implemented to minimise potential adverse affects from increased sediment loads in surface water runoff.

- Runoff from undisturbed catchments will be diverted away from disturbed areas using surface drains.
- Surface runoff from disturbed areas will be directed towards the existing sedimentation basins and managed in accordance with the mine water management system where it may be reused or treated prior to release. Should any additional sediment dams be required, these will be designed in accordance with relevant design standards (DECCW 2008).
- Surface runoff from rehabilitated areas will be managed in accordance with the mine water management system until the water quality is suitable for release.
- Saline water from mining related activities will be collected within the mine water management system. Discharges will be released in accordance with the HRSTS rules.

There are no substantial changes proposed to the HVO North water management system due to the proposed modification.

Management and monitoring measures comprise the following:

- continuation of surface and groundwater quality monitoring; and
- regular updates of the HVO water balance model to ensure currency with the current operational configuration of the mine water management system.

8.4 Conclusions

Additional surface water will be generated by the collection of runoff into the proposed fine reject emplacement and Cumnock void 3; however the management of water in the project area would essentially be the same as for the existing operations.

The establishment of the fine reject emplacement will temporarily remove some of the catchment of the Unnamed Tributary. The reduction in the Hunter River flows due to this loss of catchment will be small (57 ML/annum) in comparison with the total flows (419,000 ML/annum) in the Hunter River. When the fine reject emplacement is rehabilitated at the end of its life, the lost catchment area will be restored.

Land disturbance associated with the fine reject emplacement has the potential to adversely affect the quality of surface runoff through increased sediment loads. However, measures will be implemented to ensure there are no measurable adverse impacts on riparian and ecological values of watercourses on the site and downstream of the proposed modification.

Flood modelling indicates that the proposed fine reject emplacement will have no impact on flood levels or velocities in the Hunter River.

The water balance modelling indicates that the proposed modification will have little impact on the existing HVO North water management system and no changes will be required to the system to accommodate the proposed modification. Discharges can be managed within the HRSTS rules.

9 Ecology

This chapter provides a summary of the ecology assessment prepared by EMM, which is presented in full in Appendix E. The key findings are summarised below.

9.1 Existing environment

The project area for the proposed modification is comprised predominantly of land that has been previously disturbed for mining and mining-related activities. There are areas that have undergone rehabilitation within the footprint of the fine reject emplacement that consist of a combination of native overstorey species and pasture areas. These rehabilitated areas do not represent a naturally occurring community and do not match any known formal vegetation type, or ecological community. Photograph 9.1 shows the general condition and vegetation of the project area.

Photograph 9.1 Typical vegetation of the project area

A search of the Atlas of NSW Wildlife revealed that 23 threatened fauna species and two endangered populations listed under the TSC Act have been previously recorded within 10 km of the project area (NSW Office of Environment and Heritage (OEH) 2012). These species are listed in Table A.1 of Appendix A of the ecology assessment along with an assessment of their likelihood of occurrence within the project area.

A search for matters of National Environmental Significance (NES) or other matters protected by the Commonwealth EPBC Act revealed an additional seven fauna species, seven flora species and two critically endangered ecological communities potentially occurring within the project area. These species are listed in Table A.2 of Appendix A of the ecology assessment, along with a consideration of their potential occurrence within the project area.

Fauna habitats within the project area included *Acacia* and eucalypt species, dense grass cover (predominantly exotic grasses), one dam and ephemeral soaks that would be wet during periods of heavy rain. The *Acacia*, eucalypts and areas of dense grass cover would provide potential resources for small woodland birds, reptiles, amphibians and common macropods such as the eastern grey kangaroo (*Macropus giganteus*). Furthermore, the dam and ephemeral soaks would provide potential resources for birds, macropods and amphibians.

Two threatened fauna species, the speckled warbler (*Pyrrholaemus sagittatus*) and the spotted harrier (*Circus assimillis*), both listed as vulnerable under the TSC Act, were recorded within the project area during the field investigations. No other threatened species were observed during field surveys.

Evidence of a number of other fauna using the study area, including cattle, macropods, gliders and possums, was also found during the field investigations.

9.2 Assessment

9.2.1 Overview

The fine reject pipelines will be located and constructed in accordance with the design principles outlined in Section 3.2.2, and are not expected to have any measureable ecological impacts. As noted, a site survey of the preferred alignment must be undertaken as part of RTCA's GDP process. This process will ensure that the design principles are adhered to at all times (refer also to Section 9.3). Accordingly, this element of the proposed modification was not considered in any detail in the ecological assessment.

The potential considerations associated with the construction of the fine reject emplacement include the removal of:

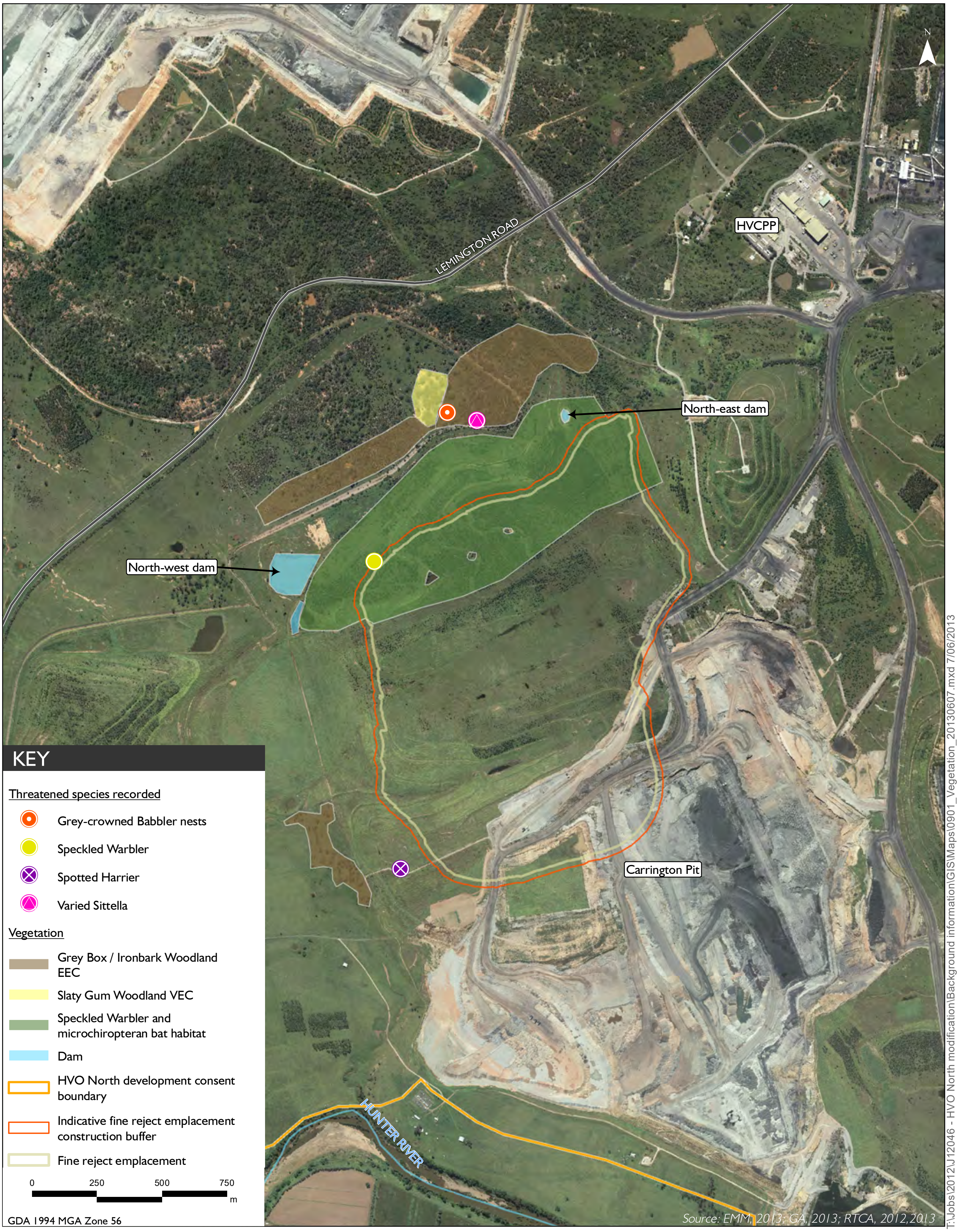
- potential habitat for small woodland birds, macropods, amphibians and reptiles;
- potential foraging habitat for microchiropteran bats;
- habitat used by threatened bird species (speckled warbler and spotted harrier); and
- a small dam in the north-east of the project area and ephemeral soaks that may provide habitat for amphibian and other species.

9.2.2 Vegetation clearance

The project area has been previously disturbed for mining and the area has undergone rehabilitation. The rehabilitated vegetation does not conform to any known vegetation type or threatened ecological community. Approximately 161 ha of rehabilitation vegetation consisting of pasture and planted *Acacia* and eucalypt species of approximately five to six years of age will be removed to enable the construction of the proposed fine reject emplacement.

9.2.3 Habitat connectivity

Given its location, the removal of vegetation and habitats from the proposed fine reject emplacement footprint is not expected to impact connectivity or habitat corridor function for local or transient species. The area may, however, be utilised as stepping stone habitat by these species as they move across the landscape from adjacent stands of remnant vegetation.



EMM

Vegetation habitats and threatened species

HVO North - Fine reject emplacement modification

Figure 9.1

9.2.4 Pest animals

The proposed modification is unlikely to increase the abundance or distribution of feral animal species, given the already disturbed nature of the project area and its surrounds. In addition, the works will not create additional shelter or den sites or create tracks or other movement corridors for pest species.

9.2.5 Key threatening processes

Key threatening processes (KTPs) are the events and processes that threaten, or could threaten, the survival or evolutionary development of species, populations or ecological communities. Thirty six KTPs are currently listed in NSW under the TSC Act and nineteen KTPs are listed under the EPBC Act. The project does not constitute, and is unlikely to exacerbate, any of the listed KTPs.

9.2.6 State Listed Threatened species and communities

Assessments of significance under Part 5A of the EP&A Act (Seven part tests) have been conducted (see Appendix E) for the following threatened species, whose habitat is considered to have the potential to be impacted by the proposed modification, namely:

- spotted harrier (*Circus assimilis*);
- speckled warbler (*Pyrrholaemus sagittatus*);
- hooded robin (*Melanodryas cucullata*);
- green and golden bell frog (*Litoria aurea*);
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*);
- eastern freetail-bat (*Mormopterus norfolkensis*);
- southern myotis (*Myotis macropus*); and
- yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*).

The assessments found that the proposed modification is unlikely to significantly impact on any threatened species. Avoidance and mitigation measures to further reduce the potential for impacts to threatened species and native flora and fauna are provided in Section 9.3.

In accordance with the precautionary principle, targeted surveys for the green and golden bell frog were conducted for the proposed modification. These surveys supplement the extensive survey effort completed for the green and golden bell frog at HVO and adjoining Ravensworth Operations during a variety of seasonal conditions. At the time of the surveys, two large sediment dams north-west of the proposed fine reject emplacement were the only potential habitat nearby that contained water. The smaller dam within the proposed fine reject emplacement footprint had dried and the surrounding ephemeral soaks were also dry. A number of frog species, including the broad-palmed frog (*Litoria latapalmata*), eastern dwarf sedge frog (*Litoria fallax*), striped marsh frog (*Limnodynastes peroni*) and spotted grass frog (*Limnodynastes tasmaniensis*) were identified at the two dams during the targeted surveys, however no green and golden bell frogs were observed or heard.

The large sediment dams to the north-west represent potential habitat for the species during periods of optimal weather and breeding conditions. However, the smaller dam, located within the disturbance footprint of the fine reject emplacement, was dry at the time of the targeted survey and does not represent breeding habitat for the species. Given this, the loss of the small dam and ephemeral soaks will not adversely impact the occurrence of this threatened species.

No threatened ecological communities within adjacent remnant vegetation will be impacted by the proposed modification. Therefore, these were not assessed further.

9.2.7 EPBC Act Significant Impact Criteria

Actions that have the potential to impact upon a matter of environmental significance under the EPBC Act require approval from the Minster for Environment Protection, Heritage and the Arts. A self assessment has been made in accordance with the *Significant Impact Guidelines 1.1: Matters of National Environmental Significance* (DEWHA, 2009), to ascertain whether the proposal has the potential for a significant impact on a matter of national significance and whether a referral would be required.

No EECs listed under the EPBC Act were recorded in or adjoining the study area. No threatened plant species listed under the EPBC Act were recorded in the study area. Three fauna species listed as Endangered under the EPBC Act have potential habitat in the study area, the Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolour*) and Spotted-tailed Quoll (*Dasyurus maculatus*). No breeding or foraging habitat for any of these species is expected to be impacted. Accordingly, the proposed modification is unlikely to have a significant impact on these three species.

Four fauna species listed as Vulnerable under the EPBC Act have known and/or potential habitat in the study area, the Australian Painted Snipe (*Rostratula australis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Green and Golden Bell Frog (*Litoria aurea*); and Large-eared Pied Bat (*Chalinolobus dwyeri*) (the latter recorded during field surveys). No limiting breeding or foraging habitat for these species is expected to be impacted. If present within the study area, individuals of these species are not considered 'important populations' as they are not likely to be key source populations either for breeding or dispersal, populations that are necessary for maintaining genetic diversity, and/or populations that are near the limit of the species range. The proposal is unlikely to have a significant impact on these species.

Pursuant to the EPBC Act, an assessment of significance was carried out for the Green and Golden Bell Frog, a vulnerable species covered by the Commonwealth legislation (see Appendix E, page C.10 for details). The assessment concluded that the project is unlikely to significantly impact the Green and Golden Bell Frog and that a referral to the DSEWPC for impacts to the Green and Golden Bell Frog was not necessary.

No migratory species were recorded during the field survey, however, potential habitat exists in the study area for 11 migratory species. Given the low importance of potential habitat for these species within the study area and that habitat connectivity would not be impacted, it is considered that significant impacts on these species would be unlikely.

The EPBC Act self assessment indicates that a referral to the Minister for Environment Protection, Heritage and the Arts is not considered necessary for the proposal.

9.3 Management and monitoring

Management and monitoring of ecology at HVO North will continue to be undertaken in accordance with Coal & Allied's existing environmental procedures including those for flora and fauna, disturbance and rehabilitation, erosion and sediment control, and weed and feral animal control.

As described in Section 3.2.2, a Ground Disturbance Permit application must also be completed prior to any works associated with the fine reject emplacement construction and pipeline installation commencing. This will provide further assurance that appropriate environmental management procedures are assigned to all disturbance areas. Standard measures include:

- minimising disturbance areas by planning for plant laydown and access routes in cleared areas, prior to works beginning;
- clearly delineating and flagging disturbance areas so that no areas outside of those assessed will be affected by machinery or personnel;
- sourcing equipment used for construction from within the operation to prevent the transfer of soil pathogens and weed seeds, where possible; and
- implementation of erosion and sediment controls for the operation.

9.4 Conclusions

The project area predominantly comprises a modified landscape, with plantings and pasture that do not conform to any Biometric vegetation type or threatened ecological community. The vegetated areas nearby provide habitat for small woodland birds, including the threatened speckled warbler.

The proposed modification will not significantly impact threatened or native species in the local area, given the availability of suitable habitat nearby and the current condition of the project area. The EPBC Act self assessment indicates that a referral to the Minister for Environment Protection, Heritage and the Arts is not considered necessary for the proposed modification.

10 Aboriginal cultural heritage

This chapter presents the Aboriginal cultural heritage assessment prepared by Rio Tinto Coal Australia's Cultural Heritage Specialists.

10.1 Existing environment

10.1.1 Previous assessments

Numerous previous cultural heritage investigations have been conducted over the project area and its general vicinity. These include investigations for the expansion of the Cumnock and Howick Pits in the 1980/90s (Brayshaw 1981 and 1989, ERM Mitchell McCotter 1995, HLA 1996), the initial development of the Carrington Pit in the late 1990s (ERM Mitchell McCotter 1999a and b, Junburra 2000), extension of mining activities at West Pit (ERM 2003) and Carrington (ERM 2005), and those conducted for the Carrington West Wing 2010 EA (McCardle CHM 2009).

10.1.2 Sites within the proposed emplacement area

The Aboriginal Heritage Information Management System (AHIMS) Register (administered by the Office of Environment and Heritage – OEH) lists 13 Aboriginal cultural heritage sites recorded in the proposed emplacement area. All 13 sites have been destroyed under a Consent to Destroy permit (SZ 311) granted under s90 of the NPW Act and are no longer extant. These sites are detailed in Table 10.1.

Table 10.1 Sites within proposed emplacement area

AHIMS ID	Site name
37-2-1508	CM 5
37-2-1512	CM 9
37-2-1518	CM 15
37-2-1524	CM 21
37-2-1525	CM 22
37-2-1526	CM 23
37-2-1527	CM 24
37-2-1528	CM 25
37-2-1542	CM 39
37-2-1864	CM 54
37-2-1886	CM 48
37-2-1887	CM 49
37-2-1888	CM 54

10.1.3 Site CM-CD1

The site known as CM-CD1 (37-2-1877) lies approximately 150 m to the south/south-west of the proposed fine reject emplacement. This site was originally identified as having the potential to contain sub-surface cultural material that may have been of Pleistocene (ie older than 10,000 years) antiquity. A comprehensive archaeological and geomorphological excavation programme was undertaken in several stages throughout 1999 (Huonbrook 1999 and 2000). While this work identified that sub-surface cultural material was present, the nature of the deposits and the cultural material did not allow for further insights into the antiquity of this deposit, although it is unlikely that they were Pleistocene in age. Further, while it was noted that additional sub-surface material may be present, it was considered unlikely that this would be present across the entirety of the CM-CD1 area.

Conditions 40 and 41 of DA 450-10-2003 require that mining and associated activities do not impact CM-CD1. Coal & Allied will ensure that the construction and operation of the fine reject emplacement will comply with these conditions.

10.2 Assessment

The entirety of the proposed emplacement area has been the subject of Aboriginal cultural heritage investigations. From these, a total of 13 cultural heritage places were recorded within, or immediately adjacent to the proposed emplacement area. All 13 sites have previously been destroyed under a finalised NPW Act s90 Consents to Destroy. Furthermore, the proposed emplacement area has been previously totally disturbed by mining activities.

It is anticipated that fine reject pipelines will have no impact on Aboriginal cultural heritage as they will be constructed overland and restricted to areas that:

- have been previously disturbed by mining and related activities; and
- are adjacent to existing infrastructure such as haul roads and pipelines.

Exact alignments will be determined during the detailed design process and guided by the principle of causing zero harm to Aboriginal cultural heritage. Before any activities start at each location, an assessment of these alignments against Aboriginal cultural heritage impacts will be completed through the auspices of the Coal & Allied's GDP process. This GDP process will ensure that Aboriginal cultural heritage values are not impacted wherever possible, and also advise appropriate and specific management conditions if necessary.

10.3 Management and monitoring

Aboriginal cultural heritage management is, and will continue to be, undertaken in accordance with the Rio Tinto Coal Australia Cultural Heritage Management System (CHMS) and relevant legislative requirements.

Specific management principles have been developed in a manner consistent with the development consent conditions with respect to Aboriginal cultural heritage for those areas in the vicinity of the project area in accordance with Rio Tinto Coal Australia's cultural heritage management standards and policies, and in consultation with the Coal & Allied Upper Hunter Valley Aboriginal Cultural Heritage Working Group.

As per the CHMS, if Rio Tinto Coal Australia personnel, contractors or visitors encounter suspected unrecorded cultural heritage within the project area, activities that might disturb the find must cease immediately, the area cordoned off to protect the find, and the find reported to the Rio Tinto Coal Australia Specialist Cultural Heritage NSW. The specialist will assess the reported find and, if required, arrange for the formal recording of the find. If found to be an Aboriginal cultural heritage site, it will be managed through the relevant sections of the approved Heritage Management Plan required by DA 450-10-2003.

10.4 Conclusions

It is considered that the proposed modification will have no impact on Aboriginal cultural heritage sites. The proposed emplacement area is completely disturbed and all previously recorded sites have been managed under the authority of valid Consent to Destroy permits, leaving no extant Aboriginal cultural heritage objects or places requiring management within the area.

There will be no harm to Aboriginal cultural heritage sites from pipeline construction as pipeline routes will be selected to avoid such harm.

11 Noise

This chapter provides a summary of the noise assessment prepared by EMM, which is presented in full in Appendix F. The key findings are summarised below.

11.1 Existing environment

The land use surrounding the project area is predominately characterised by large-scale open-cut coal mining operations, including HVO South and Wambo to the south and Ravensworth Operations to the east. Other notable features include the Plashett Reservoir to the west, Lake Liddell and the Bayswater Power Station to the north.

Hilly terrain characterises the topography to the north-east, north-west and south-west. To the south-east the terrain is generally open and gently undulating towards the lower Hunter Valley area. A large ridge line is located to the south-west between the proposed modification and the village of Jerrys Plains and would provide protection against potential adverse environmental impacts originating from the proposed modification.

The closest privately owned residences to the project area are located at the village of Jerrys Plains and along the Golden Highway approximately 4 km to the south-west. The existing ambient noise environment at these properties is typical of rural residential locations in the Hunter Valley, with influence from agricultural activities, road traffic noise, existing mining noise and natural sounds.

Coal & Allied operates an extensive network of real time noise monitoring equipment in and around HVO North, which provides data on existing noise levels in the local area. This network of real time noise monitors is supported by quarterly attended noise monitoring. Real time noise monitoring and attended noise monitoring locations are provided in Figure 11.1. Latest results from real time noise monitors and attended noise monitoring are reported in the HVO AEMR located on Rio Tinto's website (refer to Section 1.2).

11.2 Assessment

11.2.1 Approach

The operations phase of the fine reject emplacement will not introduce any acoustically significant plant and equipment and there will be no increase in overall noise levels from its operation. The installation of the above-ground fine reject pipelines will not generate any significant noise in the context of the surrounding mine noise environment and there will be no operational noise. Accordingly, this noise assessment is focussed on the construction of the fine reject emplacement.

The construction of the fine reject emplacement will be similar in many respects to other mining activities at HVO where dozers, trucks and other plant are used to move and place rock and earth. However, it will be short term and temporary in nature. Some of the construction activities could take place at night. It is appropriate then to use the noise criteria that regulate mining activities at the site for the construction of the fine reject emplacement as well.

The noise assessment was prepared in accordance with the Industrial Noise Policy (INP) (EPA, 2000). In order to maintain consistency with previous studies at HVO North, the noise levels were predicted at the nearest receptors using three dimensional noise modelling software. The model took into account distance, ground affects, atmospheric absorption and topographic detail.

It is intended that, as far as practical, existing mine plant will be used to construct the fine reject emplacement and that a limited number of additional plant may be required. However, in order to provide a worst-case conservative assessment approach, all plant and equipment associated with fine reject emplacement construction have been modelled as additional plant items and incrementally added to past modelling results for HVO North.

11.2.2 Criteria

Schedule 4 Condition 7 of DA 450-10-2003 prescribes the HVO North noise limits, reproduced in Table 11.1 below, which are based on the INP approach to the development of project specific criteria.

Table 11.1 Development consent noise limits

Day/Evening/Night $L_{Aeq(15\ minute)}$	Night $L_{A1(1\ minute)}$	Property number
40	46	4 – from year 1 to year 7
40	46	7*
36	46	4 – from year 8 to year 21
40	46	Jerrys Plains village – residence locations 13 and 14 (years 20 and 21)
39	46	2, 3, 11, 19, 31, 36 and 54
38	46	1, 18, 51 and 52 – from year 1 to year 19
40	46	1, 18, 51 and 52 – years 20 and 21
35	46	All other residential or sensitive receptors, excluding those listed in condition 1 above (being 8**, 9**, 10** and 12**).

Notes: ** Acquired by Xstrata*

*** Acquired by Rio Tinto Coal Australia since the previous consent was issued*

Schedule 4 Condition 8 of DA 450-10-2003 relates to land acquisition criteria and is reproduced in Table 11.2 below.

Table 11.2 Land acquisition criteria

Day/Evening/Night ($L_{Aeq(15\ minute)}$)	Property number
43	11
42	7*
41	All residential or sensitive receptors, excluding the receptors listed in condition 1 above (being 8**, 9**, 10** and 12**)

Notes: ** Acquired by Xstrata*

*** Acquired by Rio Tinto Coal Australia since the previous consent was issued*

If the noise generated by the proposed modification exceeds the criteria provided in the above table, Coal & Allied, upon receiving a written request for acquisition from the landowner, is bound to acquire the land.

11.2.3 Representative receptors

Ten privately owned and one mine owned (by Wambo Mine) residences were considered representative of assessable locations for the assessment of the noise impacts from the proposed fine reject emplacement. These receptors were assessed in the *West Pit Extension and Minor Modifications EIS* (ERM 2003) and the *Carrington West Wing EA* (EMM 2010) and are provided in Table 11.3 below and shown on Figure 11.1. The receptor number convention has been kept consistent with DA 450-10-2003.

Table 11.3 Surrounding sensitive receptors

Receptors		Direction from fine reject emplacement
No.	**Property owner**	
1	Hayes (Jerrys Plains closest residence)	SW
2	Skinner	SW
3	Gee	SW
4	Muller	SW
5	Bowman	SE
6	Moxey	SE
7[1]	Stapleton	E
11[2]	Wambo Owned	S
13[3]	Jerrys Plains Centre	WSW
14[3]	Jerrys Plain North	WSW
39[3]	Warkworth Village Representative	SSE

Notes: 1. This private residence has been acquired by Xstrata

2. Mined owned.

3. Privately owned receptors and representative of other privately owned receptors in the area.

11.2.4 Potential impacts

The three-dimensional digitised ground contours used for the modelling in this assessment reflect the Year 8 mine plan as assessed in *West Pit Extension and Minor Modifications EIS* (ERM, 2003) and Year 1 in the *Carrington West Wing EA* (EMM, 2010). These years were selected to ensure predicted fine reject emplacement construction noise levels are matched with the appropriate previous worst case predictions for current approved and proposed HVO North operations.

Modelling considered calm and prevailing (ie winds and temperature inversions) weather scenarios. The emplacement construction activities will occur over 24 hours a day until completed. Assessment of the night time period becomes critical during prevailing weather conditions. Therefore, in accordance with previous studies, a night time air temperature and relative humidity of 10°C and 80 per cent were assigned respectively in conjunction with calm and identified prevailing weather conditions.

The noise model predicts the summation of noise over a selected period of time (L_{eq}) based on equipment sound power levels determined from measurements conducted at West Pit. It is the energy average noise from a source, and is equivalent continuous sound pressure level over a given period. The results assume all modelled plant and equipment operate simultaneously. In practice, such an operating scenario would be unlikely to occur. The results are therefore considered conservative.

Table 11.4 summarises noise modelling results for calm and worst prevailing weather conditions from the fine reject emplacement construction in combination with the most representative previous noise predictions for HVO North operations.

Table 11.4 Noise predictions – Leq,15minute, dB(A)

Receptor No.	Mining - Carrington and West Pit (Mitigated)[1]		Fine reject emplacement construction		Combined mining and fine reject emplacement construction		Consent limits	
	Calm	Prevailing	Calm	Prevailing	Calm	Prevailing	D/E/N[2]	Acquisition
1	20	38	< 20	29	20	39	38-40	>41
2	21	37	< 20	30	21	38	39	>41
3	23	37	< 20	30	23	38	39	>41
4	30	38	23	30	31	39	36-40	>41
5	21	30	< 20	20	21	30	35	>41
6	20	28	< 20	< 20	20	29	35	>41
7	30	38	20	25	30	38	36-40	>42
11	31	38	29	30	33	39	39	>43
13	14	41	< 20	27	15	41	40	>41
14	12	41	< 20	26	13	41	40	>41
39	16	31	< 20	< 20	17	31	35	>41

Notes: *1. Year 1 scenario from the Carrington West Wing EA and includes noise levels from Carrington Pit, Carrington West Wing Pit extension and West Pit*

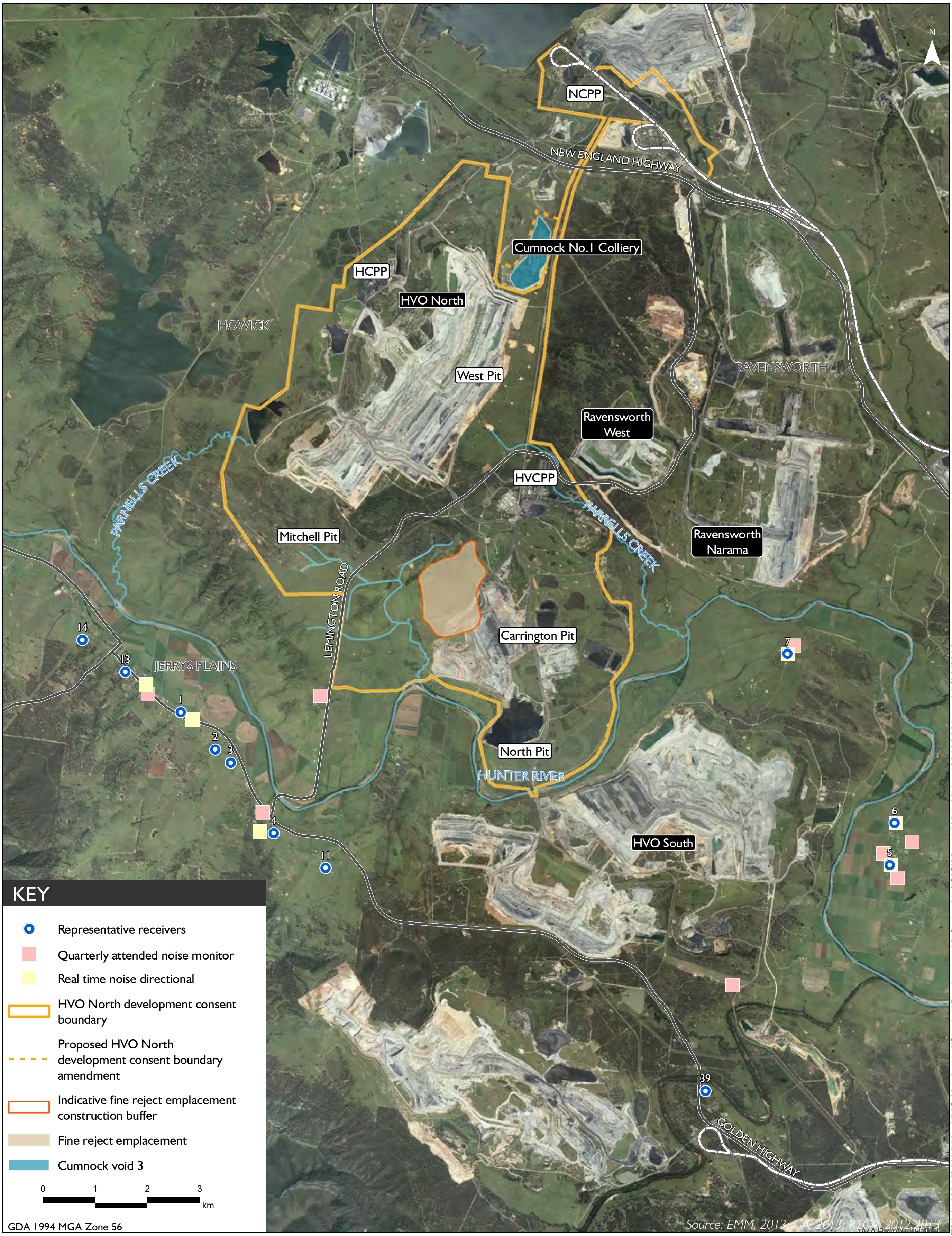
2. D/E/N = Day/Evening/Night

As shown in the above table, predicted incremental noise from the construction of the fine reject emplacement is well below the consent limits.

When combined with existing noise predictions there is a minor increase (1 dB(A)) in noise levels at receptors 1 to 4, 6 and 11. There is no change predicted to noise levels at other receptors. In addition, construction activity will be temporary and will have an imperceptible impact on overall mine noise levels.

Furthermore, in all cases the combined noise level is below the applicable acquisition criteria, and predictions at all receptors from fine reject emplacement construction in isolation are greater than 10 dB(A) below the acquisition criteria. Therefore, the contribution cannot theoretically cause exceedance of the acquisition criteria as the addition of a noise level 10 dB below another, does not change the higher value. Overall, noise levels from the temporary construction of the fine reject emplacement in conjunction with general operations at the site are not expected to result in any offsite noise impacts.

Sleep disturbance impacts, which have potential ramifications for human health, were assessed in the Carrington West Wing EA (EMM 2010), which found maximum noise level events from mining activities to be below accepted noise limits. The proposed fine reject emplacement is a further 1.5 km from the closest extent of the assessed Carrington West Wing plant locations.



T:\Jobs\2012\J12046 - HVO North modification\GIS\Maps\1101_Noise_20130607.mxd 7/06/2013

EMM
EMGA Mitchell McLennan

Noise monitoring network and representative receivers

HVO North - Fine reject emplacement modification

Figure 11.1

11.3 Management and monitoring

Noise management at HVO North is, and will continue to be, undertaken in accordance with the relevant HSEQ MS procedures and the HVO Noise Monitoring Programme and Noise Management Plan.

There are no additional management and monitoring measures required as a result of the proposed modification.

11.4 Conclusions

The construction of the fine reject emplacement represents the only potentially significant noise assessment issue from the proposed modification. Noise modelling for the construction found that, for representative receiver locations, any potential increase in noise as a result of the construction of the proposed fine reject emplacement is likely to be imperceptible when compared with current and potential future mining operations.

The operations phase of the proposed modification will not increase the overall noise levels from HVO North.

12 Air Quality

This chapter provides a summary of the air quality study prepared Todoroski Air Sciences, which is presented in full in Appendix G. The key findings are summarised below.

12.1 Existing environment

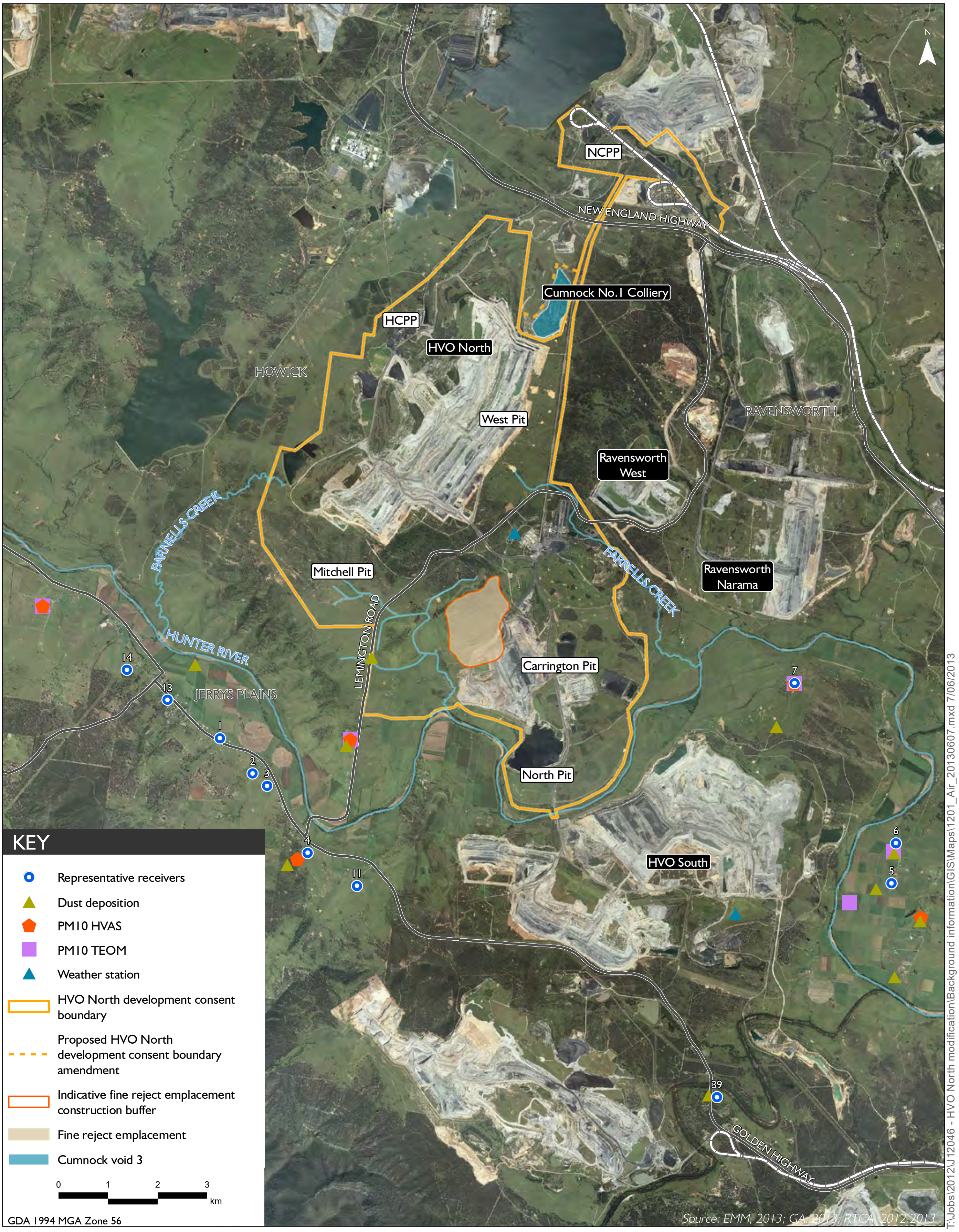
The land use and terrain surrounding the proposed modification and the location of the closest sensitive receivers are the same as described in Section 11.1 for noise.

Existing air quality in the local area is influenced by particulate matter emissions from mining activities, power generation, agriculture, vehicle movements and other industrial activities.

Meteorological data are collected at two automatic weather stations situated within the HVO mining complex; the HVO weather station and the Cheshunt weather station. The location of these stations is shown in Figure 12.1. Data collected between the periods of 2009 to 2011 have been analysed and windroses generated from these data are presented in Appendix G. The potential for particulate matter to disperse and result in impacts on nearby receptors is dependent on the quantity of particulate matter generated, size, and the prevailing wind direction and speed. Annual and seasonal windroses of meteorological data used in the assessment, provided in the full report in Appendix G, show that in summer the wind is predominantly from the south/south-east and south-east, while in winter the wind is predominantly from the north-west. Autumn and spring experience a combination of these wind conditions.

The HVO complex maintains a network of air quality monitoring equipment, including dust deposition gauges, High Volume Air Samplers (HVAS) and Tapered Element Oscillating Microbalances (TEOMs). In addition, OEH maintain two TEOMs in the area. The air quality monitoring network utilised in this study is shown on Figure 12.1. Recorded PM_{10} levels are predominately higher during the summer and spring months.

The data collected from the monitoring network, in conjunction with meteorological data and previous assessments of existing operations, provided the basis for the assessment of the potential air quality impacts of the proposed modification.



Air quality monitoring network

HVO North - Fine reject emplacement modification

Figure 12.1

12.2 Assessment

12.2.1 Approach

The proposed emplacement includes a limited period of construction activity and ongoing pumping of wet fine reject. The proposed emplacement will be on previously disturbed land, centrally within the existing operations and, therefore, would have limited capacity to influence air quality to any significant degree. The closest sensitive receivers are behind the ridgeline within the village of Jerrys Plains. This study provides a qualitative analysis of the potential dust emissions and associated impacts that may arise due to the proposed emplacement.

12.2.2 Potential impacts

Construction of the fine reject emplacement will involve the temporary disturbance of the area immediately surrounding the proposed emplacement to raise an embankment within which wet fine reject will be pumped. The material required for construction of the emplacement embankment will be sourced from suitable material types that result from approved operations. Dust may be generated by the loading, transport, emplacement and shaping operations during construction, which may be exacerbated during periods of high wind speeds.

A review of the meteorological conditions indicates that given the prevailing winds, the project area is favourably located relative to the nearest sensitive receivers, with little prevailing wind from the proposed fine reject emplacement towards receptors.

It is intended, as far as practical, that existing mine plant will be used to construct the fine reject emplacement and that a limited number of additional plant may be required (ie most, if not all, equipment required during construction of the emplacement is, at present, carrying out essentially a similar activity on site). If, however, additional plant items were required, there would be no material change to the overall activity at the site.

Given the existing dust emissions in the immediate vicinity, the duration of construction and that there will be no significant increase in overall activity at the site, it is considered that construction of the emplacement would not result in any measureable increase in dust emissions.

As there would not be a significant increase in dust produced, and the location of the activity would not be significantly close to receptors, and also as there is little prevailing wind towards receptors, it is reasonable to conclude that it is unlikely that the proposed modification would cause any additional impact at any surrounding sensitive receptor locations.

Pipelines are required to transport fine reject from active mine areas to the emplacement areas at the fine reject emplacement. The overland pipelines would generally be constructed on previously disturbed land adjacent to existing haul roads and the dust emissions generated during this activity would be minor in comparison to the total dust burden of the operations.

12.3 Management and monitoring

Given the minor nature of the proposed emplacement, it is expected that dust emissions from its construction and operation would be negligible.

Air quality management at HVO North is, and will continue to be, undertaken in conjunction with relevant HSEQ MS procedures and the HVO Dust/ Air Quality Management Plan. Additional management measures beyond those contained in the aforementioned procedure and plan are not required.

12.4 Conclusions

The fine reject emplacement is favourably located within the HVO North site relative to sensitive receptors as there is little prevailing wind in their direction. Furthermore, the construction of the fine reject emplacement will not result in a measureable increase in dust emissions. Dust emissions from either emplacement would be minimal as the fine reject material is wet. Accordingly, the construction and operation of the proposed emplacement is unlikely to result in any measureable increase in dust emissions from the HVO North site.

13 Soils and land capability

This chapter provides a summary of the soils and land capability study prepared by GSS Environmental (GSSE), which is presented in full in Appendix H. The key findings are summarised below.

13.1 Existing environment

The majority of the proposed fine reject emplacement will take place on land that has been previously disturbed at HVO North for mining activities and subsequently rehabilitated. The soils originally occurring in the study area consisted of the Liddell and Dartbrook soil landscapes, as described in Kovac & Lawrie (1991). Given this, it is likely that the topsoil used in rehabilitation was derived from, and therefore is similar to, the original Liddell soil types due to the Liddell soil landscape being the predominant soil type in the area. It is expected to be suitable for stripping and reuse for a second time. It has been assumed that the soil depth across the project area is 0.8 m, however there is considerable potential for variation.

13.2 Assessment

13.2.1 Approach

A soil map was developed using aerial photographs and topographical maps; reference information, including cadastral data, geological, vegetation and water resources studies; previous soils information, including Soil Landscapes of Singleton 1;250,000 sheet (Kovac & Lawrie, 1991) and land capability spatial data (DNR, 2005); and stratified observations.

GSSE also undertook a soil survey involving four sample sites. Soil profiles were assessed in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST 2009). One to three samples were taken from three profiles at each sample site for laboratory analysis. Each soil profile exposure pit was excavated, samples taken for analysis and the pit photographed. Vegetation type and land use were also recorded.

Soil samples were sent to the Scone Research Centre and were analysed to:

- classify soil taxonomic classes; and
- determine the suitability of soils as topdressing material for future rehabilitation works.

Given the highly disturbed nature of the study area and its history (the entire study area consists of land that has been previously disturbed by mining activity, and subsequent rehabilitation), only one soil type was identified, as shown in Table 13.1.

Table 13.1 Soil type

Soil type number	Soil landscape	Representative ASC name	Study area	
			Area (ha)	Area (%)
1	Liddell and Dartbrook	Spolic Anthroposol	160.6	100

Anthroposols are soils that result from human activities that have caused a profound modification, mixing, truncation or burial of the original soil horizons.

The topsoil (0 – 0.30 m) is suitable for stripping and reuse on other landforms. The subsoil, whilst unsuitable for use as topdressing, could be reused as an intermediate layer between spoil and topsoil, as it appears to have been on the current rehabilitated landform. It can be stripped to 0.80 m from the original surface level.

13.2.2 Land assessment

i Land and soil capability

In NSW, rural lands are currently being mapped according to two different land classification systems. The first of these was developed by the OEH and classifies land into eight classes (Classes 1 to 8) known as Land and Soil Capability (LSC) classes. This system has been recently introduced to replace the former Rural Land Capability System (Emery 1986) that was formerly the benchmark for land capability assessments in NSW.

The LSC class is calculated using the biophysical features of the land, such as slope, landform position, acidity, drainage and climate, that are associated with various hazards, including water and wind erosion, soil structure decline and acidification, salinity, waterlogging and mass movement. The project area was assessed and classified as Class 4. Class 4 land is moderately capable for a range of land-uses, but specialised practices are necessary to overcome severe limitations, primarily soil alkalinity, topsoil sodicity and likely low fertility.

ii Agricultural suitability

In NSW five classes (Classes 1 to 5), known as Agricultural Suitability classes, are generally used to classify the agricultural suitability of land.

The project area was assessed against soil properties and other landform characteristics, including texture, pH, depth, drainage characteristics and slope, as well as biophysical factors such as elevation, rainfall and temperature to determine its agricultural suitability class. The project area was classified Class 4 which means the land is not suitable for cultivation and has low to very low productivity for grazing.

iii Biophysical strategic agricultural land (BSAL)

The NSW Government released the Strategic Regional Land Use Policy to assist the development of a long-term strategy for continued progress of the mining industry that also ensures local community sustainability and on-going viability of existing industries. Part of this policy is the development of Strategic Regional Land Use Plans (SRLUPs), which includes the determination of BSAL. BSAL is defined as areas with unique natural resource characteristics highly suited for agriculture.

There are currently two documents pertaining to the assessment of BSAL, the Strategic Regional Land Use Plan for the Upper Hunter (DP&I 2012) and the Interim Protocol for Site verification and mapping of biophysical strategic agricultural land (OEH 2012). Although there is significant overlap between the two documents, there are differing BSAL assessment criteria contained in both, therefore a BSAL assessment was undertaken using both documents. Assessments against both criteria determined that no BSAL is present within the project area, primarily due to the poor fertility of the soils.

13.3 Management and monitoring

The proposed modification almost entirely comprises a modified landscape, previously disturbed by mining activity and subsequent rehabilitation. Soil management and rehabilitation for the proposed modification will continue to be undertaken in accordance with Coal & Allied's existing environmental procedures, and in accordance with the MOP.

Given the existing soil composition within the project area and the activities proposed as part of the modification, additional management measures are proposed to ensure that there will be no material change to the pre-disturbance land assessment classes.

Topsoil and subsoil will be stripped to a total depth of 0.8 m (0 – 0.3 m topsoil; 0.3 – 0.8 m subsoil). Soil layers will be stripped and stored separately. The approximate stripping depth and resource volumes are shown in Table 13.2.

Table 13.2 Recommended soil stripping depth and resource volumes

Soil type		Area (m^2)	Topsoil stripping depth (cm)	Subsoil stripping depth (cm)	Total resource volume (m^3)	
No.	**ASC name**				**Topsoil**	**Subsoil**
1	Spolic Anthroposol	1,606,000	0 - 30	30 - 80	481,800	803,000
			Total resource volume (minus 10% handling loss)		**433,620**	**722,700**
		Combined total resource volume (minus 10% handling loss)			**1,156,320**	

Where soil stripping and transportation is required, handling techniques will be in place to prevent excessive soil deterioration.

When rehabilitation of the proposed modification commences, soil will be respread onto stripped areas where practical. Topsoils stripped from the project area may be treated with the addition of organic material (such as biosolids, mulch or compost), and gypsum to reduce potential sodicity issues, if it is deemed necessary. The soil horizons will be respread to the approximate depth from which the soil was stripped.

Subsoils will only be used as an intermediate layer between spoil and topsoil, due to their high clay content. Topsoil will be spread, treated with fertiliser and seeded in one consecutive operation to reduce the potential for wind and water erosion impacts.

Monitoring of the above management proposals will be carried out during soil stripping and subsequent rehabilitation activities.

13.4 Conclusions

The soil type covering the entire area is a Spolic Anthroposol, likely to have originated from the Liddell and Dartbrook soil landscapes. Assessments for LSC and Agricultural Suitability, as well as BSAL, were undertaken and indicated a generally low compatibility with agricultural activity.

Provided the proposed management measures are implemented, there will be no impact on the pre-disturbance land and soil capability classes and agricultural suitability classes for the proposed modification.

14 Visual

14.1 Existing environment

14.1.1 Regional context

The Hunter Valley comprises a mixture of rural, built and natural landscapes, ranging from steep, forested mountain ranges to gently undulating farmland, mining pits and infrastructure and the river flats on the Hunter River floodplain. Dominant viewscape features are agricultural grazing lands, open cut coal mines and associated infrastructure and power stations, set against a backdrop of forested mountain ranges.

14.1.2 Local context

Dominant industrial elements of the landscape immediately surrounding HVO North are the existing open cut pits, mine-related infrastructure, including CHPPs, water storages, rail load out and rail loop infrastructure, rehabilitated former mine areas and high voltage transmission lines. In addition to industrial characteristics of the local viewscapes, there are expanses of agricultural grazing land on the Hunter Valley floodplain to the south, and on the steeper slopes to the west, along with scattered rural residences, farm infrastructure and remnant tree stands.

The dominant night-time visual elements surrounding HVO North are lighting for mine-related infrastructure and lights associated with mobile plant travelling on haul roads and lighting associated with active mining operations within mining areas.

Areas of HVO North are visible from the surrounding road network, nearby industrial areas, rural properties and residences. An aerial figure of HVO and surrounds is presented as Figure 1.2.

14.2 Assessment

14.2.1 Approach

The proposed fine reject pipelines will be located at previously disturbed areas adjacent to active mining areas, existing haul roads and mine-related infrastructure. Although located above ground, they will not be distinguishable from areas external to the mine sites and, therefore, will not impact visual amenity.

The fine reject emplacement will be located in an area of rehabilitated overburden emplacement, and approximately 500 m from Lemington Road. There are areas of remnant and rehabilitated vegetation to the north and east of the proposed fine reject emplacement. The emplacement will be elevated above the current landform and, accordingly, the visual assessment is focussed on this element of the proposed modification.

14.2.2 Visual amenity

The potential impacts of the fine reject emplacement on visual amenity are not significant and have been assessed by considering its visibility from surrounding areas and the visual absorption capacity of these areas.

Visual absorption capacity is the ability of a landscape to be changed and still retain its existing visual characteristics, such as rural, built or natural character. It is determined by considering the visibility of a proposed development and the degree of contrast between a proposed development and the local and regional viewscapes.

Given the central location of the fine reject emplacement within HVO North and the surrounding undulating landform, it will not be directly visible from any privately owned residences. Motorists travelling on Lemington Road, between the New England Highway and the Golden Highway, are the only sensitive receivers that will directly view the emplacement. The road passes to the west and north of the proposed emplacement. The viewscape along an approximately 2.5 km stretch of Lemington Road, will have views of the modified landform. Roadside tree plantings and the undulating landscape screen views at some locations, however, little to no screening exists for the stretch of road north-west and north of the proposed emplacement.

The height of the emplacement will be consistent with existing rehabilitated overburden emplacements within its vicinity and the visual sensitivity of Lemington Road is reduced as road users will experience only passing views of the emplacement and be travelling at approximately 100 km/hr, the road's speed limit. Furthermore, as with existing overburden emplacements at HVO North, the emplacement will be rehabilitated in accordance with the MOP (refer to Section 3.2.4).

The construction of the emplacement is intended to occur 24 hours a day, seven days per week and hence night lighting will be required. The use of lighting at night will not substantially contribute to the visual impacts of the area as the adjacent operations also operate at night and no private residences occur in the area as stated.

14.3 Management and monitoring

Visual amenity management is, and will continue to be, undertaken in accordance with relevant HSEQ MS procedures. These include actions for lighting, infrastructure design and maintenance, and maintenance of visual amenity through landscaping and rehabilitation. Measures which will be implemented for the proposal include:

- rehabilitation of the emplacement as soon as practical, in accordance with the MOP;
- design and placement of lighting instalments during construction of the fine reject emplacement to minimise lighting impacts wherever possible. This may include the provision of shields on floodlights, fitting lights with sensor switches or time switches and/ or directing lighting away from mine boundaries where possible;
- response procedures in the event that lighting is observed to impact public roads or sensitive receptors;
- management of community complaints (if any are received) in accordance with work instruction CNA-09-EWI-SITE-03 Environmental Contact Line; and

- a biannual assessment of the fine reject emplacement operations to be undertaken in accordance with the existing site procedures.

14.4 Conclusions

The construction of the fine reject pipelines is considered to be consistent with the existing viewscape and will not have a measureable visual impact.

Sections of Lemington Road will clearly view the emplacement. The existing viewscape, however, includes mining infrastructure, together with areas of rehabilitated landform and will be consistent with the existing visual setting at HVO North in terms of height and features. Views from vehicles will be at a distance of more than 500 m and vehicles will be travelling approximately 100 km/hr. Therefore, potential visual impacts are considered minor.

15 Social and economics

15.1 Existing environment

15.1.1 Introduction

A detailed socio-economic assessment was undertaken by ERM (2003) that included an assessment of the costs and benefits to the surrounding community of operations at HVO North. The assessment, along with subsequent assessments and projects, provides a good understanding of the existing social and economic benefits of the HVO complex. The proposed modification represents infrastructure which will support the continuation of the existing approved operation and its already assessed and approved attendant costs and benefits.

Coal & Allied has continued to monitor the socio-economic values of the local communities and impacts of its operations. Detailed socio-economic analysis of Singleton and surrounding shires is included within the Rio Tinto Coal Australia/ Coal & Allied Hunter Valley *Community Baseline Study*, prepared by the Hunter Valley Research Foundation (HVRF) for Coal & Allied. The intent of this study is to provide a thorough analysis of the social and economic context that supports Coal & Allied's operations across the Hunter Region, informing engagement strategies and social investment priorities.

In addition, Coal & Allied recently completed a project in conjunction with Coakes Consulting to understand how the community perceives its relationship and engagement with Coal & Allied and identifies areas for improvement. The findings of this project have informed the sections below.

15.1.2 Local and regional setting

Coal & Allied operates three mines and has one new project in the Hunter Valley, NSW. Two are centred around the town of Singleton (HVO and Mount Thorley Warkworth) and two near the town of Muswellbrook (Bengalla and the Mount Pleasant Project). The two closest communities to the proposed modification at HVO are Jerrys Plains to the west and Maison Dieu to the south-east.

The coal mining industry provides substantial economic stimulus in the Hunter Valley. The region contracts 39 per cent of NSW's recoverable coal reserves and contributes 63 per cent of NSW coal production (DPI 2009). The 2006 census data for Hunter Valley indicated that 15 per cent of people employed were employed in the mining industry. More specifically to HVO's local communities, mining employed 19.9 per cent of the employed population in Singleton and 16.6 per cent of Muswellbrook's working population. Other local industries in the region include agriculture, viticulture, power generation, defence and tourism.

HVO contributes significantly to the local economy through employment and purchase of goods and services from local suppliers. It currently directly employs approximately 1,160 people, 30 of whom are Indigenous and 25 of whom are apprentices and trainees. All employees reside within the Hunter Region, with the majority residing in the Singleton, Muswellbrook, Cessnock and Maitland local government areas. In terms of 'local spend' in the economy, HVO spent $390 million on goods and services from 450 suppliers in the Hunter Region in 2011. Of this, $84 million was spent in Singleton LGA and $62 million in Muswellbrook LGA. In addition to this direct economic stimulus through payments to suppliers and employment of contractors, in 2011, Coal & Allied paid $308 million in royalties to the NSW government.

In 2011, HVO received 102 community complaints, the majority of which were related to noise. The existing community complaint profile and the community concerns raised through consultation for this modification have been taken into account in the assessment of noise and air quality impacts associated with the proposed modification (see Chapters 11 and 12). The chart below illustrates the key areas of concern for the communities of Jerrys Plains and Maison Dieu identified by the Coakes Consulting and Coal & Allied 'Your Say' project. Importantly, community members noted that these impacts are cumulative rather than associated with a specific operation.

While not reflected in Figure 15.1, the single most frequently identified impact/issue (70 per cent of responses) is the positive impact of increased employment and training as a result of mining in the region.

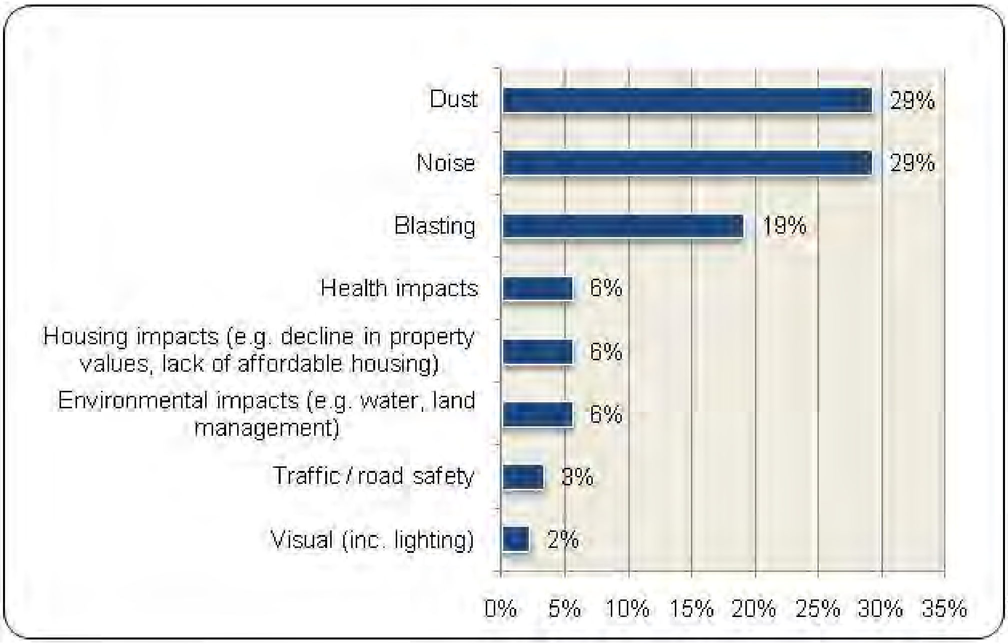


Figure 15.1 Matters raised by Jerrys Plains and Maison Dieu communities

15.2 Assessment

15.2.1 Amenity impacts

As described in Chapter 1, the proposed modification presents a continuation of mining activities at HVO and is located a significant distance away from any private residences (sensitive receivers). The proposed modification will take place on land owned predominantly by Coal & Allied and for a minor part is proposed to affect void land predominantly owned by the Cumnock Joint Venture. As such, the proposed modification will not directly impact any other private land owners.

As described in Chapters 11 and 12, the proposed modification is not anticipated to have any significant impacts on community amenity indicators including noise and dust. As the modification will use the existing workforce and machinery, there will not be any increase in traffic movements and associated impacts on local communities.

15.2.2 Economic costs and benefits

As outlined in the previous section, HVO is an important economic driver in the Hunter Valley economy. The proposed modification will support substantial regional and local economic benefits such as ongoing employment for workers at HVO North and business for suppliers and service providers. The impact of not implementing the proposed modification could include delays or reduction in operations at HVO and increased environmental costs for no community or environmental gain.

As described in Section 3.6, a number of options for the management of fine reject were considered during the development of the proposed modification. The preferred option provides the greatest increase in fine reject storage capacity with the least environmental footprint. As fine reject capacity is a core requirement of ongoing development of HVO, it is assumed that if the proposed modification were rejected, an alternative solution would be sought, however the location may not be as suitable to minimise community amenity impacts and may present greater environmental cost. As such, it is proposed that this modification presents the greatest economic benefit to the community whilst minimising environmental, community and economic costs.

15.3 Management and monitoring

Although community amenity and economics costs of the project are assessed to be minimal, Coal & Allied will continue to monitor and manage issues through a range of existing methods. These methods include:

- regular engagement with local communities through near neighbour meetings, CCC meetings, community BBQs and school engagements, which provide access to Community Relations, HVO operational staff and environmental specialists;
- analysis of the regular Community Omnibus surveys and other relevant secondary data to identify any changes in key community issues;
- inclusion of relevant project information in the quarterly Singleton Coal & Allied Community Newsletter;
- response to, and evaluation, of community complaints and concerns raised; and
- monitoring of external impacts including noise and dust, as described in Chapters 11 and 12.

Community consultation will be ongoing for the life of the proposed modification and any anticipated changes will be communicated as early as possible.

15.4 Conclusions

HVO contributes significantly to the local and regional economy through, amongst other means, the direct employment of over 1,000 people. As fine reject capacity is a core requirement of ongoing operations at HVO, the proposed modification is critical to the continuation of these significant economic contributions.

The proposed modification is not predicted to have significant impacts on community amenity, including impacts from noise and dust.

16 Other environmental considerations

16.1 Greenhouse gases

Mining activities generate greenhouse gas (GHG) emissions from a number of sources, including combustion of fossil fuels in diesel-powered equipment and electricity generation, and release of fugitive methane emissions from coal seams during the extraction of coal.

The proposed modification does not involve any increase in employee numbers, increase in production, or any increase in the haulage of coal. Fine reject is currently emplaced at HVO and the proposed modification represents a continuation of this practice. The construction of the fine reject emplacement will utilise existing plant removed from other site activities. The emplacement is, therefore, an alternative activity not an additional activity. As a result, it is considered that the proposed modification will not contribute to an increase above the previously assessed GHG emissions for the site.

Existing energy saving and GHG emission reduction measures and projects will continue to be implemented at HVO.

16.2 Traffic and transport

The public road network in the vicinity of the project area consists of the following: the New England Highway to the distant north and east; the Golden Highway to the south; and Lemington Road to the immediate west and north (see Figure 1.2).

Mine-related traffic from operations at HVO and surrounding mines comprise a significant proportion of existing traffic volumes on the road network surrounding the project area.

The proposed modification does not involve any increase in employee numbers, increase in production, or any haulage of coal on public roads, and accordingly, will not affect traffic volumes on road or rail networks.

16.3 Non-indigenous heritage

A search of the Australian Heritage Places Inventory, National Heritage List, Australian Heritage Database, NSW State Heritage Register, Roads and Maritime Services (formerly RTA) Section 170 Register, Hunter Regional Environmental Plan 1989 (Heritage) and Schedule 3 of the Singleton Local Environmental Plan 1996 undertaken on 26 March 2013 did not identify any items or places of non-indigenous heritage significance within or adjacent to the project area. The results of this search are consistent with the findings of the relevant previous assessments undertaken for HVO North. The proposed modification will not impact non-indigenous heritage.

17 Statement of commitments

This chapter describes the commitments that will be implemented throughout the life of the proposed modification to manage the potential impacts identified within the EA. Commitments include management, mitigation and monitoring measures.

As discussed in Section 2.3, all of Coal & Allied's mining operations in the Hunter Valley currently operate under an HSEQ MS which is certified to the international standard ISO:14001 (2004) and forms the basis for ongoing environmental management. The HSEQ is a management tool implemented by the company rather than a consent requirement. It will continue to be implemented across HVO. The relevant plans, procedures and monitoring programmes contained within the HSEQ will be reviewed and modified to incorporate the commitments outlined below and reflect the changes to operations resulting from the proposed modification.

The technical assessments provide a number of measures to avoid or minimise the potential impacts resulting from the proposed modification. These measures have been considered in the context of existing HVO North MOP and the HSEQ. Commitments related specifically to the proposed modification, beyond those currently implemented as standard practice, are presented in Table 17.1 below.

Table 17.1 Commitments

Attribute	Commitment
General	• Fine reject pipeline construction will generally be restricted to areas that: - have been previously disturbed by mining and related activities; - are adjacent to existing infrastructure such as haul roads and existing pipelines; and - will disturb no more than remnant isolated trees if they cannot be avoided.
Groundwater	• The monitoring bores and vibrating wire piezometers that were installed as part of the groundwater assessment will be retained and integrated into the groundwater monitoring plan for the life of the Carrington Pit.
Visual	• Lighting instalments during construction of the fine reject emplacement will be designed and located to minimise light spill where possible. This may include the provision of shields on floodlights, fitting lights with sensors or time switches or directing lighting away from public traffic areas where possible.

18 Justification and conclusion

18.1 Introduction

This chapter considers the suitability of the site, and of the proposed modification against the objects of the EP&A Act, including ESD principles, and draws conclusions based on the EA.

18.2 Suitability of the site

HVO has successfully and responsibly operated for over 50 years. An overview of the site and surrounds is provided in Section 1.3.

A vast majority of the proposed modification will take place on land that has been previously disturbed for mining activities and will not require the acquisition of additional land. The rehabilitated areas within the proposed footprint consist of areas planted with native overstorey species and pasture areas. The vegetation within this area does not conform to any known vegetation type or ecological community. There is a significant volume of baseline environmental data that exists for HVO based on a well-established environmental management framework that includes extensive monitoring programmes. Consequently, the environmental interactions at the site are well-understood. Furthermore, the closest privately owned residences are over 4 km to the west, south-west and south of the proposed fine reject emplacement and are located within the village of Jerrys Plains and along the Golden Highway.

In addition, the emplacement of fine reject in Cumnock void 3 was contemplated in the approved *Ravensworth Operations Project Environmental Assessment* (Umwelt, 2010). An arrangement has been made between Coal & Allied and the Cumnock Joint Venture for joint fine reject disposal within the Cumnock void 3.

For the reasons outlined in previous chapters above, it is concluded that the site is highly suitable for the purposes of the proposed modification.

18.3 Objects of the Environment Planning and Assessment Act 1979

The consistency of the Proposal with the relevant objects of the EP&A Act is considered below.

"To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment".

HVO is a long standing operation that has demonstrated the ability to efficiently extract one of the State's valuable natural mineral resources for the benefit of a range of stakeholders.

The proposed modification will enable the continuation of mining at HVO, providing for continued local and regional economic and social benefits.

Furthermore, an innovative approach to fine reject management underpins the proposed modification, which will, where possible, utilise existing equipment, plant and workforce and further develop Coal & Allied's existing mining and environmental management infrastructure.

Technical assessments indicate that no significant environmental impacts are anticipated as a result of the proposed modification. Notwithstanding, there are a number of environmental management measures in place to mitigate, manage and monitor any potential impacts.

Therefore, it is considered that the proposed modification is consistent with this object.

"To encourage the promotion and co-ordination of the orderly and economic use and development of land."

The proposed modification encourages the proper management and development of a natural mineral resource, and includes an innovative approach to fine reject management.

The proposed modification will utilise existing equipment, plant and workforce, and will allow for the continuation of operations at HVO North. It is considered that the proposed modification would constitute an orderly and economic use of the land and reserves, already approved for the purposes of mining and mining-related activities.

"To encourage the provision of land for public purposes."

All the elements of the proposed modification will be constructed on previously disturbed land within existing mining leases. There is no requirement for land acquisition. Accordingly, the proposed modification will have no direct impact on the provision of land for public purposes.

"To encourage the provision and co-ordination of community services and facilities."

The proposed modification will see the continuation of operations at HVO North. As the proposed modification will utilise the existing workforce during the construction phase, there will be no demand for additional community services and facilities (such as childcare, health, education and emergency services) as a direct result of the proposed modification. Therefore, adverse social impacts on community infrastructure and services are considered to be negligible. The ongoing operations will, however, enable continued support of the community through initiatives such as the Coal & Allied Community Development Fund, which has contributed over $11 million to projects in the local community since its inception in 1999.

"To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats."

Operations at HVO North are conducted in accordance with a suite of environmental management and monitoring measures. The proposed modification does not seek to increase the approved project disturbance boundary, and is not expected to adversely affect native animals and plants, including threatened species, populations and ecological communities and their habitats beyond the current approved operations. The fine reject emplacement has been designed specifically to avoid impacts to nearby remnant native vegetation.

"To encourage ecologically sustainable development"

The principles of ESD are outlined in Section 6 of the NSW *Protection of the Environment Administration Act 1991* and Schedule 2 of the EP&A Regulation 2000. The consistency of the proposed modification with each of these principles is discussed below.

Precautionary Principle: in practice this means that development should not cause serious or irreversible environmental impact. Such impacts can be avoided through the understanding of potential environmental impacts by undertaking a full environmental assessment, and incorporating effective mitigation or compensation measures into development proposals.

A significant number of design options were considered for the proposed modification, to ensure balance between potential environmental impacts and the need for fine reject capacity. Furthermore, the technical assessments are based on conservative assumptions ensuring that potential worst case impacts are captured. The environmental assessment of the proposed modification has identified and addressed the potential environmental impacts. Furthermore, Coal & Allied has committed to measures to prevent or minimise potential adverse environmental impacts from the proposed modification.

For these reasons, the proposed modification is consistent with the precautionary principle.

Social equity including intergenerational equity: the suitability of the site for the proposed modification was established in Section 18.2. The proposed modification requires no property acquisition, potential impacts to amenity are limited and, therefore, the proposed modification will not disadvantage any stakeholder. Once capacity of the emplacement has been reached, it will be rehabilitated in accordance with the relevant HSEQ management procedures and the Mining Operations Plan for HVO.

As demonstrated in this EA, the proposed modification will result in minimal adverse environmental impacts. However, in enabling the continuation of operations at HVO North, the proposed modification will enable the resource approved for mining at HVO North to be transformed into physical, human and financial capital.

Given the above, it is considered that the proposed modification will generally promote social equity.

Conservation of biological diversity and maintenance of ecological integrity: as previously discussed the proposed modification will have only minor potential impacts on ecology. Management and monitoring will be conducted to avoid or minimise potentially adverse impacts from the proposed modification.

Improved valuation and pricing of environmental resources: the potential environmental impacts of the proposal have been thoroughly addressed in this EA. The value of the proposed modification in terms of continued operations at HVO and the resultant enhanced security of employment were considered in the context of the potential environmental impacts. In this respect, it is considered that the proposed modification assists in the valuation and pricing of environmental resources.

"To promote the sharing of the responsibility for environmental planning between the different levels of government in the State."

All relevant State and local government agencies have been consulted during the preparation of the EA. Further consultation will occur during the response to submissions following exhibition and pre-determination phases. Thus all levels of State government have been involved to date and this will continue through to determination.

"To provide increased opportunity for public involvement and participation in environmental planning and assessment".

As no Director-General's Requirements (DGRs) were issued for the proposed modification, this EA has been prepared in accordance with existing Coal & Allied engagement tools, which provide for consistent proactive engagement with the community.

As substantiated in Chapter 5, the proposed modification is consistent with this object of the Act.

18.4 Conclusion

It is considered that the proposed modification of the HVO North DA 450-10-2003 to permit the construction and operation of the fine reject emplacement and pipelines leading to and from the proposed fine reject emplacement and Cumnock void 3 for joint fine reject disposal is justified, for the following reasons:

- it will allow the continuation of operations at HVO North and its ongoing economic and social benefits;
- the project area is suited for its purpose, given that the proposed modification will utilise previously disturbed land and does not require additional land acquisition;
- the EA demonstrates the environmental acceptability of the proposed modification, and indicates there would be no significant adverse social, economic or environmental impacts; and
- the proposal is generally consistent with the relevant objects of the EP&A Act, including the principles of ESD.

References

Brayshaw, H 1981, Archaeological Report – Appendix V Howick South Mine Expansion Environmental Impact Statement (never submitted) prepared for Clutha Development.

Brayshaw, H 1989, Archaeological Survey of Proposed Southern Extension (A72) Howick Mine Near Liddell, NSW prepared for BP Coal Australia by Sinclair Knight & Partners.

DECCW 2008, Biometric vegetation types database - Detailed data: Definitions of vegetation types for CMA areas - updated June 2008.

DEWHA, 2009, Significant Impact Guidelines 1.1: Matters of National Environmental Significance prepared for NSW Government.

DNR 2005, Land Capability Spatial Data.

DP&I 2012, The Upper Hunter Strategic Regional Land Use Plan: http://www.nsw.gov.au/sites/default/files/uploads/common/UpperHunterSLUP_SD_v01.pdf

DPI 2009, New South Wales Coal Industry Profile prepared for NSW Government.

Emery, K A 1986, Rural Land Capability Mapping prepared for the Soil Conservation Service of NSW.

EMM 2010, Carrington West Wing Modification Environmental Assessment prepared for Coal & Allied by EMGA Mitchell McLennan.

EPA 2000, NSW Industrial Noise Policy: http://www.environment.nsw.gov.au/resources/noise/ind_noise.pdf.

ERM Mitchell McCotter 1995, Archaeology & Anthropology, Authorisation 72 Howick Coal Mine Environmental Impact Statement prepared for Novacoal Australia.

ERM Mitchell McCotter 1999a, Carrington Mine Environmental Impact Statement prepared for Coal & Allied Operations by ERM Mitchell McCotter.

ERM Mitchell McCotter 1999b, Carrington Mine Supplementary Archaeological Information prepared for Coal & Allied Operations by ERM Mitchell McCotter.

ERM 2003, West Pit Extension and Minor Modification Environmental Impact Statement prepared for Coal & Allied by Environmental Resources Management Australia.

ERM 2005, Carrington Extension, Hunter Valley Operations Cultural Heritage Assessment prepared for Coal & Allied by ERM.

HLA-Envirosciences 1996, Environmental Impact Statement for Cumnock No.1 Colliery Expansion prepared for Cumnock No.1 Colliery by HLA.

Huonbrook Environment & Heritage 1999, A Geomorphological Assessment of the Proposed Carrington Mine Site, Hunter Valley, NSW prepared for ERM Mitchell McCotter.

Huonbrook Environment & Heritage 2000, Archaeological and Geomorphological Excavations at the Proposed Carrington Mine Site, Hunter Valley, NSW prepared for ERM.

Junburra Aboriginal Consultancy Services 2000, Wonnarua Cultural Heritage Assessment for Carrington Mine.

Kovac, M and Lawrie, J L 1991, Soil landscapes of the Singleton 1:250,000 Sheet prepared for the Soil Conservation Service of NSW, Sydney.

McCardle Cultural Heritage 2009, Carrington West Extension Study Area Indigenous Archaeological Assessment prepared for Rio Tinto Coal Australia.

MER 2010, Carrington West Wing Modification – Groundwater Assessment prepared for Coal & Allied.

National Committee on Soil and Terrain (NCST) 2009, Australian Soil and Land Survey Field Handbook, 3rd edition. Prepared for CSIRO, Australia.

OEH 2012, Office of Environment and Heritage Threatened species, populations and communities of NSW, online resource: http://www.environment.nsw.gov.au/threatenedspecies.

Umwelt 2010, Ravensworth Operations Project Environmental Assessment. Prepared for Ravensworth Operations Pty Limited.

WRM Water and Environment 2012, HVO North Modification – Tailings Emplacement Surface Water Assessment. Prepared for Coal & Allied by WRM.

Acronyms

AEMR	Annual Environmental Management Report
AHIMS	Aboriginal Heritage Information Management System
AIS	Agricultural Impact Statement
ARI	Average Recurrence Level
ASC	Australian soil classification
BSAL	Biophysical strategic agricultural land
CCC	Community Consultative Committee
CHMS	Cultural Heritage Management System
CHPP	Coal handling and preparation plant
Coal & Allied	Coal & Allied Pty Limited
CWW	Carrington West Wing
DGRs	Director-General's Requirements
DNR	Department of Natural Resources
DP&I	Department of Planning and Infrastructure
DRE	Division of Resources and Energy
DSC	Dam Safety Committee
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
EA	environmental assessment
EC	electrical conductivity
EMM	EMGA Mitchell McLennan Pty Limited
EMS	Environmental Management Strategy
EPA	Environmental Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*

EPL	Environmental Protection Licence
ESD	ecologically sustainable development
GDEs	groundwater dependent ecosystems
GDP	Ground Disturbance Permit
GSSE	GSS Environmental
GHG	greenhouse gas
ha	hectares
HRSTS	Hunter River Salinity Trading Scheme
HSEQ MS	Health, Safety, Environment & Quality Management System
HVAS	High Volume Air Samplers
HVO	Hunter Valley Operations
HVRF	Hunter Valley Research Foundation
INP	Industrial Noise Policy
km	kilometres
KTPs	key threatening processes
LEP	Local Environmental Plan
LGA	local government area
LSC	Land and soil capacity
MOP	Mining Operations Plan
MNES	Matters of National Environmental Significance
Mtpa	million tonnes per annum
NES	National Environmental Significance
NPW Act	*National Parks and Wildlife Act 1974*
NSW	New South Wales
OEH	Office of Environment and Heritage
POEO Act	*Protection of Environment Operations Act 1997*
ROM	Run-of-mine

ROP	Ravensworth Operations Project
SEPP	State Environmental Planning Policy
SRLUP	Strategic Regional Land Use Plan
TEOM	tapered element oscillating microbalance
tph	tonnes per hour
TSC Act	*Threatened Species Conservation Act 1995*
TSF	tailings storage facility
TSS	total suspended solids
WM Act	*Water Management Act 2000*
WRM	WRM Water and Environment

APPENDIX A

Study team

This EA was prepared by EMM with the assistance of a number of external specialists. Members of the study team, their roles and qualifications are listed below.

Table A.1 Study team

Role	Person	Organisation	Qualifications
Lead consultant team			
Project director	Luke Stewart	EMM	BAppSc (Hons)
Project manager	Andrew Wiltshire	EMM	BSc, PGDipEnvMgmt
Contributing authors	Peter Stewart	EMM	BE (Chem)
GIS and Graphics	Antony Edenhofner	EMM	BSc (Hons)
	Ana Ouriques	IDS	BSc
	Rebecca Gibson	IDS	BAppSc
Document production	Jamie Wharemate	EMM	
Technical specialists			
Air quality	Aleks Todoroski	TAS	BE (Mech)
	Philip Henschke	TAS	BSc
Ecology	Renae Baker	EMM	BSc (Hons)
	Katie Whiting	EMM	BSc, MWldMgt
Groundwater	Daniel Barclay	AGE	BAppSc (Hons)
	Claire Stephenson	AGE	BF (Hons), BSc
Noise	Najah Ishac	EMM	BSc
	Daniel Weston	EMM	BEngTech MDesSc
Soils and land capability	Clayton Richards	GSSE	BNatRes, Dip Ed
	Rhys Worrall	GSSE	BSc (Hons)
Surface water	Greg Roads	WRM	BE (Civil) (Hons)
	Mathew Briody	WRM	BE (Civil) (Hons)

APPENDIX B

DA 450-10-2003

Development Consent

Section 80 of the *Environmental Planning and Assessment Act 1979*

I, the Minister for Infrastructure, Planning and Natural Resources, approve the Development Application referred to in schedule 1, subject to the conditions in schedules 3 to 6.

These conditions are required to:
- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the on-going environmental management of the development.

Craig Knowles MP
Minister for Infrastructure and Planning
Minister for Natural Resources

Sydney, 2004 File No: S02/02690

SCHEDULE 1

Development Application:	DA 450-10-2003.
Applicant:	Coal & Allied Operations Pty Ltd.
Consent Authority:	Minister for Infrastructure and Planning.
Land:	See Appendix 1.
Proposed Development:	The extension of open cut coal mine operations at the West Pit of Hunter Valley Operations in general accordance with the Environmental Impact Statement for the *Hunter Valley Operations - West Pit Extension and Minor Modifications*, which includes: • extending open cut mining operations to the east of currently approved development; • using existing mining methods and equipment; • using existing coal preparation facilities at the West Pit to process up to 6 million tonnes per annum (Mtpa) of coal and use of related coal reject disposal facilities; • continuing coal production at the rate of 12 Mtpa at West Pit; • increasing the approved production capacity of the Carrington Pit from 6 Mtpa to 10 Mtpa; • increasing approved coal haulage from mining areas south of the Hunter River to the Hunter Valley Coal Preparation Plant from 8 Mtpa to 16 Mtpa; • upgrading the capacity of the Hunter Valley Coal Preparation Plant from 13 Mtpa to 20 Mtpa; • upgrading the Belt Line Conveyor from the Hunter Valley Coal Preparation Plant to the Hunter Valley Loading Point; • constructing a conveyor between the Hunter Valley Loading Point and the Newdell Loading Point; • hauling coal, on an intermittent basis, between the Hunter Valley Loading Point and Newdell Loading Point and the Ravensworth Coal Terminal; • hauling coal, on an intermittent basis, between the Hunter Valley Coal Preparation Plant and the Hunter Valley Loading Point along a private haul road;

- moving coal and coal rejects between mining areas and facilities of the Hunter Valley Operations, including mining areas and facilities located south of the Hunter River;
- constructing temporary crossings of the Hunter River to allow the relocation of heavy mining equipment; and
- consolidating 15 existing development approvals, applying to Hunter Valley Operations north of the Hunter River, into a single consent.

State Significant Development:	The proposal is classified as State significant development, under section 76A(7) of the *Environmental Planning and Assessment Act 1979*, because it involves coal-mining related development that requires a new mining lease under section 63 of the *Mining Act 1992*.
Integrated Development:	The proposal is classified as integrated development, under section 91 of the *Environmental Planning and Assessment Act 1979*, because it requires additional approvals under the: • *Protection of the Environment Operations Act 1997;* • *National Parks and Wildlife Act 1974*; • *Water Act 1912;* • *Rivers and Foreshores Improvement Act 1948*; • *Roads Act 1993*; and • *Mine Subsidence Compensation Act 1961*.
Designated Development:	The proposal is classified as designated development, under section 77A of the *Environmental Planning and Assessment Act 1979*, because it is for a coal mine that would "*produce or process more than 500 tonnes of coal a day*", and consequently meets the criteria for designated development in schedule 3 of the *Environmental Planning and Assessment Regulation 2000*.
BCA Classification:	Class 10b: Coal conveyor

Note:
1) *To find out when this consent becomes effective, see section 83 of the Environmental Planning and Assessment Act 1979 (EP&A Act);*
2) *To find out when this consent is liable to lapse, see section 95 of the EP&A Act; and*
3) *To find out about appeal rights, see section 97 of the EP&A Act.*

Red type represents August 2005 modification
Blue type represents June 2006 modification
Green type represents March 2013 modification

SCHEDULE 2
DEFINITIONS

AEMR	Annual Environmental Management Report
Applicant	Coal & Allied Operations Pty Ltd
ARTC	Australian Rail Track Corporation
BCA	Building Code of Australia
Bore	Any bore or well or excavation or other work connected or proposed to be connected with sources of sub-surface water, and used or proposed to be used or capable of being used to obtain supplies of such water whether the water flows naturally at all times or has to be raised whether wholly or at times by pumping or other artificial means
CCC	Community Consultative Committee
Council	Singleton Shire Council
DA	Development Application
Day	Day is defined as the period from 7am to 6pm on Monday to Saturday, and 8am to 6pm on Sundays and Public Holidays
Department	Department of Planning
Director-General	Director-General of the Department of Planning, or delegate
DPI	Department of Primary Industries
DRE	Division of Resources and Energy within the Department of Trade, Investment, Regional Infrastructure and Services
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPL	Environment Protection Licence
EPL 640	Environment Protection Licence No. 640 issued for HVO's operations north of the Hunter River or any subsequent replacement for, or variation of, EPL 640
Evening	Evening is defined as the period from 6pm to 10pm
Executive Director Mineral Resources	Executive Director of Mineral Resources within DRE, or equivalent position
Feasible	Feasible relates to engineering considerations and what is practical to build or carry out
GTA	General Term of Approval
HVO	Hunter Valley Operations
Land	As defined in the EP&A Act, except for where the term is used in the noise and air quality conditions in schedules 3 and 4 of this consent where it is defined to mean the whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at Land and Property Information at the date of this consent
LPB	Low Permeability Barrier
Mining operations	Includes the removal of overburden and extraction, processing, handling, storage and transportation of coal on site
MOP	Mining Operations Plan
MSC	Muswellbrook Shire Council
MSB	Mine Subsidence Board
Negligible	Small and unimportant, such as to be not worth considering
Night	Night is defined as the period from 10pm to 7am on Monday to Saturday, and 10pm to 8am on Sundays and Public Holidays
NOW	NSW Office of Water within the Department of Primary Industries
NP&W Act	*National Parks and Wildlife Act 1974*
OEH	Office of Environment and Heritage
PCA	Principal Certifying Authority appointed under Section 109E of the Act
POEO Act	*Protection of the Environment Operations Act 1997*
Privately owned land	Land that is not owned by a public agency, or a mining company, or its subsidiary
Reasonable	Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements
ROM coal	Run-of-mine coal
RMS	Roads and Maritime Services
Site	The land described in Appendix 1
Vacant land	Vacant land is defined as the whole of the lot in a current plan registered at the Land Titles Office that does not have a dwelling situated on the lot and is permitted to have a dwelling on that lot at the date of this consent.

TABLE OF CONTENTS

SCHEDULE 3
ADMINISTRATIVE CONDITIONS

Obligation to Minimise Harm to the Environment

1. The Applicant shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the development.

Terms of Approval

2. The Applicant shall carry out the development generally in accordance with the:
   (a) DA 450-10-2003;
   (b) EIS titled *Hunter Valley Operations – West Pit Extension and Minor Modifications*, volumes 1 – 4, dated October 2003, and prepared by Environmental Resources Management Australia;
   (c) the section 96(1A) modification application for the Hunter Valley Loading Point, dated 30 June 2005, and prepared by Matrix Consulting;
   (d) *Carrington Pit Extended Statement of Environmental Effects* volumes 1 & 2, dated October 2005, and prepared by Environmental Resources Management Australia;
   (e) *Carrington Pit Extension Response to Submissions Report*, dated May 2006, and prepared by Environmental Resources Management Australia;
   (f) Summary of Commitments for Carrington Pit as Extended, dated 28 May 2006 and prepared by the Applicant;
   (g) *Carrington West Wing Environmental* Assessment dated 1 October 2010, *Carrington West Wing Response to Submissions* dated 21 December 2010, *Carrington West Wing Agricultural Impact Assessment* dated 10 June 2011, *Carrington West Wing Statement of Commitments* dated 4 March 2013; and
   (h) conditions of this consent.

3. If there is any inconsistency between the above documents, the most recent document shall prevail to the extent of the inconsistency. However, the conditions of this consent shall prevail over all other documents to the extent of any inconsistency.

4. The Applicant shall comply with any reasonable requirement/s of the Director-General arising from the Department's assessment of:
   (a) any reports, strategies, plans, programs, reviews, audits or correspondence that are submitted in accordance with this consent; and
   (b) the implementation of any actions or measures contained in these documents.

Surrender of Consents

5. Within 3 months of the submission of the revised West Pit extension MOP to the DRE, the Applicant shall surrender all existing development consents and existing use rights associated with Hunter Valley Operations' (HVO's) mining operations and related facilities north of the Hunter River in accordance with clause 97 of the *EP&A Regulation*.

Limits on Approval

6. The Applicant may carry out mining operations on the site until 12 June 2025.

   Note: Under this consent, the Applicant is required to rehabilitate the site and carry out additional undertakings to the satisfaction of both the Director-General and the Executive Director Mineral Resources. Consequently, this consent will continue to apply in all other respects other than the right to conduct mining operations until the rehabilitation of the site and those additional undertakings have been carried out satisfactorily.

7. The Applicant shall not extract more than 12 million tonnes per annum (Mtpa) of ROM coal from the West Pit and 10 Mtpa of ROM coal from the Carrington Pit.

8. The Applicant shall ensure that the Hunter Valley Coal Preparation Plant does not receive more than 16 Mtpa of coal from mining operations south of the Hunter River, and process more than 20 Mtpa of coal.

9. The Applicant shall ensure that the West Pit Coal Preparation Plant does not process more than 6 Mtpa of coal.

Structural Adequacy

10. The Applicant shall ensure that all new buildings and structures, and any alterations or additions to existing buildings and structures, are constructed in accordance with the relevant requirements of the BCA.

Notes:

1) *Under Part 4A of the EP&A Act, the Applicant is required to obtain construction and occupation certificates for the proposed building works.*
2) *Part 8 of the EP&A Regulation sets out the requirements for the certification of development.*
3) [1]*The development is located in the Patrick Plains Mine Subsidence District. Under section 15 of the Mine Subsidence Compensation Act 1961, the Applicant is required to obtain the Mine Subsidence Board's approval before constructing or relocating any improvements on the site.*

Demolition

11. The Applicant shall ensure that any demolition work is carried out in accordance with *AS 2601-2001: The Demolition of Structures*, or its latest version.

Operation of Plant and Equipment

12. The Applicant shall ensure that all plant and equipment used at the site, or to transport coal off-site, are:
    (a) maintained in a proper and efficient condition; and
    (b) operated in a proper and efficient manner.

Community Enhancement Contribution

13. Before carrying out any development, or as agreed otherwise by Council, the Applicant shall pay Council $15,000 for the provision of stream improvement works in the Hunter River or its tributaries. If Council has not carried out these enhancement works within 12 months of payment, the Applicant may retrieve the funds from Council.

Staged Submission of any Strategy, Plan and Program

14. With the approval of the Director-General, the Applicant may submit any strategy, plan or program required by this consent on a progressive basis.

Notes:

- *While any strategy, plan or program may be submitted on a progressive basis, the Applicant will need to ensure that the existing operations of the site are covered by suitable strategies, plans or programs at all times; and*
- *If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program.*

[1] Incorporates MSB GTA.

SCHEDULE 4
SPECIFIC ENVIRONMENTAL CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from any landowner of the land listed in Table 1, the Applicant shall acquire the land in accordance with the procedures in conditions 6-7 of schedule 5 and condition 5 of schedule 5 for property 8.

Table 1: Land subject to acquisition upon request

8 - Holz	10 - Moses
9 - Dallas	12 - Barry

Note: To identify the locations referred to in Table 1, see Appendix 2.

2. While the land listed in condition 1 is privately-owned, the Applicant shall implement all practicable measures to ensure that the impacts of the development comply with the predictions in the EIS, to the satisfaction of the Director-General.

AIR QUALITY & GREENHOUSE GAS

Odour

3. The Applicant shall ensure that no offensive odours are emitted from the site, as defined under the POEO Act.

Greenhouse Gas Emissions

4. The Applicant shall implement all reasonable and feasible measures to minimise the release of greenhouse gas emissions from the site to the satisfaction of the Director-General.

Air Quality Criteria

4A. Except for the air quality affected land in Table 1, the Applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not exceed the criteria listed in Tables 2, 3 or 4 at any residence on privately-owned land or on more than 25 percent of any privately-owned land.

In this condition 'reasonable and feasible avoidance and mitigation measures' includes, but is not limited to, the operational requirements in Condition 5 of Schedule 4 and the requirements in Conditions 5 and 6 of Schedule 4 to develop and implement a real-time air quality management system that ensures effective operational responses to the risks of exceedance of the criteria.

Table 2: Long term criteria for particulate matter

Pollutant	Averaging Period	[d] Criterion
Total suspended particulate (TSP) matter	Annual	[a] 90 $\mu g/m^3$
Particulate matter < 10 µm (PM_{10})	Annual	[a] 30 $\mu g/m^3$

Table 3: Short term criterion for particulate matter

Pollutant	Averaging Period	[d] Criterion
Particulate matter < 10 µm (PM_{10})	24 hour	[a] 50 $\mu g/m^3$

Table 4: Long term criteria for deposited dust

Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
[c] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes to Tables 2–4:

- [a] *Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources);*
- [b] *Incremental impact (i.e. incremental increase in concentrations due to the development on its own);*

- [c] *Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.*
- [d] *Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed by the Director-General.*

Air Quality Acquisition Criteria

4B. If particulate matter emissions generated by the development exceed the criteria in Tables 5, 6 or 7 on a systemic basis at any residence on privately-owned land or on more than 25 percent of any privately-owned land, then upon receiving a written request for acquisition from the landowner the Applicant shall acquire the land in accordance with the procedures in Conditions 7 and 8 of Schedule 5.

Table 5: Long term acquisition criteria for particulate matter

Pollutant	Averaging Period	[d] Criterion
Total suspended particulate (TSP) matter	Annual	[a] 90 $\mu g/m^3$
Particulate matter < 10 µm (PM_{10})	Annual	[a] 30 $\mu g/m^3$

Table 6: Short term acquisition criteria for particulate matter

Pollutant	Averaging period	[d] Criterion
Particulate matter < 10 µm (PM_{10})	24 hour	[a] 150 $\mu g/m^3$
Particulate matter < 10 µm (PM_{10})	24 hour	[b] 50 $\mu g/m^3$

Table 7: Long term acquisition criteria for deposited dust

Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
[c] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes to Tables 5-7:

- [a] *Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources);*
- [b] *Incremental impact (i.e. incremental increase in concentrations due to the development on its own);*
- [c] *Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.*
- [d] *Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed by the Director-General.*

Mine-owned Land

4C. The Applicant shall ensure that particulate matter emissions generated by the development do not exceed the criteria listed in Table 2, Table 3 and Table 4 at any occupied residence on any mine-owned land (including land owned by adjacent mines) unless:

(a) the tenant and landowner has been notified of health risks in accordance with the notification requirements under Schedule 5 of this consent;

(b) the tenant on land owned by the Applicant can terminate their tenancy agreement without penalty, subject to giving reasonable notice, and the Applicant uses its best endeavours to provide assistance with relocation and sourcing of alternative accommodation;

(c) air mitigation measures (such as air filters, a first flush roof water drainage system and/or air conditioning) are installed at the residence, if requested by the tenant and landowner (where owned by another mine other than the Applicant);

(d) particulate matter air quality monitoring is undertaken to inform the tenant and landowner of potential health risks; and

(e) monitoring data is presented to the tenant in an appropriate format, for a medical practitioner to assist the tenant in making an informed decision on the health risks associated with occupying the property,

to the satisfaction of the Director-General.

Air Quality Operating Conditions

5. The Applicant shall:
   (a) implement best management practice to minimise the off-site odour, fume and dust emissions of the development, including best practice coal loading and profiling and other measures to minimise dust emissions from coal transportation by rail;
   (b) operate a comprehensive air quality management system on site that uses a combination of predictive meteorological forecasting, predictive and real time air dispersion modelling and real-time air quality monitoring data to guide the day to day planning of mining operations and implementation of both proactive and reactive air quality mitigation measures to ensure compliance with the relevant conditions of this approval;
   (c) manage $PM_{2.5}$ levels in accordance with any requirements of any EPL;
   (d) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see note d above under Table 5-7);
   (e) minimise any visible off-site air pollution;
   (f) minimise the surface disturbance of the site generated by the development; and
   (g) co-ordinate air quality management on site with the air quality management at nearby mines (Mount Thorley Warkworth, Wambo, Ravensworth and HVO South mines) to minimise the cumulative air quality impacts of these mines and the development,

   to the satisfaction of the Director-General.

Air Quality & Greenhouse Gas Management Plan

6. The Applicant shall prepare and implement a detailed Air Quality & Greenhouse Gas Management Plan for the development to the satisfaction of the Director-General. This plan must:
   (a) be prepared in consultation with the EPA, and submitted to the Director-General for approval by the end of June 2013;
   (b) describe the measures that would be implemented to ensure:
      - best management practice is being employed;
      - the air quality impacts of the development are minimised during adverse meteorological conditions and extraordinary events; and
      - compliance with the relevant conditions of this consent.
   (c) describe the proposed air quality management system;
   (d) include a risk/response matrix to codify mine operational responses to varying levels of risk resulting from weather conditions and specific mining activities;
   (e) include commitments to provide summary reports and specific briefings at CCC meetings on issues arising from air quality monitoring;
   (f) include an air quality monitoring program that:
      - uses a combination of real-time monitors and supplementary monitors to evaluate the performance of the development;
      - adequately supports the proactive and reactive air quality management system;
      - includes $PM_{2.5}$ monitoring;
      - includes monitoring of occupied development-related residences and residences on air quality-affected land listed in Table 1, subject to the agreement of the tenant;
      - evaluates and reports on the effectiveness of the air quality management system; and
      - includes a protocol for determining any exceedances of the relevant conditions in this approval; and
   (g) include a protocol that has been prepared in consultation with the owners of nearby mines (Mt Thorley Warkworth, Wambo, Ravensworth and HVO South mines) to minimise the cumulative air quality impacts of these mines and the development.

[2]NOISE

Noise Impact Assessment Criteria

7. The Applicant shall ensure that the noise generated by the development does not exceed the noise impact assessment criteria presented in Table 9 at any privately-owned land.

Table 9: Noise impact assessment criteria dB(A)

Day/Evening/Night $L_{Aeq(15\ minute)}$	Night $L_{A1(1\ minute)}$	Land Number

[2] Incorporates EPA GTAs

40	*46*	*4 – Muller (from year 1 to year 7)* *7 – Stapleton* *Jerrys Plains Village – represented by residence locations 13 and 14 on Figure 24, volume 4 of the EIS (years 20 & 21).* *1 – Hayes (years 20 & 21)* *18 – Bennet (years 20 & 21)* *51 – Nicholls (years 20 & 21)* *52 – Old – (years 20 & 21)*
39	*46*	*2 – Skinner* *3 – Elisnore* *11 – Fisher* *19 – Biralee Feeds* *31 – Cooper* *36 – Garland* *54 – Skinner*
38	*46*	*1 – Hayes (from year 1 to year 19)* *18 – Bennet (from year 1 to year 19)* *51 – Nicholls (from year 1 to year 19)* *52 – Old (from year 1 to year 19)*
36	*46*	*4 – Muller (from year 8 to year 21)*
35	*46*	*All other residential or sensitive receptors, excluding the receptors listed in condition 1 above.*

Notes:

(a) *The years referenced in Table 9 are to be considered as the position of mining operations as set out in the EIS for that year. If mining operations are delayed or accelerated from the planned location as shown in the EIS for a particular year, then the noise assessment criteria will be adjusted in accordance with the location of actual mining operations. The location of actual mining operations in relation to locations predicted in the EIS, will be indicated in the AEMR (see schedule 6, condition 5).*

(b) *The noise limits in Table 9 are for the noise contribution of the West Pit extension and all Hunter Valley Operations north of the Hunter River and coal haulage identified in the EIS from the south side of the Hunter River.*

(c) *Noise from the development is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the $L_{Aeq(15\ minute)}$ noise limits in the above table.*

(d) *To determine compliance with the $L_{Aeq(15\ minute)}$ noise limits in the above table. Where it can be demonstrated that direct measurement of noise from the development is impractical, the EPA may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.*

(e) *Noise from the development is to be measured at 1 metre from the dwelling façade to determine compliance with the* $L_{A1(1\ minute)}$ noise limits in the above table.

(f) *The noise limits in Table 9 are to be applied in accordance with the limitations and requirements set out in Appendix 3.*

Land Acquisition Criteria

8. If the noise generated by the development exceeds the criteria in Table 10, the Applicant shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in Conditions 6 and 7 of Schedule 5.

Table 10: Land acquisition criteria dB(A)

Day/Evening/Night $L_{Aeq(15\ minute)}$	***Property***
43	*11 – Fisher*
42	*7 - Stapleton*
41	*All residential or sensitive receptors, excluding the receptors listed in condition 1 above*

Note: See notes (c) to (f) to Table 9.

Noise Operating Conditions

9. The Applicant shall:
   (a) implement best management practice to minimise the operational, low frequency, road and rail traffic noise of the development;
   (b) operate a comprehensive noise management system on site that uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day to

day planning of mining operations and the implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this approval;

(c) maintain the effectiveness of any installed noise suppression equipment on plant at all times and ensure defective plant is not used operationally until fully repaired;

(d) ensure that any noise attenuated plant on site is deployed preferentially in locations relevant to sensitive receivers;

(e) minimise the noise impacts of the development during meteorological conditions when the noise limits in this approval do not apply;

(f) ensure that the site is only accessed by locomotives that are approved to operate on the NSW rail network in accordance with the noise limits in ARTC's EPL (No. 3142);

(g) use its best endeavours to ensure that the rolling stock supplied by service providers is designed, constructed and maintained to minimise noise;

(h) co-ordinate the noise management on site with the noise management at nearby mines (Mt Thorley Warkworth, Wambo, Ravensworth and HVO South mines) to minimise the cumulative noise impacts of these mines and the development,

to the satisfaction of the Director-General.

Noise Management Plan

10. The Applicant shall prepare and implement a Noise Management Plan for the development to the satisfaction of the Director-General. This plan must:
   (a) be prepared in consultation with the EPA, and submitted to the Director-General for approval by the end of June 2013;
   (b) describe the measures that would be implemented to ensure:
      - best management practice is being employed;
      - the noise impacts of the development are minimised during meteorological conditions when the noise criteria in this consent do not apply; and
      - compliance with the relevant conditions of this consent.
   (c) describe the proposed noise management system in detail, including:
      - nomination of the real-time noise monitoring locations and the noise levels that would trigger additional noise management actions;
      - a matrix of predetermined actions to be employed when trigger levels are exceeded; and
      - procedures for varying the rates and locations of attended monitoring should the real-time monitoring data suggest that the relevant noise limits are being exceeded;
   (d) include a risk/response matrix to codify mine operational responses to varying levels of risk resulting from weather conditions and specific mining activities;
   (e) include a noise monitoring program that:
      - uses attended monitoring to evaluate the performance of the development, including a minimum of four days attended monitoring per quarter at locations agreed to by the Director-General, or more regularly where required;
      - uses real-time monitoring to support the proactive and reactive noise management system on site;
      - evaluates and reports on the effectiveness of the noise management system on site;
      - provides for the annual validation of the noise model for the development; and
   (f) include a protocol that has been prepared in consultation with the owners of nearby mines (Mt Thorley Warkworth, Wambo, Ravensworth and HVO South mines) to minimise the cumulative noise impacts of these mines and the development.

METEOROLOGICAL MONITORING

11. The Applicant shall maintain a permanent meteorological station at a location approved by the EPA, and to the satisfaction of the Director-General, to monitor the parameters specified in Table 13, using the specified units of measure, averaging period, frequency, and sampling method in the table.

Table 11: Meteorological monitoring

Parameter	***Units of measure***	***Averaging period***	**Frequency**	***Sampling method***[1]
Lapse rate	*^{o}C/100m*	*1 hour*	Continuous	*Note*[2]
Rainfall	*mm/hr*	*1 hour*	Continuous	*AM-4*
Sigma Theta @ 10 m	*°*	*1 hour*	*Continuous*	*AM-2*
Siting	*-*	*-*	*-*	*AM-1*
Temperature @ 10 m	*K*	*1 hour*	*Continuous*	*AM-4*
Temperature @ 2 m	*K*	*1 hour*	*Continuous*	*AM-4*
Total Solar Radiation @ 2m	*W/m^2*	*1 hour*	*Continuous*	*AM-4*
Wind Direction @ 10 m	*°*	*1 hour*	*Continuous*	*AM-2*
Wind Speed @ 10 m	*m/s*	*1 hour*	Continuous	*AM-2*

[1] *NSW EPA, 2001, Approved Methods for the Sampling and Analysis of Air Pollutants in NSW.*
[2] *The Applicant shall calculate lapse rate from measurements made at 2m and 10m or any improved system of the determination of inversions.*

BLASTING & VIBRATION

Airblast Overpressure Limits

12. The Applicant shall ensure that the airblast overpressure level from blasting at the development does not exceed the criteria in Table 14 at any residence on privately-owned land.

Table 12: Airblast overpressure impact assessment criteria

Airblast overpressure level (dB(Lin Peak))	Allowable exceedance
115	5% of the total number of blasts in a 12 month period
120	0%

Ground Vibration Impact Assessment Criteria

13. The Applicant shall ensure that the ground vibration level from blasting at the development does not exceed the criteria in Table 15 at any residence on privately-owned land.

Table 13: Ground vibration impact assessment criteria

Peak particle velocity (mm/s)	Allowable exceedance
5	5% of the total number of blasts in a 12 month period
10	0%

Blasting Hours

14. The Applicant shall only carry out blasting at the development between 7 am and 6 pm Monday to Saturday inclusive. No blasting is allowed on Sundays, Public Holidays or any other time without the written approval of the EPA.

Blasting Frequency

14A. The Applicant may carry out a maximum of:
(a) 3 blasts a day, unless an additional blast is required following a blast misfire; and
(b) 12 blasts a week,
for all open cut mining operations at the HVO North mine.

This condition does not apply to blasts that generate ground vibration of 0.5 mm/s or less at any residence on privately-owned land, or to blasts required to ensure the safety of the mine or its workers.

Note: For the purposes of this condition, a blast refers to a single blast event, which may involve a number of individual blasts fired in quick succession in a discrete area of the mine.

Interactions With Adjoining Mines

15. Prior to carrying out any mining or associated development within 500 metres of active mining areas at Ravensworth Operations, the Applicant shall enter into an agreement with Ravensworth Operations Pty Ltd (or its assigns or successors in title) to address the potential interactions between the two mines. If during the course of entering into this agreement, or subsequently implementing this agreement, there is a dispute between the parties about any aspect of the agreement, then either party may refer the matter to the Director-General for resolution.

16. Prior to carrying out any mining or associated development within 500 metres of active mining areas at Cumnock No. 1 Colliery, the Applicant shall enter into an agreement with Cumnock No. 1 Colliery Pty Ltd (or its assigns or successors in title) to address the potential interactions between the two mines. If during the course of entering into this agreement, or subsequently implementing this agreement, there is a dispute between the parties about any aspect of the agreement, then either party may refer the matter to the Director-General for resolution.

Property Inspections

16A. If the Applicant receives a written request from the owner of any privately-owned land within 2 kilometres of the approved open cut mining pit/s on site for a property inspection to establish the baseline condition of any buildings and/or structures on his/her land, or to have a previous property inspection updated, then within 2 months of receiving this request the Applicant shall:
(a) provide the Director-General with a report that:
- establishes the baseline condition of any buildings and other structures on the land, or updates the previous property inspection report; and
- identifies measures that should be implemented to minimise the potential blasting impacts of the development on these buildings and/or structures; and

(b) provide the landowner with a copy of the new or updated property inspection report.

The report is to be prepared by a suitably qualified, experienced and independent person, whose appointment is acceptable to both parties. If there is a dispute over the selection of the suitably qualified, experienced and independent person, or the Applicant or the landowner disagrees with the findings of the inspection report, either party may refer the matter to the Director-General for resolution.

If the Applicant considers that an extension of time is required to complete the report, the Applicant may apply in writing to the Director-General for an extension. The Applicant shall provide a copy of the request and of the Director-General's decision to the landowner.

Property Investigations

16B. If the owner of any privately-owned land claims that buildings and/or structures on his/her land have been damaged as a result of blasting on the site, then within 2 months of receiving this claim the Applicant shall:
(a) provide the Director-General with a report that:
- investigates the claim; and
- identifies measures or works that should be implemented to rectify any blasting impacts of the development on these buildings and/or structures; and

(b) provide the landowner with a copy of the claim inspection report and recommendations.

If this independent property investigation confirms the landowner's claim, and both parties agree with these findings, then the Applicant shall repair the damage to the satisfaction of the Director-General.

The report is to be prepared by a suitably qualified, experienced and independent person, whose appointment is acceptable to both parties. If there is a dispute over the selection of the suitably qualified, experienced and independent person, or the Applicant or the landowner disagrees with the findings of the claim inspection report, either party may refer the matter to the Director-General for resolution.

If the Applicant considers that an extension of time is required to complete the report, the Applicant may apply in writing to the Director-General for an extension. The Applicant shall provide a copy of the request and of the Director-General's decision to the landowner.

Blasting Operating Conditions

17. During mining operations on site, the Applicant shall:
(a) implement best management practice to:
- protect the safety of people and livestock in the surrounding area;
- protect public or private infrastructure/property in the surrounding area from any damage; and
- minimise the dust and fume emissions of any blasting;

(b) minimise the frequency and duration of any road closures, and avoid road closures during peak traffic periods;
(c) co-ordinate the timing of blasting on site with the timing of blasting at nearby mines (including the Mt Thorley Warkworth, Wambo, Ravensworth and HVO South mines) to minimise the cumulative blasting impacts of these mines and HVO North mine; and
(d) operate a suitable system to enable the public to get up-to-date information on the proposed blasting schedule on site,

to the satisfaction of the Director-General.

18. The Applicant shall not undertake blasting on site within 500 metres of:
(a) any public road without the approval of the appropriate road authority; or
(b) any land outside the site that is not owned by the Applicant; unless

- the Applicant has a written agreement with the relevant landowner to allow blasting to be carried out closer to the land, and the Applicant has advised the Department in writing of the terms of this agreement, or
- the Applicant has:
  - demonstrated to the satisfaction of the Director-General that the blasting can be carried out closer to the land without compromising the safety of the people or livestock on the land, or damaging the buildings and/or structures on the land; and
  - updated the Blast Management Plan to include the specific measures that would be implemented while blasting is being carried out within 500 metres of the land.

Blast Management Plan

19. The Applicant shall prepare and implement a Blast Management Plan for the development to the satisfaction of the Director-General. This plan must:
    (a) be submitted to the Director-General for approval by the end of September 2013 unless otherwise agreed;
    (b) propose and justify any alternative ground vibration limits for any public infrastructure in the vicinity of the site;
    (c) describe the measures that would be implemented to ensure:
    - best management practice is being employed;
    - compliance with the relevant conditions of this consent;
    - that blasting will not cause damage to the Carrington West Wing Groundwater Barrier (LPB) as described in Condition 23 of Schedule 4.

    (d) include a road closure management plan for blasting within 500 metres of a public road, that has been prepared in consultation with the RMS and Council;
    (e) include a specific blast fume management protocol to demonstrate how emissions will be minimised including risk management strategies if blast fumes are generated;
    (f) include a monitoring program for evaluating the performance of the development, including:
    - compliance with the applicable criteria;
    - minimising the fume emissions from the site; and

    (g) include a protocol that has been prepared in consultation with the owners of nearby mines (including the Mt Thorley Warkworth, Wambo, Ravensworth and HVO South mines) to minimise the cumulative blasting impacts of these mines and the HVO North mine.

[3]SURFACE & GROUND WATER

Note: Under the Water Act 1912 and/or Water Management Act 2000, the Applicant is required to obtain the necessary water licences and approvals for the development.

Pollution of Waters

20. Except as may be expressly provided by an EPA licence, the Applicant shall comply with section 120 of the *Protection of the Environment Operations Act 1997* during the carrying out of the development.

Water Supply

20A. The Applicant shall ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of mining operations to match its available water supply, to the satisfaction of the Director-General.

Compensatory Water Supply

20B. The Applicant shall provide compensatory water supply to any landowner of privately-owned land whose water supply is adversely and directly impacted (other than an impact that is negligible) as a result of the development, in consultation with NOW, and to the satisfaction of the Director-General.

The compensatory water supply measures must provide an alternative long-term supply of water that is equivalent to the loss attributed to the development. Equivalent water supply should be provided (at least on an interim basis) within 24 hours of the loss being identified, unless otherwise agreed with the landowner.

If the Applicant and the landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Director-General for resolution.

[3] Incorporates EPA GTA

If the Applicant is unable to provide an alternative long-term supply of water, then the Applicant shall provide alternative compensation to the satisfaction of the Director-General.

Discharge Limits

21. Except as may be expressly provided by an EPA licence or the Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002 (or any subsequent version of the Regulation), the Applicant shall:
    (a) not discharge more than 237 ML/day from the licensed discharge points at HVO north of the Hunter River;
    (b) ensure that the discharges from licensed discharge points comply with the limits in Table 17:

Table 15: Discharge Limits

Pollutant	Units of measure	100 percentile concentration limit
pH	pH	6.5 ≤ pH ≤ 9.5
Non-filterable residue	mg/litre	NFR ≤ 120

Note: This condition does not authorise the pollution of waters by any other pollutants.

[4]Water Licensing

22. Prior to the renewal of a licence obtained under the *Water Act*, or 5 years after the issue date (whichever is first), the Applicant must undertake a comparison of predicted impacts, on water resources, in the EIS against actual impacts, to the satisfaction of the NOW.

Groundwater Barrier

22A. Within 2 years of commencing mining in the Carrington Pit Southern Extension, or as otherwise agreed with the Director-General, the Applicant shall construct a groundwater barrier wall across the eastern arm of the palaeochannel of the Hunter River, to the satisfaction of the Director-General and at a location no further south than shown in the figure "*Carrington River Red Gums, Billabong and Associated Infrastructure*" included in the *Carrington Pit Extension Response to Submissions Report*, dated May 2006.

22B. By 31 December 2006, or as otherwise agreed with the Director-General, the Applicant shall submit a report to the Department and the NOW that:
    (a) examines all reasonable and feasible options for the design and construction of the groundwater barrier wall (including matters such as materials, timing and method of construction, costs, projected initial and long-term effectiveness) to the satisfaction of the Director-General; and
    (b) recommends a preferred option for the approval of the Director-General.

Carrington West Wing Groundwater Barrier (LPB)

23. The Applicant shall design the Carrington West Wing LPB to the satisfaction of NOW and the Director-General. The detailed design must:
    (a) ensure that negligible movement of water can occur through the barrier in either direction over the long term;
    (b) be prepared by a suitably qualified and experienced expert/s;
    (c) be endorsed by NOW and approved by the Director-General, prior to construction of the LPB;
    (d) achieve the relevant performance measures including:
        - applicable permeability of 10^{-8} metres/second or less;
        - applicable Australian Standards (including AS 3798-2007); and
        - hydraulic, geomorphologic and seismic stability which will withstand any blasting-related vibrations, mining operations, fluvial and weather events, decay corrosive and biological attack.

Note: The conceptual low permeability barrier is shown in Appendix 4.

24. Prior to undertaking any mining operations within 100 metres of the western arm of the Hunter River paleochannel, the Applicant shall:
    (a) install the LPB in the western arm of the paleochannel;

[4] Incorporates NOW GTAs

(b) submit an as-executed report to the Director-General and NOW by a suitably qualified and experienced practising engineer, certifying that the LPB has been constructed to achieve the relevant performance measures set out in Condition 23(d) of Schedule 4; and
(c) obtain endorsement on the installed LPB from NOW.

If there is evidence after its installation that the LPB is not achieving the performance objective and performance measures in Condition 23 of Schedule 4, mining operations within 100 metres of the western arm of the Hunter River paleochannel must cease until approval to recommence is granted by the Director-General.

LPB Monitoring and Management Plan

25. The Applicant must prepare and implement a Low Permeability Barrier Monitoring and Management Plan to the satisfaction of NOW and the Director-General. The plan must:
    (a) address the monitoring and management of both the Carrington West Wing LPB and the Carrington Pit Southern Extension LPB;
    (b) be prepared by a suitably qualified and experienced expert;
    (c) be endorsed by NOW and approved by the Director-General, prior to construction of the Carrington West Wing LPB;
    (d) describe the monitoring and maintenance procedures to be implemented and the scheduling of these procedures;
    (e) demonstrate that the monitoring system is capable of timely detection of any failure or deficiency in either LPB; and
    (f) describe the contingency measures that will be implemented in the event of a failure or deficiency in either LPB.

Flood Design Works

26. The Applicant shall design and construct the flood levees and associated flood design works in the Carrington West Wing area at least 1.0 metres higher than the 1 in 100 year ARI flood event, to the satisfaction of NOW.

Water Management Plan

27. The Applicant shall prepare and implement a Water Management Plan for the HVO North mine to the satisfaction of the Director-General. This plan must be prepared in consultation with NOW and the EPA by suitably qualified and experienced persons whose appointment has been approved by the Director-General, and submitted to the Director-General by the end of September 2013 unless otherwise agreed. This plan must include:
    (a) a Site Water Balance that:
    - includes details of:
        - sources and security of water supply, including contingency planning for future reporting periods;
        - water use on site;
        - water management on site, including details of water sharing between neighbouring mining operations;
        - any off-site water transfers and discharges;
        - reporting procedures, including comparisons of the site water balance for each calendar year; and
    - describes the measures that would be implemented to minimise clean water use on site;

    (b) a Surface Water Management Plan, that includes:
    - detailed baseline data on surface water flows and quality in the waterbodies that could be affected by the development;
    - a detailed description of the water management system on site, including the:
        - clean water diversion systems and their final positioning;
        - erosion and sediment controls; and
        - water storages;
    - detailed plans, including design objectives and performance criteria, for:
        - design and management of the final voids;
        - design and management of the evaporative sink;
        - design and management of any tailings dams;
        - ensuring the stability of high walls adjacent to low permeability barriers;
        - establishment of drainage lines on the rehabilitated areas of the site; and
        - control of any potential water pollution from the rehabilitated areas of the site;
    - performance criteria for the following, including trigger levels for investigating any potentially adverse impacts associated with the development:
        - the water management system;
        - the stability of high walls adjacent to low permeability barriers;

- surface water quality of the Hunter River; and
    - stream and riparian vegetation health of the Hunter River;
  - a program to monitor:
    - the effectiveness of the water management system; and
    - surface water flows and quality, stream and riparian vegetation health in the Hunter River (in so far as it could potentially be affected by the development); and
  - a plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the development.

(c) a Groundwater Management Plan, which includes:
  - detailed baseline data on groundwater levels, yield and quality in the region, and privately-owned groundwater bores, that could be affected by the development;
  - groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;
  - a program to monitor:
    - groundwater inflows to the open cut mining operations;
    - the impacts of the development on:
      - the alluvial aquifers, including additional groundwater monitoring bores as required by NOW;
      - the effectiveness of the low permeability barrier;
      - base flows to the Hunter River;
      - any groundwater bores on privately-owned land that could be affected by the development; and
      - groundwater dependent ecosystems, including the River Red Gum Floodplain Woodland EEC located in the Hunter River alluvium;
    - the seepage/leachate from water storages, backfilled voids and the final void;
  - a program to validate and recalibrate (if necessary) the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions; and
  - a plan to respond to any exceedances of the groundwater assessment criteria.

Final Void Management Plan

28. At least 5 years before the cessation of open cut coal extraction that will result in the creation of a final void, or as otherwise agreed with the Director-General, the Applicant shall prepare and implement a Final Void Management Plan for each void, in consultation with DRE and NOW, and to the satisfaction of the Director-General. Each plan must:
    (a) assess locational, design and future use options;
    (b) be integrated with the Site Water Management Plan and the Landscape and Rehabilitation Management Strategy;
    (c) assess short term and long term groundwater and other impacts associated with each option; and
    (d) describe the measures to be would be implemented to avoid, minimise, manage and monitor potential adverse impacts of the final void over time.

[5]Temporary Crossing of the Hunter River

29. Prior to the commencement of any work within 40 metres of the Hunter River, a permit under Part 3A of the *Rivers and Foreshores Improvement Act 1948* shall be obtained from the NOW. All works shall be:
    (a) undertaken in accordance with the permit application, except as otherwise provided by conditions of the permit;
    (c) designed and constructed such that the works do not cause sedimentation, erosion or permanent diversion of the Hunter River;
    (d) constructed in accordance with section 10.8 (Temporary Crossing of the Hunter River), volume 1 of the EIS, dated October 2003; and titled *"Hunter Valley Operations – West Pit Extension and Minor Modifications";* and
    (e) constructed in accordance with the Statement of Environmental Effects, prepared by Coal & Allied, dated August 2001, titled *"Proposed relocation of a dragline and electric rope shovel - Ravensworth and Hunter Valley Operations."*

    Notes:
    (a) Should Crown land, as defined under the Crown Lands Act 1989, be included in the temporary crossing, there is a requirement to seek approval from the Department of Lands under the Crown Lands Act; and
    (b) Any works on Crown public roads require the Department of Lands' approval and must satisfy the statutory requirements of the Roads Act 1993.

[5] Incorporates NOW GTAs

FAUNA & FLORA

Rehabilitation/Regeneration Strategy

30. The Applicant shall not destroy or disturb more than 1 mature river red gum in the river red gum population associated with the Carrington billabong, and ensure that the mining highwall is located at least 150 metres from the standing water line of the billabong.

31. By 30 June 2007, the Applicant shall prepare and implement a comprehensive Rehabilitation and Restoration Strategy for the Carrington billabong and river red gum population, in consultation with NOW, and to the satisfaction of the Director-General. This strategy must be prepared by suitably qualified expert/s, and must include:
    (a) the rehabilitation and restoration objectives for the billabong and associated river red gum population;
    (b) a description of the short, medium and long term measures that would be implemented to rehabilitate and restore the billabong and associated river red gum population (including measures to address matters which affect the long term health and sustainability of the billabong and river red gums such as surface and ground water supply, and controlling weeds, livestock and feral animals); and
    (c) detailed assessment and completion criteria for the rehabilitation and restoration of the billabong and associated river red gum population.

    Note. The billabong, standing water line and river red gum population referred to are the billabong, standing water line and endangered population of river red gums located on land owned by the Applicant between the Hunter River and Levee 5, as shown in the figure "Carrington River Red Gums, Billabong and Associated Infrastructure" included in the Carrington Pit Extension Response to Submissions Report, dated May 2006.

32. By 30 June 2007, the Applicant shall prepare and implement a conceptual Landscape and Rehabilitation Management Strategy, in consultation with affected agencies, to the satisfaction of the Director-General. The strategy must:
    (a) include objectives for landscape management and rehabilitation of the site and a justification for the proposed strategy;
    (b) present a conceptual plan for landscape management and rehabilitation of the site;
    (c) be integrated with the relevant requirements of the Mining Operations Plan;
    (d) describe the measures that would be implemented to achieve the objectives (including an indicative timetable for mine closure);
    (e) include proposals to offset the flora and fauna impacts of the development (including proposals resulting from condition 31 above), and an outline of how the strategy would integrate with existing and planned corridors of native vegetation in areas surrounding the development; and
    (f) outline how the proposed strategy would be integrated with the landscape management and rehabilitation of the other operations within Hunter Valley Operations (both north and south of the Hunter River) and other coal mines in the vicinity.

Strategic Study Contribution

33. If, during the development, the Department or the OEH commissions a strategic study into the regional vegetation corridor stretching from the Wollemi National Park to the Barrington Tops National Park, then the Applicant shall contribute a reasonable amount, up to $10,000, towards the completion of this study.

Operating Conditions

34. The Applicant shall salvage and reuse as much material as possible from the land that will be mined, such as soil, seeds, tree hollows, rocks and logs. Cleared vegetation must be reused or recycled to the greatest extent practicable. No burning of cleared vegetation shall be permitted. Reuse options including removing millable logs, recovering fence posts, mulching and chipping unusable vegetation waste for on-site use are to be implemented.

Flora and Fauna Management

35. The Applicant shall prepare and implement procedures for the management of flora and fauna for the development. These procedures shall:
    (a) provide details on:
        - delineating areas of disturbance;
        - protecting areas outside of the disturbance areas;
        - identifying when pre-clearance surveys are required for fauna;

- determining the best time to clear vegetation to avoid nesting/breeding activities of threatened fauna;
- capturing and releasing fauna;
- relocating bat roosts;
- salvaging habitat resources and collecting seed;
- controlling weeds in regeneration/rehabilitation areas; and
- controlling access to the regeneration/rehabilitation areas;

(b) describe how the land in regeneration areas would be revegetated;
(c) describe how the mined areas would be rehabilitated for grazing and biodiversity values;
(d) identify actions to minimise the potential impacts of the development on threatened fauna;
(e) describe how the performance of the revegetation/rehabilitation strategies would be monitored over time including, as a minimum, the parameters in Table 18; and
(f) identify who is responsible for monitoring, reviewing, and implementing the procedures.

The Applicant shall submit a copy of these procedures to the Director-General for approval within 6 months of the date of this consent.

Table 16: Parameters and Units of Measure for Fauna and Flora Monitoring

Parameter	***Units of measure***
Density of vegetation	*Plants/m^2*
	Understorey
	Ground cover
Diversity of flora	*Species/m^2*
Age/maturity of flora	*Vegetation height/diameter/form*
Vegetation health	-
Disturbance	*Weeds/m^2*
	Erosion
	Feral animals
	Stock
Density of fauna	*Fauna (Avian/Mammals/Reptiles-Amphibians)/m^2*
Diversity of fauna	*Species/m^2*
Density of fauna habitat	*Hollow-bearing trees/nesting sites/ logs/dams, etc.* *Habitat Complexity Score*
Ecosystem Function	*Landscape Function Analysis*

Note: The requirements of condition 35 may be satisfied within the Rehabilitation Management Plan required under Condition 62C of Schedule 4.

Annual Review

36. The Applicant shall
(a) review the performance of the flora & fauna management procedures annually, and, if necessary,
(b) revise these documents to take into account any recommendations from the annual review.

[6]ABORIGINAL CULTURAL HERITAGE

Note: The Applicant is required to obtain consent from the OEH under the National Parks and Wildlife Act 1974 to destroy Aboriginal sites and objects on the site. The OEH has issued General Terms of Approval for the sites listed in condition 37.

West Pit Extension - Consents to Destroy

37. The Applicant shall obtain consent from OEH to destroy the following sites:
- WPE 1
- WPE 2
- WPE 3
- WPE 4
- WPE 5
- WPE 6
- WPE 7
- WPE 8
- WPE 9
- WPE 10
- WPE 11
- 37-2-1964
- 37-2-1965
- 37-2-1966
- 37-2-1967
- 37-2-0038
- 37-2-0144
- 37-2-0894
- 37-2-0896
- 37-2-0805

[6] Incorporates OEH GTAs.

West Pit Extension - Salvage

38. Before making application for section 90 consents under NP&W Act, the Applicant shall prepare a salvage program for the sites listed in condition 37 in consultation with the OEH and Aboriginal communities, and to the satisfaction of the OEH.

39. The Applicant shall obtain consent under the *National Parks and Wildlife Act 1974* to destroy the following sites:

- 37-2-0145
- 37-2-0147
- 37-2-0148
- 37-2-0523
- 37-2-0524
- 37-2-0525
- 37-2-0526
- 37-2-0527
- 37-2-0528
- 37-2-0562
- 37-2-0777
- 37-2-0778
- 37-2-0779
- 37-2-0780
- 37-2-0781
- 37-2-0782
- 37-2-0783
- 37-2-0784
- 37-2-0785
- 37-2-0786
- 37-2-2078 (C1)
- 37-2-2079 (C2)
- 37-2-2080 (C3)
- 37-5-0494 (C4)
- 37-2-2083 (C8)
- 37-2-2084 (C9)
- 37-2-0787
- 37-2-0788
- 37-2-0789
- 37-2-0790
- 37-2-0791
- 37-2-0792
- 37-2-0793
- 37-2-0794
- 37-2-0795
- 37-2-0796
- 37-2-0895
- 37-2-1865
- 37-2-1866
- 37-2-1867
- 37-2-1868
- 37-2-1869
- 37-2-1870
- 37-2-1871
- 37-2-1872
- IF1
- 37-2-2085 (C10)
- 37-2-1962 (CM45)
- 37-2-1963 (CM46)
- 37-2-1504 (CM1)
- 37-2-1505 (CM2)
- 37-2-1522 (CM19)
- TD
- TG
- 37-2-1504
- 37-2-1522
- 37-2-1535
- 37-2-1864
- 37-2-1874
- 37-2-1875
- 37-2-1876
- 37-2-1962
- 37-2-1963
- 37-5-0061
- 37-2-1861
- 37-2-1862
- 37-2-1873
- 37-2-1860
- 37-5-0131
- 37-3-0286
- 37-5-0061
- 37-1-0399
- 37-2-1535 (CM32)
- 37-2-2754
- 37-2-2755
- 37-2-2756
- 37-2-2757

Aboriginal Heritage Site 37-2-1877 (CM-CD1)

40. Mining operations and associated activities in the Carrington West Wing area are not permitted to be carried out within 20 metres of Aboriginal heritage site 37-2-1877 (CM-CD1) and the Older Stratum as shown on the plan in Appendix 5.

    Note: for clarification purposes, Condition 40 of Schedule 4 does not prohibit heritage surveys and studies to be undertaken within CM-CD1 or within 20 metres of CM-CD1 and the Older Stratum.

40A. The Applicant must ensure that mining operations (including blasting) and associated activities do not cause any impact to Aboriginal heritage site 37-2-1877 (CM-CD1) and the Older Stratum.

Heritage Management Plan

41. The Applicant shall prepare and implement a Heritage Management Plan for the development to the satisfaction of the Director-General. This plan must:
    (a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Director-General;
    (b) be prepared in consultation with OEH and the Aboriginal stakeholders (in relation to the management of Aboriginal heritage values);
    (c) be submitted to the Director-General for approval by the end of June 2013, unless the Director-General agrees otherwise;
    (d) include the following for the management of Aboriginal Heritage:
    - a detailed plan of management for Aboriginal heritage site 37-2-1877 (CM-CD1) including a description of the measures that would be implemented to protect, monitor and manage the site from mining operations and associated activities;
    - a description of the measures that would be implemented for:
        - managing heritage items on the site, including any proposed archaeological investigations and/or salvage measures;
        - managing the discovery of any human remains or previously unidentified Aboriginal objects on site;

  - maintaining and managing reasonable access for Aboriginal stakeholders to heritage items on site;
  - ongoing consultation with the Aboriginal stakeholders on the conservation and management of Aboriginal cultural heritage both on-site and within any Aboriginal heritage conservation areas; and
  - ensuring any workers on site receive suitable heritage inductions prior to carrying out any development on site, and that suitable records are kept of these inductions; and
- a strategy for the storage of any heritage items salvaged on site, both during the development and in the long term.

41A. Prior to disturbance by mining, the Applicant shall ensure that the scarred tree 37-2-2080 (C3) is removed and relocated to a site where it will be protected from future development, in consultation with the Wonnarua Tribal Council, and to the satisfaction of the Director-General.

Note: In conditions 37 – 41A, all seven-figure numbers refer to Aboriginal site listings in OEH's Aboriginal Heritage Information Management System (AHIMS). All other numbers are site numbers used by the Applicant in on-site Aboriginal heritage studies. Site numbers beginning with C or CM are associated with the Carrington Pit, as shown in Fig 5.1 of Annex G of the Carrington Pit Extended Statement of Environmental Effects.

Trust Fund Contribution

42. Before carrying out the development, or as agreed otherwise by the Director-General, the Applicant shall contribute $20,000 to the Hunter Aboriginal Cultural Heritage Trust Fund for further investigations into Aboriginal cultural heritage, as defined by the Trust Deed.

TRAFFIC & TRANSPORT

New Access Intersection to Hunter Valley Loading Point

Note: The Applicant requires Council approval under the Roads Act 1993 for the new road entry from Liddell Station Road to the Hunter Valley Loading Point.

43. [7]The Applicant shall design, construct and maintain for the duration of this consent, the proposed new access intersection from Liddell Station Road to the Hunter Valley Loading Point to the satisfaction of the Council.

Road Closure

Note: The Applicant requires MSC approval under the Roads Act 1993 prior to closing a section of Pikes Gully Road.

44. Within 12 months of the date of this consent, unless otherwise agreed by the Director-General, the Applicant is to complete the relevant requirements to enable the section of Pikes Gully Road situated in the Muswellbrook local government area to be closed as a public road.

45. The Applicant shall not blast within 500 metres of a public road while the road is open to the public. Any road closures with respect of blasting shall be subject to a plan of management approved by Council.

Lemington Road

46. The Applicant shall reimburse Council for any road upgrading works undertaken on Lemington Road, to a maximum amount of $30,000.

47. The Applicant shall alter or cease mining operations if driver visibility or traffic safety on Lemington Road is adversely affected by dust, in accordance with the requirements of Council.

48. The Applicant shall be responsible for the full cost of the maintenance of the Lemington Road deviation undertaken for the Carrington Pit until March 2011, in accordance with the standards and requirements of Council.

Intersection of Lemington Road and the Golden Highway

49. Within 2 years of the date of this consent, the Applicant shall upgrade the intersection of the Golden Highway (SH 27) and Lemington Road to a type "BAR" intersection with a sealed shoulder to the satisfaction of the RMS.

---

[7] Incorporates Council GTA

Road Safety Audit

49A.

(a) By 31 December 2006, the Applicant shall prepare and submit a road safety audit to the RMS and Council for all public roads used by mine employees and service vehicles in the vicinity of the development, including an audit of the existing intersections of all mine access roads with public roads;

(b) any improvement to meet accepted road safety standards required by the relevant road manager (ie the RMS or Council) for public roads as a result of impacts related to the development as identified by the audit shall be undertaken at the Applicant's cost and to the satisfaction of the road manager;

(c) any dispute between the Applicant and the relevant road manager in relation to the audit findings and the requirements of the road manager for improvements of public roads is to be determined by the Director-General; and

(d) any maintenance of line marking and sign posting required by the relevant road manager at existing intersections of mine access roads with public roads shall be undertaken at the Applicant's cost and to the satisfaction of the road manager.

Coal Haulage

50. [8]The Applicant shall ensure that spillage of coal from coal haulage vehicles is minimised and that sediment-laden runoff from roads is effectively managed, to the satisfaction of the Director-General. Measures that shall be implemented include:

(a) covering all loads where loaded coal trucks leave the site and enter public roads;
(b) ensuring the gunwhales of all loaded trucks are clean of coal;
(c) providing effective wheel wash facilities at all coal load and unload facilities prior to vehicles entering public roads; and
(d) sweeping, at regular intervals and at the completion of campaign hauls, public roads used for the transportation of coal.

51. The Applicant shall enter into an agreement with Council for the maintenance of the sections of Pikes Gully Road and Liddell Station Road whilst used by the Applicant for the haulage of coal, and during the period the roads are owned by Council.

Monitoring

52. The Applicant shall maintain and include in each AEMR records of the:

(a) amount of coal transported from the site each year;
(b) amount of coal received from Hunter Valley Operations south of the Hunter River;
(c) amount of coal hauled by road to the Hunter Valley Loading Point;
(d) amount of coal hauled by road to the Newdell Loading Point;
(e) amount of coal hauled by road from the Newdell Loading Point to the Ravensworth coal Terminal;
(f) amount of coal hauled by road from the Hunter Valley Loading Point to the Ravensworth Coal Terminal; and
(g) number of coal haulage truck movements generated by the development.

VISUAL IMPACT

Visual Amenity

53. The Applicant shall implement measures to mitigate visual impacts including:

(a) design and construction of development infrastructure in a manner that minimises visual contrasts; and
(b) progressive rehabilitation of mine waste rock emplacements (particularly outer batters), including partial rehabilitation of temporarily inactive areas.

54. The Applicant shall plant trees to provide an effective visual screen from Lemington Road in the vicinity of the Belt Line Road and adjacent to the Mitchell pit area. The plan for this tree planting is to:

(a) provide for tree planting within 2 years of the date of this consent;
(b) achieve an 80% survival rate by the 5th year;
(c) be submitted to DRE and Director-General for review and approval; and
(d) provide an assessment of whether visual bunds are required to supplement the vegetative visual screen.

---

[8] This may include the use of sediment dams or the incorporation of runoff into the mine water management system.

Lighting Emissions

55. The Applicant shall take all practicable measures to mitigate off-site lighting impacts from the development.

56. All external lighting associated with the development shall comply with *Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting*.

WASTE MINIMISATION

57. The Applicant shall minimise the amount of waste generated by the development to the satisfaction of the Director-General.

HAZARDS MANAGEMENT

Spontaneous Combustion

58. The Applicant shall:
    (a) take the necessary measures to prevent, as far as is practical, spontaneous combustion on the site; and
    (b) manage any spontaneous combustion on-site to the satisfaction of DRE.

Dangerous Goods

59. The Applicant shall ensure that the storage, handling, and transport of:
    (a) dangerous goods is done in accordance with the relevant *Australian Standards*, particularly *AS1940* and *AS1596*, and the *Dangerous Goods Code*; and
    (b) explosives are managed in accordance with the requirements of DRE.

BUSHFIRE MANAGEMENT

60. The Applicant shall:
    (a) ensure that the development is suitably equipped to respond to any fires on-site; and
    (b) assist the Rural Fire Service and emergency services as much as possible if there is a fire on-site during the development.

61. The Applicant shall ensure that the Bushfire Management Plan for the site, is to the satisfaction of Council and the Rural Fire Service.

REHABILITATION

Rehabilitation Objectives

62. The Applicant shall rehabilitate the site to the satisfaction of the Executive Director Mineral Resources. The rehabilitation must be generally in accordance with the proposed rehabilitation strategy described by the documents listed in Condition 2 of Schedule 3 (and depicted conceptually in the final landform plans in Appendices 6 and 7) and the objectives in Table 17.

Table 17: Rehabilitation Objectives

Area/Domain	Rehabilitation Objectives
Mine site (as a whole), including the final void	Safe, stable & non-polluting
Carrington West Wing revised proposed extension area	Reinstatement of Rural Land Capability agricultural land values to be measured as: 65.0 hectares of Class II and 65.0 hectares of Class III
Surface infrastructure	To be decommissioned and removed, unless the Executive Director Mineral Resources agrees otherwise
Community	Ensure public safety Minimise the adverse socio-economic effects associated with mine closure

Note: The Carrington West Wing revised proposed extension area is shown in Appendix 5.

Operating Conditions

62A. The Applicant shall:
    (a) develop a detailed soil management protocol that identifies procedures for
        - comprehensive soil surveys prior to soil stripping;

- assessment of top-soil and sub-soil suitability for mine rehabilitation; and
- annual soil balances to manage soil handling including direct respreading and stockpiling;

(b) maximise the salvage of suitable top-soils and sub-soils and biodiversity habitat components such as bush rocks, tree hollows and fallen timber for rehabilitation of disturbed areas within the site and for enhancement of biodiversity offset areas;

(c) ensure that coal reject or any potentially acid forming interburden materials must not be emplaced at elevations within the pit shell or out of pit emplacement areas where they may promote acid or sulphate species generation and migration beyond the pit shell or out of pit emplacement areas; and

(d) ensure that no dirty water can drain from an out of pit emplacement area to any offsite watercourse or to any land beyond the lease boundary.

Progressive Rehabilitation

62B. The Applicant shall carry out rehabilitation of the site progressively, that is, as soon as reasonably practicable following disturbance. All reasonable and feasible measures must be taken to minimise the total area exposed for dust generation at any time. Interim rehabilitation strategies shall be employed when areas prone to dust generation cannot yet be permanently rehabilitated.

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

Rehabilitation Management Plan

62C. The Applicant shall prepare and implement a Rehabilitation Management Plan for the HVO North mine to the satisfaction of the Executive Director Mineral Resources. This plan must:

(a) be prepared in consultation with the Department, NOW, OEH, Council and the CCC;
(b) be submitted to the Executive Director Mineral Resources by the end of September 2013;
(c) be prepared in accordance with any relevant DRE guideline;
(d) include an Agricultural Land Reinstatement Management Plan;
(e) include detailed performance and completion criteria for evaluating the achievement of the rehabilitation objectives in Table 17 and the overall rehabilitation of the site, and triggering remedial action (if necessary);
(f) include proposals to offset the flora and fauna impacts of the development (including proposals resulting from condition 31 above), and an outline of how the plan would integrate with existing and planned corridors of native vegetation in areas surrounding the development;
(g) describe the measures that would be implemented to ensure compliance with the relevant conditions of this consent, and address all aspects of rehabilitation including mine closure, final landform and final land use;
(h) outline how the proposed plan would be integrated with the landscape management and rehabilitation of the other operations within Hunter Valley Operations (both north and south of the Hunter River) and other coal mines in the vicinity;
(i) include interim rehabilitation where necessary to minimise the area exposed for dust generation;
(j) include a program to monitor, independently audit and report on the effectiveness of the measures, and progress against the detailed performance and completion criteria; and
(k) build to the maximum extent practicable on the other management plans required under this consent.

Agricultural Land Reinstatement Management Plan

62D. The Agricultural Land Reinstatement Management Plan required under Condition 62C of Schedule 4 is intended to ensure that the alluvial lands are restored to a productive capacity at least equivalent to their pre-mining state and are able to be managed using techniques and equipment common to management of equivalent lands in the district. The plan must:

(a) be prepared in consultation with DPI and to the satisfaction of the Director-General;
(b) be prepared in accordance with any relevant DPI guideline;
(c) include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the Carrington West Wing revised proposed extension area, and triggering remedial action (if necessary);
(d) include a long-term monitoring programme on the success of reinstating alluvial lands, which must:
    - assess a comprehensive suite of indicators of productivity and environmental sustainability (such as soil settling, soil profile development, other soil characteristics, water transmissivity and soil water availability, agricultural productivity, fertilizer needs, weeds and pests) over an extended period (a minimum of 20 years);
    - compare the performance of the reinstated alluvial lands with a reference site; and
    - make monitoring results publicly available.
(e) in accordance with Condition 4(h) of Schedule 6 provide for reviews of progress against

the plan every 3 years (unless otherwise agreed by the Director-General after completion of the second review) and for a final review by the end of 2033.

Note: The Carrington West Wing revised proposed extension area is shown in Appendix 5.

MINE EXIT STRATEGY

63. Within 5 years of the date of this consent, the Applicant shall work with the Council and MSC to investigate the minimisation of adverse socio-economic effects of a significant reduction in local employment levels and closure of the development at the end of its life.

SCHEDULE 5
ADDITIONAL PROCEDURES FOR AIR QUALITY AND NOISE MANAGEMENT

Notification of Landowners/Tenants

1. By the end of September 2013, the Applicant shall:
   (a) notify in writing any remaining private owners of:
   - the land listed in Table 1 of schedule 4 that they have the right to require the Applicant to acquire their land at any stage during the development;
   - any residence on the land listed in Table 1 of schedule 4 that they have the right to request the Applicant to ask for additional noise and/or air quality mitigation measures to be installed at their residence at any stage during the development; and
   - any privately-owned land within 2 kilometres of the approved open cut mining pit/s that they are entitled to ask for an inspection to establish the baseline condition of any buildings or structures on their land, or to have a previous property inspection report updated;

   (b) notify the tenants of any mine-owned land of their rights under this approval; and
   (c) send a copy of the NSW Health fact sheet entitled "Mine Dust and You" (as may be updated from time to time) to the owners and/or existing tenants of any land (including mine-owned land) where the predictions in the documents listed in condition 2 of schedule 3 identify that dust emissions generated by the development are likely to be greater than any air quality criteria in schedule 4 at any time during the life of the development.

2. Prior to entering into any tenancy agreement for any land owned by the Applicant that is predicted to experience exceedances of the recommended dust and/or noise criteria, or for any of the land listed in Table 1 purchased by the Applicant, the Applicant shall:
   (a) advise the prospective tenants of the potential health and amenity impacts associated with living on the land, and give them a copy of the NSW Health fact sheet entitled "Mine Dust and You" (as may be updated from time to time);
   (b) advise the prospective tenants of the rights they would have under this approval; and
   (c) request the prospective tenants consult their medical practitioner to discuss the air quality monitoring data and prediction and health impacts arising from this information,

   to the satisfaction of the Director-General.

3. As soon as practicable after obtaining monitoring results showing:
   (a) an exceedance of any criteria in schedule 4, the Applicant shall:
   - notify each affected landowner and/or tenant of the land (including the tenants of any mine-owned land) in writing of the exceedance; and
   - provide each affected party with regular monitoring results until the development is again complying with the relevant criteria; and

   (b) an exceedance of the air quality criteria in schedule 4, the Applicant shall additionally provide each affected party with:
   - a copy of the NSW Health fact sheet entitled "Mine Dust and You" (as may be updated from time to time), if not recently provided; and
   - monitoring data in an appropriate format such that the party's medical practitioner can assist them in making an informed decision on the health risks associated with continued occupation of the property,

   to the satisfaction of the Director-General.

Independent Review

4. If an owner of privately-owned land considers the development to be exceeding the criteria in Schedule 4, then he/she may ask the Director-General in writing for an independent review of the impacts of the development on his/her land.

   If the Director-General is satisfied that an independent review is warranted, then within 2 months of the Director-General's decision, the Applicant shall:
   (a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Director-General, to:
   - consult with the landowner to determine his/her concerns;
   - conduct monitoring to determine whether the development is complying with the relevant impact assessment criteria in Schedule 4; and
   - if the development is not complying with these criteria then:
     - determine if more than one mine is responsible for the exceedance, and if so the relative share of each mine regarding the impact on the land;
     - identify the measures that could be implemented to ensure compliance with the relevant criteria; and

   (b) give the Director-General and landowner a copy of the independent review.

5. If the independent review determines that the development is complying with the criteria in Schedule 4, then the Applicant may discontinue the independent review with the approval of the Director-General.

If the independent review determines that the development is not complying with the criteria in Schedule 4, and that the development is primarily responsible for this non-compliance, then the Applicant shall:

(a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent person, and conduct further monitoring until the development complies with the relevant criteria; or

(b) secure a written agreement with the landowner to allow exceedances of the relevant impact assessment criteria,

to the satisfaction of the Director-General.

If the independent review determines that the development is not complying with the relevant acquisition criteria in Schedule 4, and that the development is primarily response for this non-compliance, then upon receiving a written request from the landowner, the Applicant shall acquire all or part of the landowner's land in accordance with the procedures in Conditions 7 and 8 below.

6. If the independent review determines that the relevant criteria are being exceeded, but that more than one mine is responsible for this exceedance, then together with the relevant mine/s the Applicant shall:

(a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent person, and conduct further monitoring until there is compliance with the relevant criteria; or

(b) secure a written agreement with the landowner and other relevant mine/s to allow exceedances of the relevant impact assessment criteria,

to the satisfaction of the Director-General.

If the independent review determines that the development is not complying with the relevant acquisition criteria in Schedule 4, but that more than one mine is responsible for the exceedance, then upon receiving a written request from the landowner, the Applicant shall acquire all or part of the landowner's land on as equitable a basis as possible with the relevant mine/s in accordance with the procedures in Conditions 7 and 8 below.

Land Acquisition

7. Within 3 months of receiving a written request from a landowner with acquisition rights, the Applicant shall make a binding written offer to the landowner based on:

(a) the current market value of the landowner's interest in the land at the date of this written request, as if the land was unaffected by the development, having regard to the:
   - existing and permissible use of the land, in accordance with the applicable planning instruments at the date of the written request; and
   - presence of improvements on the land and/or any approved building or structure which has been physically commenced on the land at the date of the landowner's written request, and is due to be completed subsequent to that date;

(b) the reasonable costs associated with:
   - relocating within the Singleton or Muswellbrook local government areas, or to any other local government area determined by the Director-General; and
   - obtaining legal advice and expert advice for determining the acquisition price of the land, and the terms upon which it is to be acquired; and

(c) reasonable compensation for any disturbance caused by the land acquisition process.

However, if at the end of this period, the Applicant and landowner cannot agree on the acquisition price of the land and/or the terms upon which the land is to be acquired, then either party may refer the matter to the Director-General for resolution.

Upon receiving such a request, the Director-General will request the President of the NSW Division of the Australian Property Institute (the API) to appoint a qualified independent valuer to:

- consider submissions from both parties;
- determine a fair and reasonable acquisition price for the land and/or the terms upon which the land is to be acquired, having regard to the matters referred to in paragraphs (a)-(c) above;
- prepare a detailed report setting out the reasons for any determination; and
- provide a copy of the report to both parties.

Within 14 days of receiving the independent valuer's report, the Applicant shall make a binding written offer to the landowner to purchase the land at a price not less than the independent valuer's determination.

However, if either party disputes the independent valuer's determination, then within 14 days of receiving the independent valuer's report, they may refer the matter to the Director-General for review. Any request for a review must be accompanied by a detailed report setting out the reasons why the party disputes the independent valuer's determination. Following consultation with the independent valuer and both parties, the Director-General will determine a fair and reasonable acquisition price for the land, having regard to the matters referred to in paragraphs (a)-(c) above, the independent valuer's report, the detailed report disputing the independent valuer's determination, and any other relevant submissions.

Within 14 days of this determination, the Applicant shall make a binding written offer to the landowner to purchase the land at a price not less than the Director-General's determination.

If the landowner refuses to accept the Applicant's binding written offer under this condition within 6 months of the offer being made, then the Applicant's obligations to acquire the land shall cease, unless the Director-General determines otherwise.

8. The Applicant shall pay all reasonable costs associated with the land acquisition process described in Condition 7 above, including the costs associated with obtaining Council approval for any plan of subdivision (where permissible), and registration of this plan at the Office of the Registrar-General.

SCHEDULE 6
ENVIRONMENTAL MANAGEMENT, MONITORING, AUDITING & REPORTING

ENVIRONMENTAL MANAGEMENT STRATEGY

1. Within 6 months of the date of this consent, the Applicant shall prepare and implement an Environmental Management Strategy for the development to the satisfaction of the Director-General. This strategy must:
   (a) provide the strategic context for environmental management of the development;
   (b) identify the statutory requirements that apply to the development;
   (c) describe in general how the environmental performance of the development would be monitored and managed during the development;
   (d) describe the procedures that would be implemented to:
      - keep the local community and relevant agencies informed about the operation and environmental performance of the development;
      - receive, handle, respond to, and record complaints;
      - resolve any disputes that may arise during the course of the development;
      - respond to any non-compliance;
      - manage cumulative impacts; and
      - respond to emergencies; and
   (e) describe the role, responsibility, authority, and accountability of all the key personnel involved in environmental management of the development.

2. Within 14 days of the Director-General's approval, the Applicant shall:
   (a) send copies of the approved strategy to the relevant agencies, Council, and the CCC; and
   (b) ensure the approved strategy is publicly available during the development.

2A. Within 6 months of the completion of the Independent Environmental Audit, the Applicant shall review, and if necessary revise, the Environmental Management Strategy to the satisfaction of the Director-General.

ENVIRONMENTAL MONITORING PROGRAM

3. Within 6 months of the date of this consent, the Applicant shall prepare an Environmental Monitoring Program for the development in consultation with the relevant agencies, and to the satisfaction of the Director-General. This program must consolidate the various monitoring requirements in schedule 4 of this consent into a single document.

3A. Within 6 months of the completion of the Independent Environmental Audit, the Applicant shall review, and if necessary revise, the Environmental Management Strategy to the satisfaction of the Director-General.

MANAGEMENT PLAN REQUIREMENTS

4. The Applicant shall ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include:
   (a) detailed baseline data;
   (b) a description of:
      - the relevant statutory requirements (including any relevant consent, licence or lease conditions);
      - any relevant limits or performance measures/criteria;
      - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures/criteria;
   (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;
   (d) a program to monitor and report on the:
      - impacts and environmental performance of the development;
      - effectiveness of any management measures (see c above);
   (e) a contingency plan to manage any unpredicted impacts and their consequences;
   (f) a program to investigate and implement ways to improve the environmental performance of the development over time;
   (g) a protocol for managing and reporting any:
      - incidents;
      - complaints;
      - non-compliances with statutory requirements; and
      - exceedances of the impact assessment criteria and/or performance criteria; and

(h) a protocol for periodic review of the plan and for a final review. Any final review must be submitted for the approval of the Director-General and include an assessment as to whether the objectives of the plan have been met and any requirements for further action(s) to ensure objectives are met. The Director-General may require the Applicant to carry out the further actions to the satisfaction of the Director-General, or require the Applicant to provide an annuity or other funding arrangement to enable the actions to be carried out to the satisfaction of the Director-General.

ANNUAL REVIEW

5. By the end of March 2014, and annually thereafter, unless otherwise agreed, the Applicant shall review the environmental performance of the development to the satisfaction of the Director-General. This review must:
   (a) describe the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the next calendar year;
   (b) include a comprehensive review of the monitoring results and complaints records of the development over the past calendar year, which includes a comparison of these results against the:
   - the relevant statutory requirements, limits or performance measures/criteria;
   - the monitoring results of previous years; and
   - the relevant predictions in the EA;

   (c) identify any non-compliance over the past calendar year, and describe what actions were (or are being) taken to ensure compliance;
   (d) identify any trends in the monitoring data over the life of the development;
   (e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and
   (f) describe what measures will be implemented over the next year to improve the environmental performance of the development.

REVISION OF STRATEGIES, PLANS AND PROGRAMS

5A. Within 3 months of:
   (a) the submission of an annual review under Condition 5 above;
   (b) the submission of an incident report under Condition 5B below;
   (c) the submission of an audit under Condition 6 below; and
   (d) any modification to the conditions of this consent (unless the conditions require otherwise),

   the Applicant shall review, and if necessary revise, the strategies, plans, and programs required under this consent to the satisfaction of the Director-General.

   Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the development.

INCIDENT REPORTING

5B. The Applicant shall notify, at the earliest opportunity, the Director-General and any other relevant agencies of any incident that has caused, or threatens to cause, material harm to the environment. For any other incident associated with the development, the Applicant shall notify the Director-General and any other relevant agencies as soon as practicable after the Applicant becomes aware of the incident. Within 7 days of the date of the incident, the Applicant shall provide the Director-General and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.

REGULAR REPORTING

5C. The Applicant shall provide regular reporting on the environmental performance of the development on its website in accordance with:
   (a) the reporting arrangements in any plans or programs approved under the conditions of this approval;
   (b) the requirements of condition 9; and
   (c) the requirements of an approved on-line communication plan to be submitted to the Director-General by the end of September 2013 containing a description of the content and frequency of posting for information that could reasonably be expected to be provided on the website concerning:
   - incidents of the type included in condition 5B;
   - any other non-compliance by the development;
   - responses to operational requirements imposed by real-time management systems for air and noise;
   - data from real-time management systems for air and noise.

INDEPENDENT ENVIRONMENTAL AUDIT

6. Within 3 years of the date of this consent, and every 3 years thereafter, unless the Director-General directs otherwise, the Applicant shall commission and pay the full cost of an Independent Environmental Audit of the development. This audit must:
   (a) be conducted by suitably qualified, experienced, and independent expert/s whose appointment has been endorsed by the Director-General;
   (b) assess the various aspects of the environmental performance of the development, and its effects on the surrounding environment;
   (c) assess whether the development is complying with the relevant standards, performance measures, and statutory requirements;
   (d) review the adequacy of any strategy/plan/program required under this consent; and, if necessary,
   (e) recommend measures or actions to improve the environmental performance of the development, and/or any strategy/plan/program required under this consent.

7. Within 3 months of completion of this audit, the Applicant shall submit a copy of the audit report to the Director-General, with a response to any of the recommendations contained in the audit report.

COMMUNITY CONSULTATIVE COMMITTEE

8. The Applicant shall establish and operate a new Community Consultative Committee (CCC) for the development to the satisfaction of the Director-General. This CCC must be operated in general accordance with the *Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects* (Department of Planning, 2007, or its latest version, and be operating by the end of September 2013.

   Notes:
   - *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Applicant complies with this approval; and*
   - *The CCC should have an independent chair and include appropriate representation from the Proponent, Council, recognised environmental groups and the local community.*

9. The Applicant shall:
   (a) by the end of September 2013, make the following information publicly available on its website:
      - all documents referred to in Condition 2 of Schedule 3;
      - all current statutory approval for the development;
      - approved strategies, plans and programs required under the conditions of this consent;
      - a comprehensive summary of the monitoring results of the development, which have been reported in accordance with the various plans and programs approved under the conditions of this consent;
      - a complaints register, which is to be updated on a monthly basis;
      - minutes of CCC meetings;
      - the last five AEMRs or Annual Reviews;
      - any independent environmental audit, and the Applicant's response to the recommendations in any audit;
      - any other material required by the Director-General; and
   (b) keep this information up to date,

   to the satisfaction of the Director-General.

APPENDIX 1
SCHEDULE OF LAND

Development Application Area - Lot and DP Schedule						
Hunter Valley Operations, West Pit Extension and Minor Modifications						
DP	**Lot**	**Portion**	**Part**	**Volume**	**Folio**	**Property Owner**
752468	128					Coal & Allied Operations Pty Limited
1018576	1					Coal & Allied Operations Pty Limited
1017998	100					Novacoal Australia Pty Limited
705454	161					Novacoal Australia Pty Limited and Mitsubishi Development Pty Ltd
727718	165					Coal & Allied Operations Pty Limited
191982	1					Coal & Allied Operations Pty Limited
752481			20	3269	568	Coal & Allied Operations Pty Limited
752481		170				Coal & Allied Operations Pty Limited
808301	2					Coal & Allied Operations Pty Limited
90727	1			7716	156	Coal & Allied Operations Pty Limited
752481						Coal & Allied Operations Pty Limited
544091	201					Coal & Allied Operations Pty Limited
752481	98					Coal & Allied Operations Pty Limited
752481	21					J. & A. Brown and Abermain Seaham Collieries Limited
752481	18					Coal & Allied Operations Pty Limited
752481	17					Coal & Allied Operations Pty Limited
752481	22					J. & A. Brown and Abermain Seaham Collieries Limited
752481	124					Coal & Allied Operations Pty Limited
752481	125					Coal & Allied Operations Pty Limited
752481	126					Coal & Allied Operations Pty Limited
752481	127					Coal & Allied Operations Pty Limited
752481	123					Coal & Allied Operations Pty Limited
752481	122					Coal & Allied Operations Pty Limited
752481	121					Coal & Allied Operations Pty Limited
752481	120					Coal & Allied Operations Pty Limited
752481	119					Coal & Allied Operations Pty Limited
752481	118					Coal & Allied Operations Pty Limited
752481	117					Coal & Allied Operations Pty Limited
7542481		89				J. & A. Brown and Abermain Seaham Collieries Limited
740183	10					Coal & Allied Operations Pty Limited
752481	171			6353	145	J. & A. Brown and Abermain Seaham Collieries Limited
110662	1			13933	249	J. & A. Brown and Abermain Seaham Collieries Limited
737796	1					Coal & Allied Operations Pty Limited
110656	1			11057	141	J. & A. Brown and Abermain Seaham Collieries Limited
752468	126					Novacoal Australia Pty Limited
779625	1					Novacoal Australia Pty Limited
779626	1					Novacoal Australia Pty Limited
625507	1					Novacoal Australia Pty Limited and Mitsubishi Development Pty Ltd
48165						Lemington Road
786904	22					Coal & Allied Operations Pty Limited
786904	21					Novacoal Australia Pty Limited
48555	4					Novacoal Australia Pty Limited

1037665	101			Coal & Allied Operations Pty Limited
752468	80	1782	37	Novacoal Australia Pty Limited
752468	81			Novacoal Australia Pty Limited
752468	53	7834	45	Novacoal Australia Pty Limited
752468	83	7834	45	Novacoal Australia Pty Limited
752468	157			Novacoal Australia Pty Limited
752481	83	6408	207	Novacoal Australia Pty Limited
752481	82	6408	207	Novacoal Australia Pty Limited
596670	3	13659	69	J. & A. Brown and Abermain Seaham Collieries Limited
868175	305			Novacoal Australia Pty Limited
752481	200	6408	207	Novacoal Australia Pty Limited
752468	158	6408	206	Novacoal Australia Pty Limited
752468	84	6408	206	Novacoal Australia Pty Limited
752468	54	6408	206	Novacoal Australia Pty Limited
752468	65			Novacoal Australia Pty Limited
752468	70	1782	37	Novacoal Australia Pty Limited
752468	71			Novacoal Australia Pty Limited
752468	68	1782	37	Novacoal Australia Pty Limited
752468	66	6408	206	Novacoal Australia Pty Limited
752468	159	6408	206	Novacoal Australia Pty Limited
252530	8	8625	137	Novacoal Australia Pty Limited
752468	94	6408	206	Novacoal Australia Pty Limited
752468	156	6408	206	Novacoal Australia Pty Limited
752468	102	6408	206	Novacoal Australia Pty Limited
700554	12	8625	137	Novacoal Australia Pty Limited
130831	1	10547	67	Novacoal Australia Pty Limited
252530	2	8625	137	Novacoal Australia Pty Limited
252530	4	8625	137	Novacoal Australia Pty Limited
48555	7			Novacoal Australia Pty Limited
252530	5	8625	137	Novacoal Australia Pty Limited
130831	2			Novacoal Australia Pty Limited
252530	3	8625	137	Novacoal Australia Pty Limited
393657	1			Novacoal Australia Pty Limited
780177	1	8625	137	Novacoal Australia Pty Limited
868175	304			Novacoal Australia Pty Limited
860535	319			Coal & Allied Operations Pty Limited
48555	3			Novacoal Australia Pty Limited
48555	2			Novacoal Australia Pty Limited
48555	5			Novacoal Australia Pty Limited
752481	58	8625	137	Novacoal Australia Pty Limited
256503	2			J. & A. Brown and Abermain Seaham Collieries Limited
130831	4	10547	67	Novacoal Australia Pty Limited
130831	3	10547	67	Novacoal Australia Pty Limited
752468	82	1782	37	Novacoal Australia Pty Limited
752481	38	8625	137	Novacoal Australia Pty Limited
48537	1			Novacoal Australia Pty Limited
727260	1			Novacoal Australia Pty Limited and Mitsubishi Development Pty Ltd
574166	1			Macquarie Generation
211043	1			Cumnock No 1 Colliery Pty Limited
574166	2			Novacoal Australia Pty Ltd and Mitsubishi Development Pty Ltd

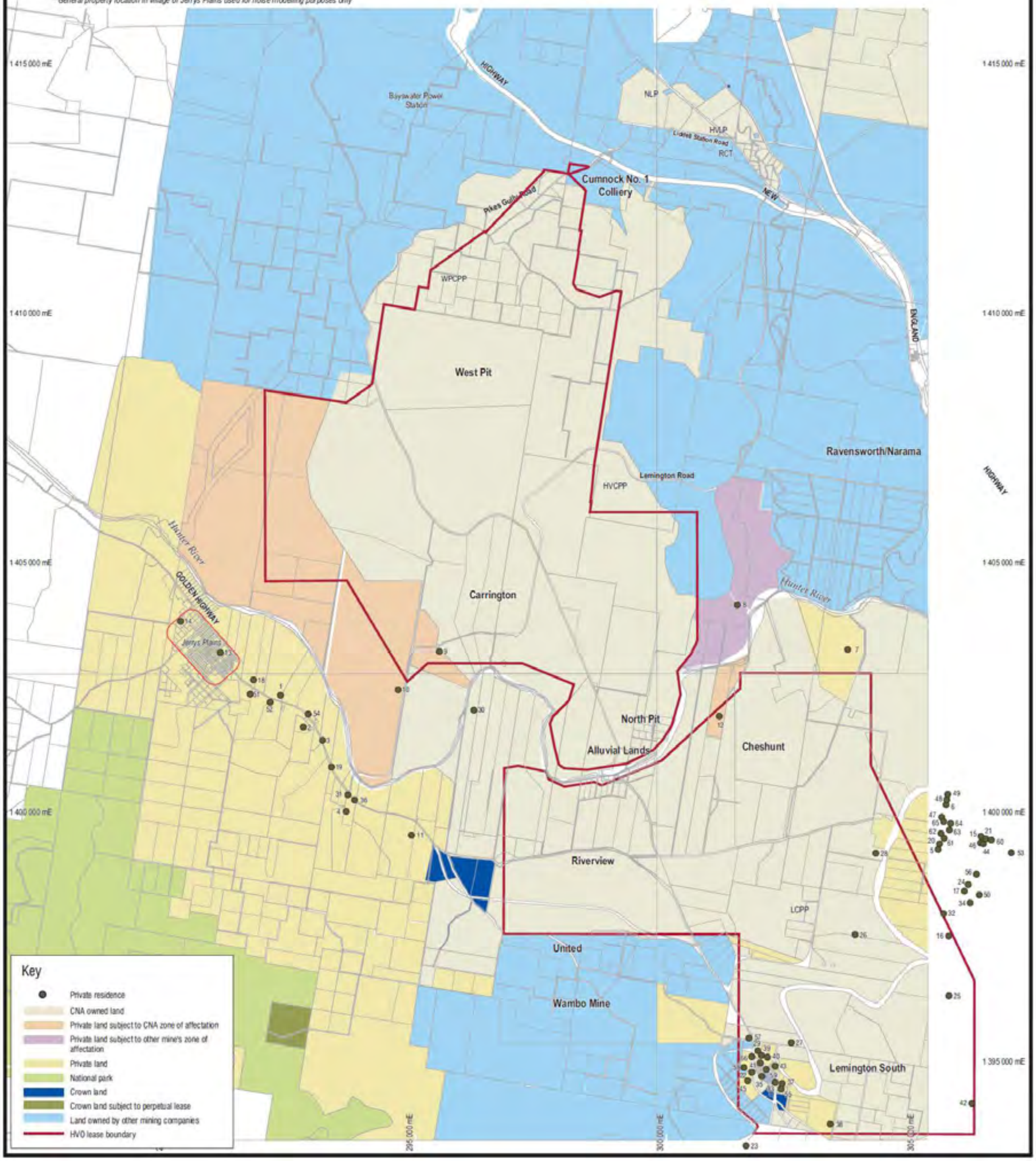
700429	100					The Shortland County Council
979456						J. & A. Brown & Abermain Seaham Collieries Ltd
869839	380					Novacoal Australia Pty Limited and Mitsubishi Development Pty Ltd
808431	2					Novacoal Australia Pty Limited
1019325	601					Macquarie Generation
808431	1					Coal & Allied Operations Pty Limited
201214	1					Novacoal Australia Pty Limited
869399	22					Coal Operations Australia Limited, Cumnock No.1 Colliery Pty Limited, Muswellbrook Coal Company Limited, BCA No. 11 Pty Limited
858172	11					Coal & Allied Operations Pty Limited
752470						Coal & Allied Operations Pty Limited
659810	1					J. & A. Brown and Abermain Seaham Collieries Limited
114966	2			12915	20	J & A Brown & Abermain Seaham Collieries Limited
700429	101					Coal & Allied Operations Pty Limited
729048	1					Coal & Allied Operations Pty Limited
752470	148					Crown Land Reserve 144
93617						Crown land Reserve 68816

Carrington West Wing Extension Area						
DP	**Lot**	**Portion**	**Part**	**Volume**	**Folio**	**Property Owner**
808301	2					Coal & Allied Operations Pty Limited
1078618	1					Coal & Allied Operations Pty Limited
1113789	7					Novacoal Australia and Coal & Allied Operations Pty Limited
597726	300					Coal & Allied Operations Pty Limited
752468	127					Coal & Allied Operations Pty Limited

APPENDIX 2
LANDOWNERSHIP PLAN & RESIDENTIAL RECEIVERS

Property No.	Last name or Company name	First name	Property No.	Last name or Company name	First name	Property No.	Last name or Company name	First name	Property No.	Last name or Company name	First name
1	Hayes	RJ	18	Bennet	K	35	Exxon	C & M	52	Old	
2	Skinner	DR	19	Biralee Feeds		36	Garland		53	Shortland Electricity	MR
3	Elsnore		20	Bowman	E	37	Hall	J	54	Skinner	
4	Muller		21	Burley	PR & CM	38	Henderson	H	55	St Phillips Church	
5	Bowman	E	22	Burley/Bushfire Brigade	T	39	Kannar	H	56	Tansil Pty Ltd	
6	Moxey	EA & MM	23	Cec M Hawkes Pty Ltd		40	Kannar	H	57	Wambo Mining Corporation Pty Ltd	
7	Stapleton	N	24	Clifton & Edwards	JV & JS	41	Kannar	H	58	Wambo Mining Corporation Pty Ltd	
8	Holz	N & L	25	Coal & Allied		42	Kannar	H	59	Wambo Mining Corporation Pty Ltd	
9	Dallas	G	26	Coal & Allied		43	Kannar (Abandoned House)	HJ, WH & H	60	Witchard	BH & CJ
10	Moses	RJ	27	Coal & Allied		44	Kauter, Bowman & Wright	WM & L	61	Wyoming Holstiens	
11	Fisher	C	28	Coal & Allied		45	Kelly	CI	62	Wyoming Holstiens	
12	Barry	E	29	Coal & Allied		46	Maskey	EA & MM	63	Wyoming Holstiens	
13	Jerrys Plains Centre *		30	Coal & Allied		47	Moxey	EA & MM	64	Wyoming Holstiens	
14	Jerrys Plains North *		31	Cooper		48	Moxey	EA & MM	65	Wyoming Holstiens	
15	Adamson	KJ & CP	32	Curlewis Pastoral Company		49	Moxey	NR & GJ	66	Xstrata Coal Pty Ltd	
16	Algie	RJ & CY	33	Edward & Haynes	K & LF	50	Nelson				
17	Algie	RJ & CY	34	Ernst	GJ & JG	51	Nicholls	TP & CM			

* General property location in village of Jerrys Plains used for noise modelling purposes only



APPENDIX 3
NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

1. The criteria in Table 9 and 10 apply under all meteorological conditions except:

    a) during periods of rain or hail;

    b) when average wind speed at microphone height exceeds 5 m/s;

    c) when wind speeds greater than 3 m/s are measured at 10 m above ground level; or

    d) during temperature inversion conditions greater than 3℃/100 m.

Determination of Meteorological Conditions

2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be those recorded by the meteorological station located on the site.

Compliance Monitoring

3. Attended monitoring is to be used to evaluate compliance with the relevant conditions of this approval.

4. Unless otherwise agreed with the Director-General, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW *Industrial Noise Policy* (as amended or replaced from time to time), including the requirements relating to:

    a) monitoring locations for collection of representative noise data;

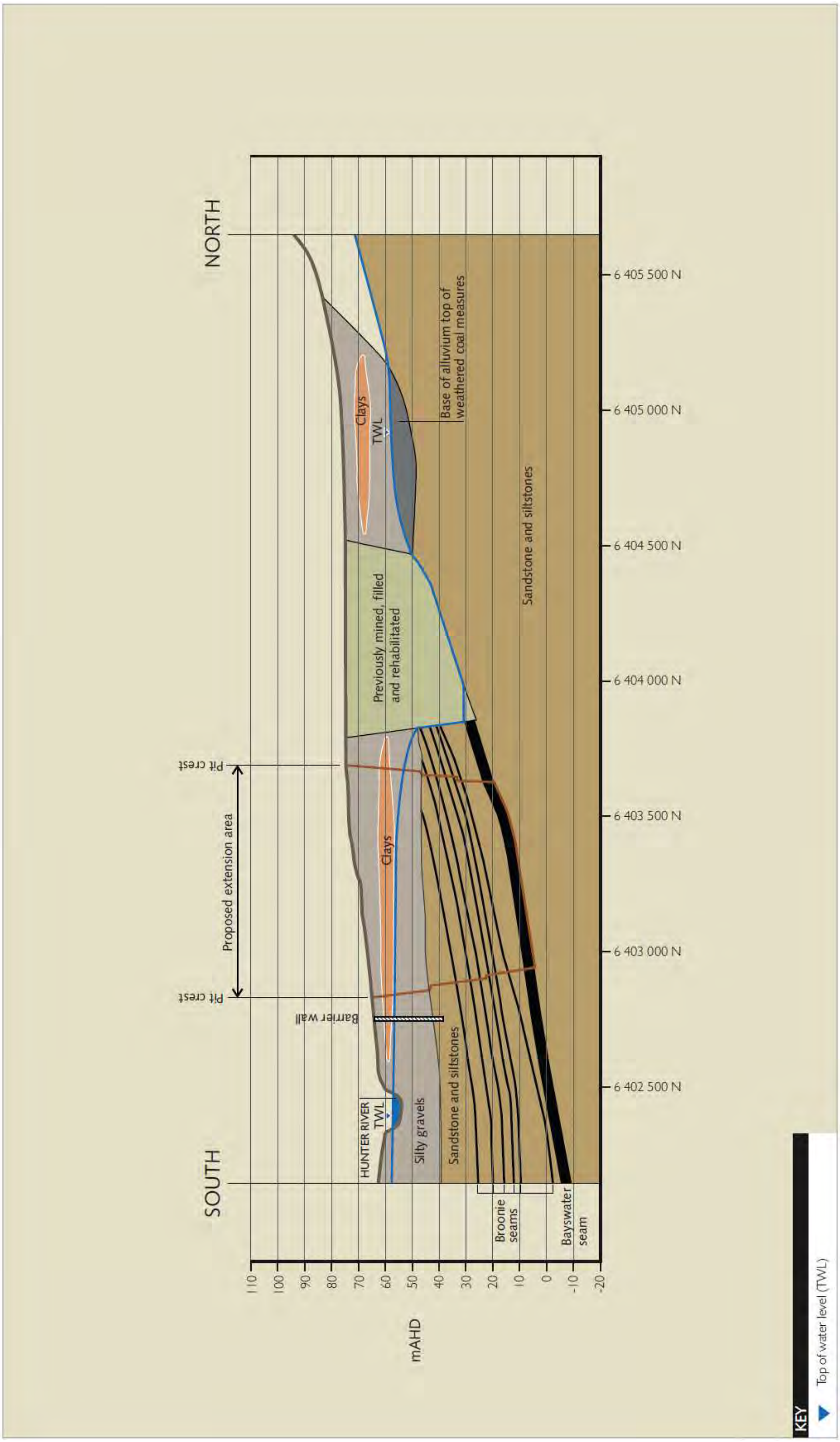
    b) meteorological conditions during which collection of noise data is not appropriate;

    c) equipment used to collect noise data, and conformation with relevant Australian Standards for such equipment; and

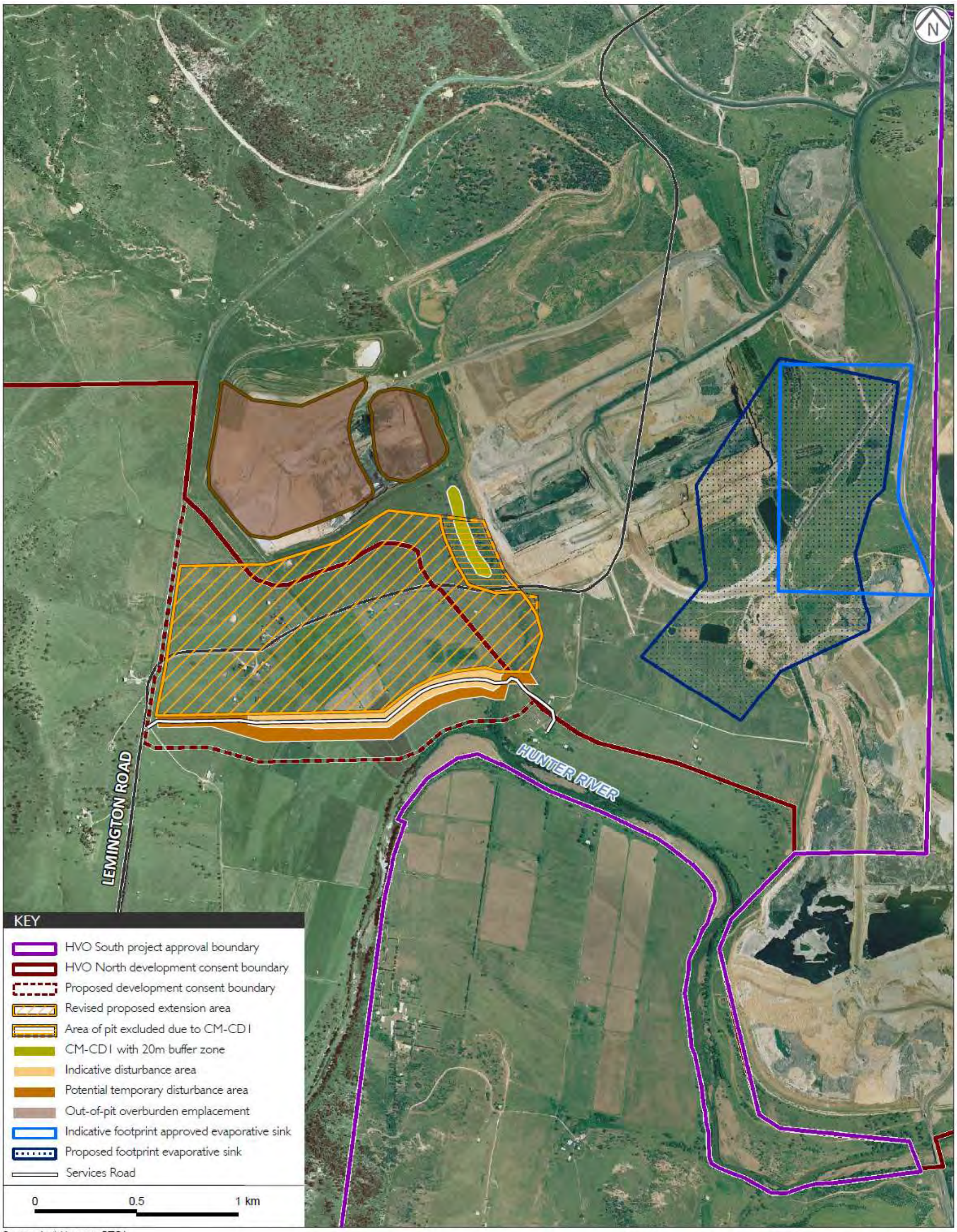
    d) modifications to noise data collected, including the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.

APPENDIX 4

CONCEPTUAL GROUNDWATER BARRIER WALL



APPENDIX 5
REVISED MINE PLAN AVOIDING SITE CM-CD1



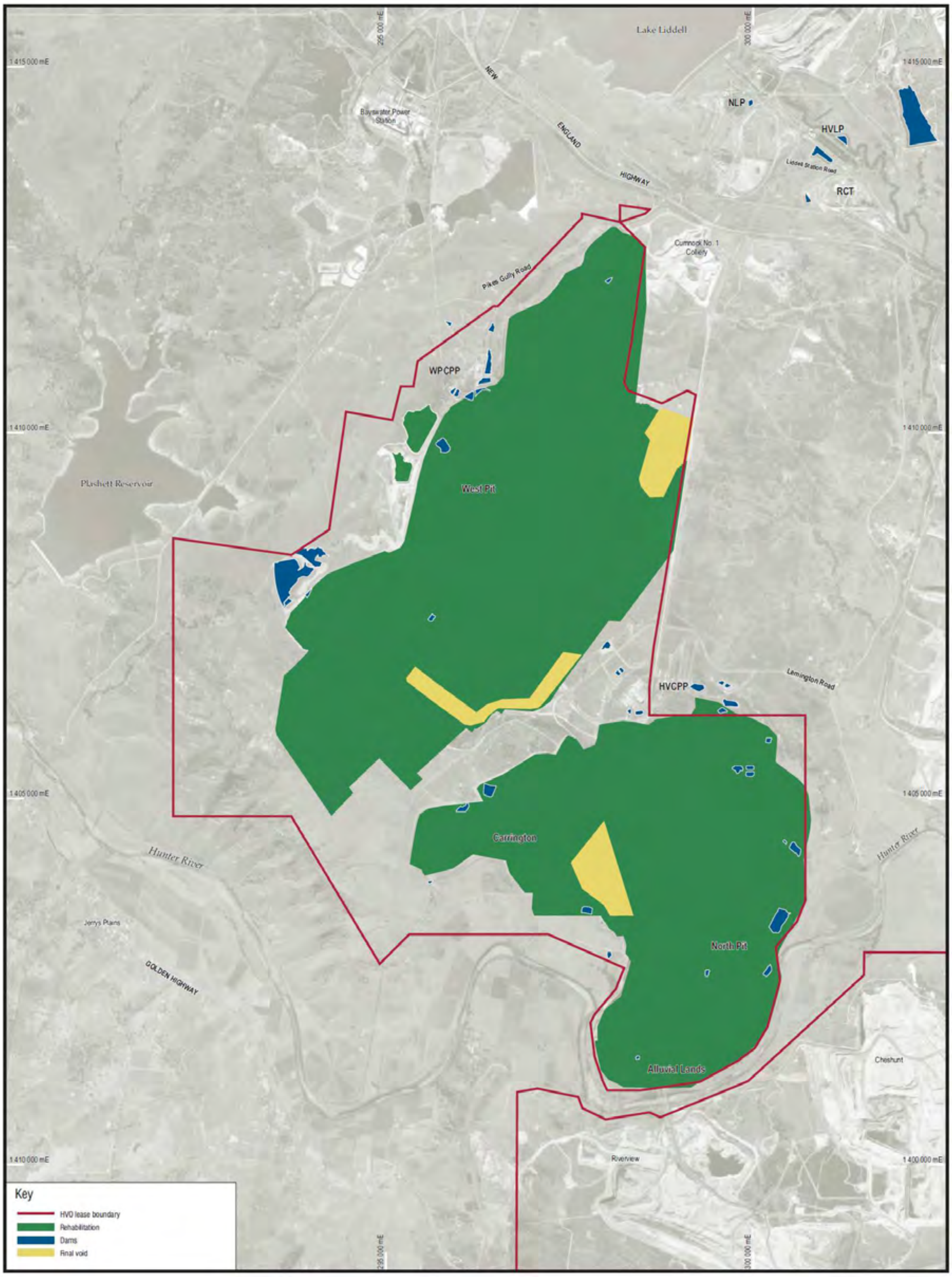
Source: Aerial imagery RTCA

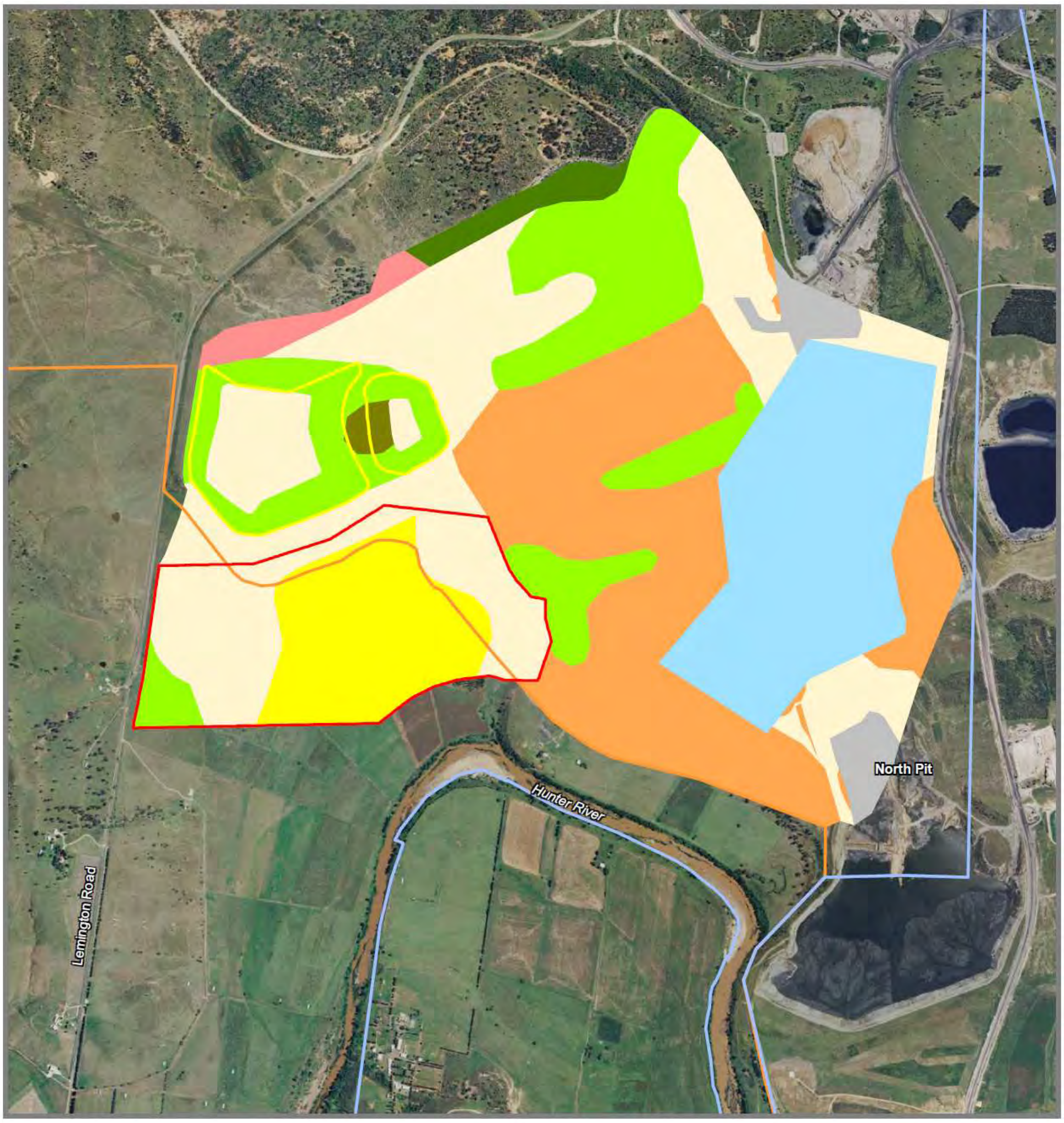
Revised key project elements

Carrington West Wing

FIGURE 1

APPENDIX 6
CONCEPTUAL FINAL LANDFORM PLANS

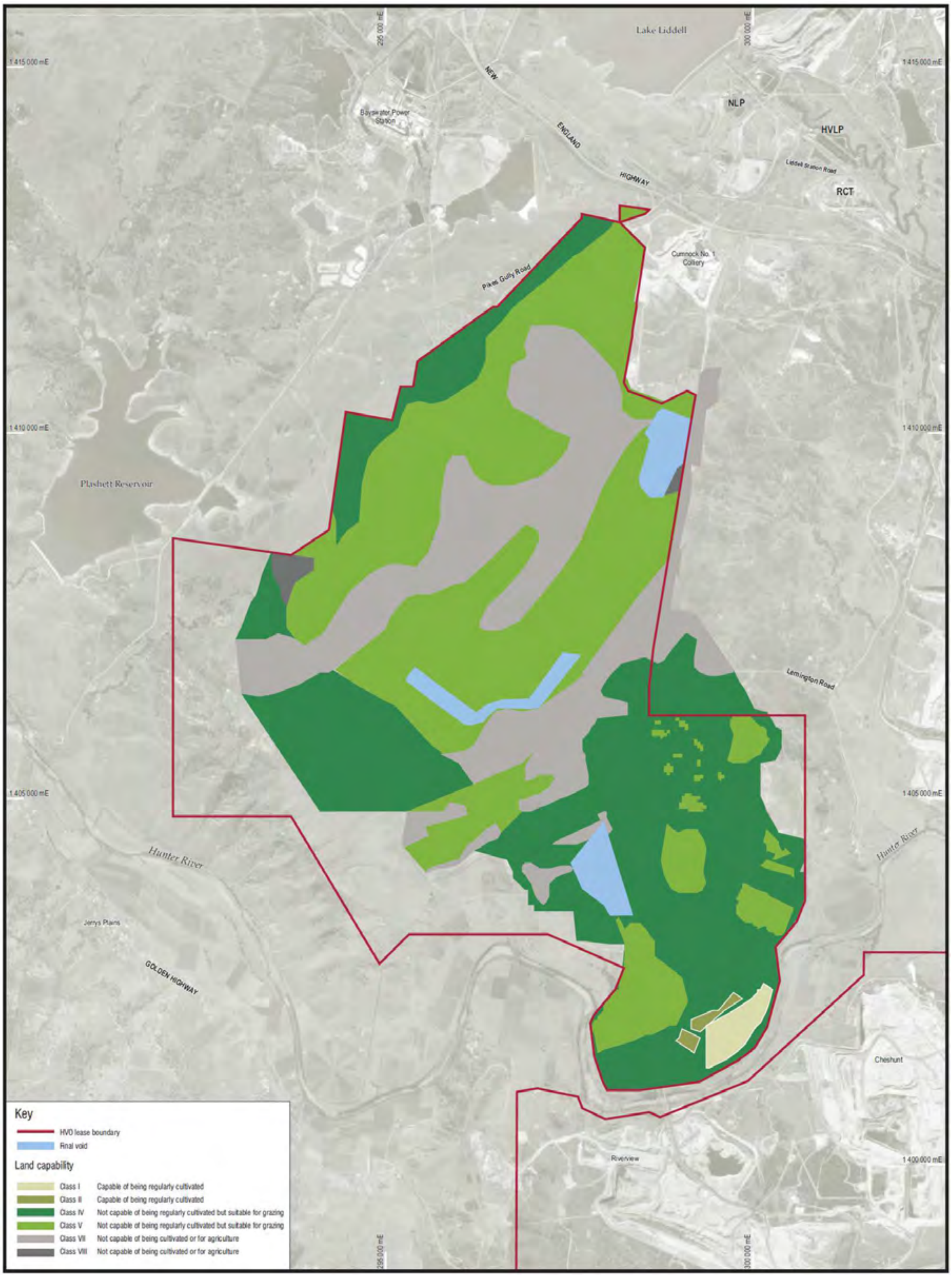




Regenerated Grassland (grazing)
Regenerated Woodland (biodiversity)
Rehabilitated Grassland (grazing/cropping)
Rehabilitated Woodland (biodiversity)
Rehabilitated Woodland (grazing)
Void / dam / mining area
Rehabilitated Woodland (Central Hunter Box - Ironbark Woodland) - indicative location
Rehabilitated Grassland (grazing/ cropping) - Class II land capability

HVO North current development consent boundary
HVO South project approval boundary
Proposed footprint of evaporative sink
Out-of-pit overburden emplacement
Proposed extension area

APPENDIX 7
CONCEPTUAL FINAL LANDUSE PLANS



Source: Aerial imagery RTCA

EMM

Post-mining agricultural suitability classes

Carrington West Wing

FIGURE 2

APPENDIX C

Groundwater assessment

Australasian Groundwater & Environmental Consultants Pty Ltd

REPORT on

HVO NORTH MODIFICATION FINE REJECT EMPLACEMENT

GROUNDWATER ASSESSMENT

prepared for
COAL AND ALLIED OPERATIONS PTY LTD

Project No. G1591/B2
June 2013

ABN:64 080 238 642

Australasian
Groundwater & Environmental
Consultants Pty Ltd

REPORT on

HVO NORTH MODIFICATION FINE REJECT EMPLACEMENT

GROUNDWATER ASSESSMENT

prepared for

COAL AND ALLIED OPERATIONS PTY LTD

Project No. G1591/B2
June 2013

Level 2 / 15 Mallon Street
Bowen Hills Qld 4006
Ph (+617) 3257 2055
Fax (+617) 3257 2088
Email: brisbane@ageconsultants.com.au
Web: www.ageconsultants.com.au

A.B.N 64 080 238 642

EXECUTIVE SUMMARY

HVO North is located approximately 24 km from Singleton. Coal & Allied Operations Pty Limited (Coal & Allied) owns and operates HVO North, while Rio Tinto Coal Australia (RTCA) provides management services for Coal & Allied. Coal & Allied is applying for a modification to the existing Development Consent (proposed modification). The proposed modification will allow for the sustained disposal of fine rejects at HVO North for a six-year period, and consists of the construction and operation of a 14,400 mega litre (ML) fine rejects emplacement to the north of the existing Carrington Pit, and fine reject emplacement in Cumnock void 3, located to the north-east of West Pit.

This groundwater impact assessment was prepared for the Environmental Assessment to support the proposed modification to the existing Development Consent, under Section 75W of the *Environmental Planning and Assessment Act 1979*. However, as fine reject emplacement at Cumnock void 3 has already been assessed and approved, the impact of fine reject emplacement in Cumnock void 3 is not considered as part of this report.

The groundwater impact assessment therefore relates to the 14,400 ML fine reject emplacement and includes a review of studies undertaken at HVO North, conceptualisation of the groundwater regime, modification of a finite difference (SURFACT) groundwater flow model, and prediction of the impact of the proposed modification on the groundwater regime.

Groundwater Systems

A review of existing data and reports indicates that the hydrogeological regime at HVO North consists of:

- palaeochannel alluvium;
- Spoil placed in mined areas; and
- Permian formations (coal seam and interburden).

The fine reject emplacement will be located on an area that has been mined and filled with spoil. Prior to mining, the topmost 10m to 20 m of the subject area was part of a former meander of the Hunter River, known as a palaeochannel. A remnant of palaeochannel alluvium remains to the north of the backfilled Carrington Pit which is effectively isolated from the remainder of the palaeochannel alluvium to the south. The spoil that has been used to backfill the Carrington Pit hydraulically connects the dissected alluvium to the north and the in-situ alluvium to the south.

Groundwater in the palaeochannel is typically brackish to slightly saline in quality with water chemistry indicating historical upward leakage from the coal seams and relatively low rates of rainfall recharge. The palaeochannel sediments interfinger with the alluvial sediments associated with the Hunter River and are hydraulically connected.

The Permian formations and coal seams outcrop in the elevated terrain of HVO North and dip to the south-west below the Hunter River. They are generally low yielding and contain poor quality brackish to slightly saline water. The water table / potentiometric surface of the Permian formations and coal seams is locally depressurised due to seepage to the Carrington Pit. The depressurisation of the coal seams has resulted in a downward vertical gradient from the alluvium to the Permian.

Numerical Model

An existing finite difference numerical model developed for the Carrington West Wing (CWW) extension using the SURFACT software package was modified to include the proposed modification. The model consists of seven layers, the upper layer representing the alluvium and weathered bedrock (regolith). The intermediate layers represent the Permian coal measures, these being the major coal seams separated by interburden.

The predictive numerical model includes the approved activities associated with the Carrington Pit and CWW and the fine reject emplacement. These developments were included in the predictive simulations to assess potential cumulative impacts.

Predictive Simulations

Results of the analytical 2D and 3D modelling are summarised below:

- Predictions using the analytical seepage model indicates that the fine reject emplacement could produce up to 703 m^3/day of seepage after accounting for rainfall and evaporative loss. This steady state solution considers a “conservative” or “worst case” estimate. The calculations are based on the maximum hydraulic head within the fine reject emplacement which will only occur during the final stages of deposition.
- The HVO North site water balance for 2011 calculates that there is a total of 3,977 m^3/day that is discharged to the existing fine reject facility (dam 29N). The water balance assumes approximately 2,320 m^3/day is decanted from the fine reject emplacement and pumped back to the CHPP, and the remaining 1,657 m^3/day of water resides in the fine reject emplacement. Some of this water is evaporated (139 m^3/day) and the remainder (1,519 m^3/day) is either retained in the fine reject or is lost through seepage to groundwater. The water balance model estimates that 326 m^3/day is retained in the existing facility, leaving 1,193 m^3/day as seepage.
- The 2D SEEP/W modelling provides a steady state solution for seepage through the floor of the fine reject emplacement. Two models were developed and seepage rates of 859 m^3/day and 777 m^3/day were predicted. As per the analytical seepage model, the SEEP/W modelling is a steady state solution that considers a “conservative” or “worst case” scenario whereby the calculations are based on the maximum hydraulic head within the fine reject emplacement, which will only occur during the final stages of fine reject deposition.
- The seepage rates predicted from the SEEP/W modelling (and confirmed with site data and analytical calculations) were applied to an existing 3D numerical model. The 3D modelling predicts the following:
    - Mounding as a result of the fine reject seepage will occur in the immediate vicinity of the fine reject emplacement. This water level change is predicted to occur within all model layers with the 1 m contour extending a maximum distance of 500 m to 600 m from the footprint. This mounding will be more prominent to the south-east as the seepage migrates toward the open cut pit and final void. The maximum mounding in Layer 6 beneath the fine reject emplacement (for the Carrington Model) is predicted to be 10.9 m after the completion of Stage 2. This reduces to 7.5 m after the completion Stage 3.
    - Seepage to the open cut pit is predicted to be 0.11 ML/day and 0.15 ML/day for the Carrington Pit and CWW, respectively. The current modelling is predicting slightly higher rates of seepage to the CWW mined void than predicted by MER (2010b).

This is likely due to the way the backfilled spoil has been simulated in the respective models. MER (2010b) did not simulate the backfilling of the mined voids with spoil, rather the mined voids were maintained as drains.

- The application of fine reject results in a very minor net change in flow (0.02 ML/day) from the regolith back to the alluvium. This is likely to be due from slightly elevated heads in the regolith forcing groundwater back into the alluvium under a higher hydraulic gradient. The proposed modification results in a net change in flow of 0.05 ML/day from the alluvium to the spoil. Once the fine reject emplacement is decommissioned, the net change in flow steadily reduces from 0.05 ML/day to 0.02 ML/day. There is no appreciable change in flux from the alluvium to the Permian strata. Whilst the major net change between model layers is predicted at 0.05 ML/day (18 ML/year), the total seepage rate applied to the fine reject emplacement is 859 m^3/day. It has been demonstrated that a large component of this seepage will not flow far from the footprint area, and will result in a change in storage in both the alluvium and spoil beneath the fine reject. This change in storage is expressed as localised mounding of the water table.
- The net change in leakage from the Hunter River as a result of the proposed modification is predicted to be negligible.
- The model predicts very localised mounding in response to fine reject seepage. As the water level change is local, the proposed modification will not impact on the Carrington Billabong GDE. Furthermore, the closest privately owned bores are located approximately 2.5 km south of Carrington Pit, and given the localised effect of mounding due to fine reject seepage, there is unlikely to be any impact to these bores from the proposed modification.

Post Closure Conditions

Seepage from the fine reject emplacement will not occur into perpetuity. After it is decommissioned and active deposition and decant stops, rainfall recharge will be the only input. The output from the fine reject emplacement will be drainage under gravity and evaporation from the surface and embankments. After decommissioning, recharge to groundwater within the fine reject emplacement footprint is highly likely to reduce to rates approaching those occurring pre-mining. As a result of this, seepage is unlikely to influence either the final void water level or the approximate time taken to stabilise.

Numerical modelling predicts that the seepage from the proposed modification is unlikely to reach the open cut within the active mining period, and there will be no appreciable change in mine inflow water quality during mining. In the long term, the final void water quality predictions presented for the CWW extension are still valid, that is "*most likely to exhibit a pH range from 7.5 to 9.5, a TDS range from 1,000mg/L increasing to about 3,000-4,000mg/L in the long term with a speciated signature Na>Mg>Ca and HCO_3>Cl>SO_4".* However, it is expected that final void water quality will be more sulphate dominant as a result of the fine reject seepage.

Licensing

Licensing under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources* is required to account for any reduction of flow to the alluvium. The current Carrington operations already have approvals to account for any alluvial water loss and MER (2010b) presents any additional licensing required for the CWW extension.

The modelling for the proposed modification predicts that there is no additional alluvial loss or river leakage, and as a result, there is no additional licensing required as part of the approval process to offset these losses.

Groundwater Management

Groundwater management is currently undertaken in accordance with the existing Water Management Plan for HVO North. This monitoring is undertaken as a strategy to assess potential impacts relating to:

- Open cut depressurisation;
- Continuing loss of coal measures aquifer pressures;
- Change in groundwater quality in coal measures; and
- Leakage of groundwater from shallow aquifers.

Groundwater level change is predicted to be limited to localised mounding beneath and adjacent to the fine reject emplacement, as a result there are no specific management measures that are recommended as part of the proposed modification.

It is however recommended that the monitoring bores and vibrating wire piezometers installed as part of this assessment be included in the groundwater monitoring plan for the Carrington Pit. The purpose of these bores will be to monitor the water levels beneath the fine reject emplacement to ensure that the localised water level mounding that will occur as a result of seepage is consistent with model predictions. No additional monitoring bores need to be installed.

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

Page No.

List of Figures:

TABLE OF CONTENTS
(Continued)

Page No.

List of Tables:

List of Appendices:

REPORT ON

HVO NORTH MODIFICATION – FINE REJECT EMPLACEMENT GROUNDWATER ASSESSMENT

1 INTRODUCTION

The Hunter Valley Operations (HVO) mining complex is located approximately 24 kilometres (km) north-west of Singleton, New South Wales (NSW). The mining and processing activities at HVO are geographically divided by the Hunter River, into HVO North and HVO South. While HVO is managed as one operation, HVO North and HVO South each have separate planning approvals. Coal & Allied Operations Pty Limited (Coal & Allied) owns and operates HVO, while Rio Tinto Coal Australia (RTCA) provides management services for Coal & Allied.

The HVO North complex comprises the active Carrington, North, West and Mitchell Pits and related mining activities and infrastructure, such as overburden emplacement areas. There are two coal preparation plants operating at HVO North, the Hunter Valley and Howick Coal Preparation Plants (CPPs), and two train load-out areas, the Hunter Valley and Newdell load points.

HVO North currently operates under Development Consent No. DA 450-10-2003 (DA 450-10-2003), which was issued by the then Minister for Infrastructure and Planning in 2004, under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Coal & Allied is applying for a modification to the existing Development Consent (proposed modification), under Section 75W of the *Environmental Planning and Assessment Act 1979 (EP&A Act).*

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) were commissioned by Coal & Allied to review the impacts of the proposed modification on the groundwater systems. This report details the groundwater impact assessment, which forms part of the Environmental Assessment (EA) being prepared by EMGA Mitchell McLennan Pty Ltd (EMM) on behalf of Coal & Allied.

2 PROJECT OVERVIEW

HVO North currently operates under DA 450-10-2003. Coal & Allied is proposing to modify the DA under section 75W of the EP&A Act, to allow for:

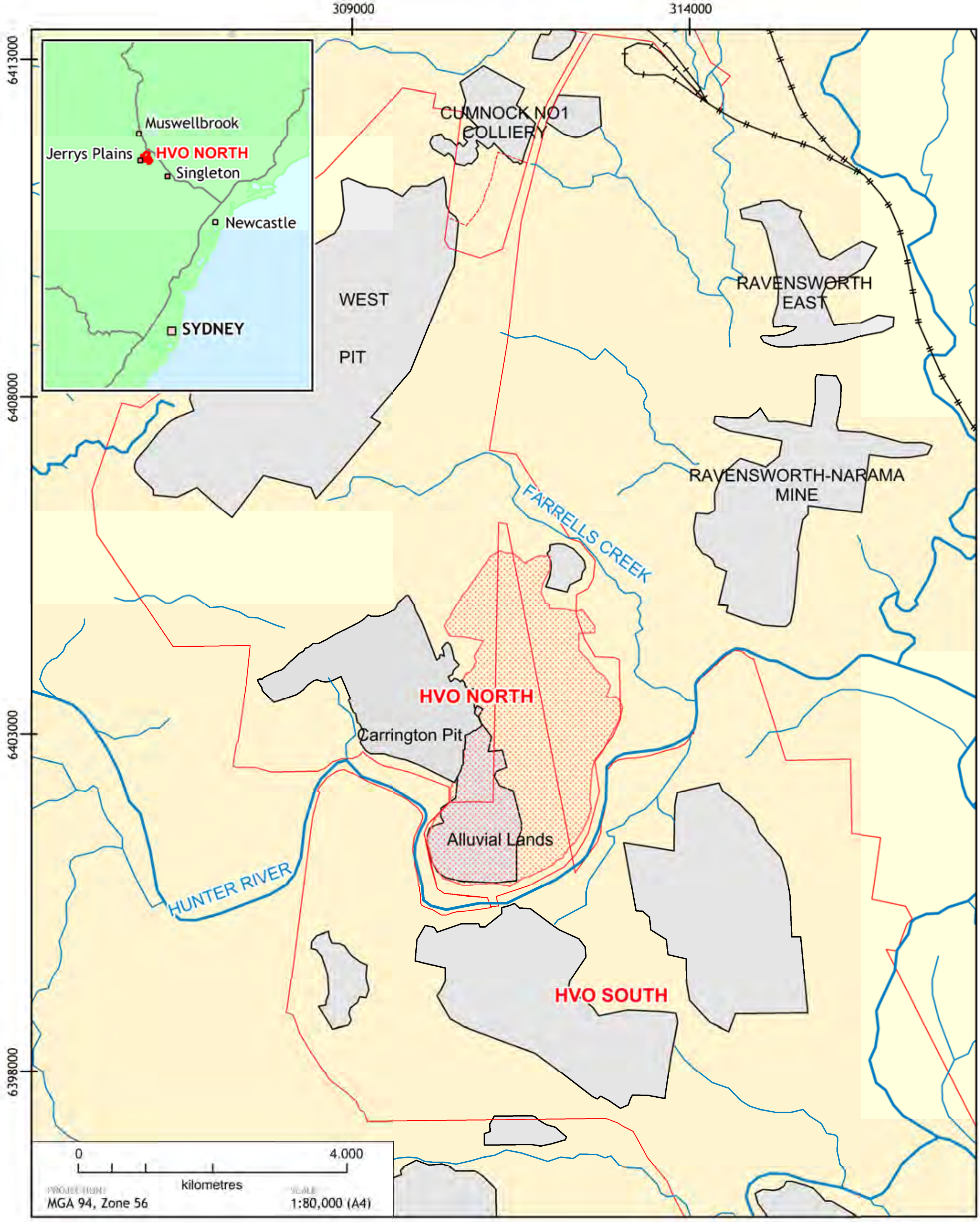
- construction and operation of a 14,400 mega litre (ML) fine reject emplacement to the north of the existing Carrington Pit (Figure 2.1); and
- fine reject emplacement in Cumnock void 3, located to the north-east of West Pit.

A minor amendment to the HVO North development consent boundary, which will encompass Cumnock void 3, is proposed in order to accommodate the modification. The proposed modification elements are referred to collectively as 'HVO North Modification – Fine Reject Emplacement'. For the purpose of this assessment, the term 'proposed modification' relates solely to the fine reject emplacement. The 'project area' comprises the proposed emplacement and areas of associated disturbance, including pipelines.

The Cumnock void 3 is located outside of the HVO North development consent boundary and within a mining lease held by the Cumnock Joint Venture. The use of the void as a fine reject emplacement was assessed in the *Ravensworth Operations Project Environmental Assessment*, prepared by Umwelt (2010) and approved under DA 09-0176.

As noted in the Umwelt (2010) EA, the designated reject emplacement areas presented within the report have sufficient capacity to store fine reject for the life of the project. A draft joint use agreement between the Cumnock Joint Venture and Coal & Allied is in place with respect of each of their use of the void. Coal & Allied's contribution to fine reject emplacement in Cumnock void will utilise about 25 per cent of the void's emplacement capacity. The draft agreement will be finalised prior to Coal & Allied transferring any fine reject to the void.

As fine reject emplacement at Cumnock void 3 has already been assessed and approved, the impact of fine reject emplacement in Cumnock void 3 is not considered as part of this report.



HVO Development Consent Boundary

Proposed Boundary Extension

Alluvial Lands Void

Mine Area

Drainage Line / Creek

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

General Location Plan

DATE: 5/6/2013

FIGURE No: **2.1**

3 SCOPE OF WORK

3.1 Methodology

The methodology adopted for the study, to address the potential impacts from the proposed modification, comprised:

- liaison with RTCA, and review studies with inter-relationships with groundwater including surface water, geochemistry and ecology components;
- identification of groundwater resources or usage in the vicinity of the site that could be impacted by the proposed modification;
- assessment of post-mine groundwater impacts;
- development of groundwater management strategies;
- assessment of the potential for any groundwater impacts resulting from the construction or use of proposed new infrastructure;
- identification of any groundwater impact mitigation measures necessary for the proposed modification; and
- a recommended pre- and post-approval groundwater monitoring and groundwater management program.

The key environmental issues to be addressed as part of this assessment are the impact of the proposed modification on the Hunter River, the Hunter River alluvium and the Carrington Billabong Groundwater Dependent Ecosystem (GDE). These issues are important because the water associated with the Hunter River is typically of better quality and has the highest environmental value in the region. The protection of the Hunter River and alluvial water sources are discussed further in Section 4.2, whereas the environmental value of the water is discussed in Section 4.3.1.

The seepage modelling of the fine reject emplacement was carried out using SEEP/W. SEEP/W is used extensively in the mining industry for assessing seepage through artificial embankments, emplacement facilities and water impoundments. The results of the SEEP/W modelling enabled seepage estimates to be assessed. These seepage rates were then transferred to the existing MODFLOW-SURFACT model to assess the more regional implications of this seepage.

The existing numerical groundwater flow model for the CWW was developed by Mackie Environmental Research (MER, 2010b). The fine reject emplacement is proposed to be constructed immediately to the north of the existing Carrington Pit, and hence, the existing numerical model was used to assess the change in groundwater levels that would result from the proposed modification.

In summary, the numerical modelling allowed predictions to be made of:

- the likely range of groundwater inflow to the open pits, as a function of mine position and timing;
- the area of influence of dewatering, including the level and rate of drawdown at specific locations;
- areas of potential risk, where groundwater impact mitigation/control measures may be necessary;
- the mitigation/control strategies, where adverse impacts are identified;

- impact of mine dewatering on groundwater discharges and other groundwater users, including an assessment of the cumulative impacts from other nearby coal mines; and
- flow of saline water to the Hunter River.

The modelling scope did not include the provision of water quality modelling. A qualitative assessment of water quality is provided as part of this assessment; however, a quantitative assessment has not been carried out as this is within the scope of the surface water assessment being undertaken for the proposed modification.

4 LEGISLATION, POLICY AND GUIDELINES

The following section outlines NSW State Government legislation, policy and guidelines, with respect to groundwater, that must be addressed in assessing a mining proposal.

4.1 Water Act 1912

The *Water Act 1912* (Water Act) governs the issue of water licences from water sources including rivers, lakes and groundwater aquifers in NSW. It also manages the trade of water licences and allocations.

The Water Act is progressively being replaced by the *Water Management Act 2000* (WM Act), but some provisions of the Water Act are still in force where water sharing plans are not in place. This is not the case in the project area. There are two Water Sharing Plans that are valid for HVO North. These are known as the *Water Sharing Plan for the Hunter Regulated River Water Source* and the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources.* These were released in 2004 and 2009, respectively.

4.2 Water Management Act 2000

The objective of the WM Act is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources. It provides the following four types of approval:

- water use approval – which authorises the use of water at a specified location for a particular purpose, for up to 10 years;
- water management work approval;
- controlled activity approval; and
- aquifer interference activity approval – which authorises the holder to conduct activities that affect an aquifer such as approval for activities that intersect groundwater, other than water supply bores, and may be issued for up to 10 years.

For controlled activities and aquifer interference activities, the WM Act requires that the activities avoid or minimise their impact on the water resource and land degradation, and where possible the land must be rehabilitated.

4.2.1 Water Sharing Plan for the Hunter Regulated River Water Source 2004

The *Water Sharing Plan for the Hunter Regulated River Water Source* commenced in July 2004. The Water Sharing Plan was suspended on 29 December 2006 and recommenced 20 February 2009. The Water Sharing Plan applies until June 2014 and sets rules for protecting the environment, extractions, managing licence holders' water accounts and water trading.

According to the NSW Office of Water (NOW) the Hunter Regulated River Water Source lies within the Hunter Water Management Area and comprises the following:

- the bed and banks of all rivers, from the upstream limit of Glenbawn Dam water storage 1 downstream to the estuary of the Hunter River, and from the upstream limit of Glennies Creek Dam water storage downstream to the junction with the Hunter River; and
- the unconsolidated alluvial sediments underlying the waterfront of all rivers which have been declared by the Minister to be regulated rivers, except those unconsolidated alluvial sediments within one metre of works taking water pursuant to licences issued under Part V of the *Water Act 1912* or their equivalent aquifer access licences issued under the *Water Management Act 2000*.

4.2.2 Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009

The *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources* commenced in August 2009. The Water Sharing Plan sets the framework for managing groundwater in the Hunter alluvial aquifers until 2019. The Water Sharing Plan for the Hunter Unregulated Alluvial Water Sources includes the Hunter unregulated rivers and creeks, and the highly connected alluvial groundwater. There are 39 water sources covered by the Water Sharing Plan, and nine of these are further sub-divided into management zones. HVO North is included within the Upstream Glennies Creek Management Zone, comprising that part of the water source adjacent to the Hunter River upstream of its junction with Glennies Creek.

The objectives of the Water Sharing Plan are to:

> *"(a) protect the important water dependent environmental, Aboriginal, cultural and heritage values,*
>
> *(b) protect basic landholder rights,*
>
> *(c) manage the river and alluvial groundwater to ensure equitable sharing between users,*
>
> *(d) provide opportunities for market-based trading of licences and water allocations,*
>
> *(e) provide flexibility for licence users in how they can use their water,*
>
> *(f) allow for adaptive management, that is, to allow changes to be made when more information is available."*

A summary of the aquifer access licences presented in the Water Sharing Plan surrounding the project area are shown in Table 1.

Table 1: SUMMARY OF ACCESS LICENCES – HUNTER RIVER REGULATED ALLUVIAL WATER SOURCE

Category	Aquifer Volumetric Licence (ML/year)
Domestic and Stock	0
Local Water Utility	4,932
Major Utility	0
Unregulated River Access	0
Unregulated River (High Flow)	0
Aquifer Access	24,132

4.3 State Groundwater Policy

The NSW State Groundwater Policy (Framework Document) was adopted in 1997 and aims to manage the State's groundwater resources to sustain their environmental, social and economic uses. The policy has three components parts, namely:

- the NSW Groundwater Quality Protection Policy, adopted in December 1998;
- the NSW Groundwater Dependent Ecosystems Policy adopted in 2002; and
- the NSW Groundwater Quantity Management Policy (undated document).

4.3.1 Groundwater Quality Protection

The NSW Groundwater Quality Protection Policy (Department of Land & Water Conservation, 1998), states that the objectives of the policy will be achieved by applying the management principles listed below.

1. *"All groundwater systems should be managed such that their most sensitive identified beneficial use (or environmental value) is maintained.*
2. *Town water supplies should be afforded special protection against contamination.*
3. *Groundwater pollution should be prevented so that future remediation is not required.*
4. *For new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the groundwater resource.*
5. *A groundwater pumper shall bear the responsibility for environmental damage or degradation caused by using groundwaters that are incompatible with soil, vegetation and receiving waters.*
6. *Groundwater dependent ecosystems will be afforded protection.*
7. *Groundwater quality protection should be integrated with the management of groundwater quality.*
8. *The cumulative impacts of developments on groundwater quality should be recognised by all those who manage, use, or impact on the resource.*
9. *Where possible and practical, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored."*

4.3.2 Groundwater Dependent Ecosystems

The NSW Groundwater Dependent Ecosystems Policy is specifically designed to protect valuable ecosystems which rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of these dependent ecosystems are maintained or restored for the benefit of present and future generations. The policy defines GDEs as *"communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater".*

Five management principles establish a framework by which groundwater is managed in ways that ensure, whenever possible, that ecological processes in dependent ecosystems are maintained or restored. A summary of the principles follows:

- GDEs can have important values. Threats should be identified and action taken to protect them;
- groundwater extractions should be managed within the sustainable yield of aquifers;
- priority should be given to GDEs, such that sufficient groundwater is available at all times to meet their needs;
- where scientific knowledge is lacking, the precautionary principle should be applied to protect GDEs; and
- planning, approval and management of developments should aim to minimise adverse effects on groundwater by maintaining natural patterns, not polluting or causing changes to groundwater quality and rehabilitating degraded groundwater ecosystems where necessary.

4.3.3 Groundwater Quantity Protection

The objectives of managing groundwater quantity in NSW are:

- *"to achieve the efficient, equitable and sustainable use of the State's groundwater;*
- *to prevent, halt and reverse degradation of the State's groundwater and their (sic) dependent ecosystems;*
- *to provide opportunities for development which generate the most cultural, social and economic benefits to the community, region, state and nation, within the context of environmental sustainability; and*
- *to involve the community in the management of groundwater resources."*

4.3.4 Aquifer Interference Policy

The Aquifer Interference (AI) Policy forms the basis for assessment of aquifer interference activities under the EP&A Act. It clarifies the need to hold water access licences or Water licences (as the case may be) under the WM Act and Water Act and establishes consideration in assessing whether 'minimal impact' occurs.

The WM Act defines an aquifer interference activity as that which involves any of the following:

- penetration of an aquifer;
- interference with water in an aquifer;
- obstruction of the flow of water in an aquifer;

- taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations; and
- disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations.

Examples of aquifer interference activities (NOW, 2012) include mining, coal seam gas extraction, injection of water, and commercial, industrial, agricultural and residential activities that intercept the water table or interfere with aquifers.

According to the WM Act, an aquifer is defined as a geological structure or formation, or an artificial landfill that is permeated with water or is capable of being permeated with water. This is at odds with the commonly used definition, which refers to an aquifer as a groundwater system that is sufficiently permeable to yield productive volumes of groundwater. The definition of aquifer provided by the WM Act is more consistent with the term groundwater system, which refers to any type of saturated geological formation that can yield low to high volumes of water.

The Policy states that "*all water taken by aquifer interference activities, regardless of quality, needs to be accounted for within the extraction limits defined by the water sharing plans. A water licence is required under the WM Act (unless an exemption applies or water is being taken under a basic landholder right) where any act by a person carrying out an aquifer interference activity causes:*

- *the removal of water from a water source; or*
- *the movement of water from one part of an aquifer to another part of an aquifer; or*
- *the movement of water from one water source to another water source, such as:*
    - *from an aquifer to an adjacent aquifer; or*
    - *from an aquifer to a river/lake; or*
    - *from a river/lake to an aquifer.*

The AI Policy requires assessment of the likely volume of water taken from a water source(s) as a result of an aquifer interference activity. These predictions need to occur prior to project approval. After project approval and during operations these volumes need to be measured and reported in annual environmental management reports (AEMR). The water access licence must hold sufficient share component and water allocation to account for the take of water from the relevant water source at all times.

The AI Policy states that a water licence is required for the aquifer interference activity regardless of whether water is taken directly for consumptive use or incidentally. Activities may induce flow from adjacent groundwater sources or connected surface water. Flows induced from other water sources also constitute take of water. In all cases, separate access licences are required to account for the take from all individual water sources.

In water sources where water sharing plans do not yet apply, an aquifer interference activity that takes groundwater is required to hold a water licence under the Water Act. It is possible for the Water Act to apply in a groundwater source and the WM Act to apply in a connected surface water source or vice versa. Where this occurs and the aquifer interference activity is taking water from both water sources then licences will be required under each Act.

In addition to the volumetric water licensing considerations, the following information needs to be considered to enable assessment and approval of the activity:

- establishment of baseline groundwater conditions including groundwater depth, quality and flow based on sampling of all existing bores in the area;
- a strategy for complying with any water access rules applying to relevant categories of water access licences, as specified in relevant water sharing plans;
- details of potential water level, quality or pressure drawdown impacts on nearby water users who are exercising their right to take water under a basic landholder right;
- details of potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources;
- details of potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems;
- details of potential for increased saline water inflows to aquifers and highly connected river systems;
- details of the potential to cause or enhance hydraulic connection between aquifers; and
- details of the potential for river bank instability, or high wall instability or failure to occur.

In particular, the AI Policy describes minimal impact considerations for aquifer interference activities based upon whether the water source is highly productive or less productive and whether the water source is alluvial or porous / fractured rock in nature. In general the policy applies a predicted 2 m drawdown maximum limit at existing groundwater users.

The NOW's assessment of impacts and subsequent advice and proposed conditions of approval for a project is based on an "*account for, mitigate, avoid/ prevent, and remediate*" approach. NOW's methodology is based on "*a risk management approach to assessing the potential impacts of aquifer interference activities, where the level of detail required to be provided by the proponent is proportional to a combination of the likelihood of impacts occurring on water sources, users and dependent ecosystems and the potential consequences of these impacts*."

The AI Policy divides groundwater sources into "highly productive" and "less productive". Highly productive groundwater is defined by the AI Policy as a groundwater source that is declared in the Regulations and will be based on the following criteria:

a) has total dissolved solids of less than 1,500 mg/L, and
b) contains water supply works that can yield water at a rate greater than 5 L/sec. Highly productive groundwater sources are further grouped by geology into alluvial, coastal sands, porous rock, and fractured rock. "Less productive" groundwater includes aquifers that cannot be defined as "highly productive" according the yield and water quality criteria.

The Hunter River alluvium adjacent to the project has been assessed and determined to satisfy the "highly productive" criteria, while the Permian coal measures are "less productive" porous rock. The AI Policy defines the following Minimal Impact Considerations for "highly productive" and less productive groundwater. Table 2 summaries the Minimal Impact Considerations for the "highly productive" Hunter River alluvium, and the "less productive" Permian coal measures. If these considerations are not met the project needs to demonstrate to the Minister's satisfaction that the impact will be sustainable, or that "make good agreements" are in place.

<table>
<tr><th colspan="4">Table 2: SUMMARY MINIMAL IMPACT CONSIDERATIONS – AQUIFER INTERFERENCE POLICY</th></tr>
<tr><th>Category</th><th>1. Water Table</th><th>Water Pressure</th><th>Water Quality</th></tr>
<tr><td>Highly productive alluvium – Hunter River Alluvium</td><td rowspan="2">1. Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m from any:

(a) high priority groundwater dependent ecosystem; or
(b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan; or

A maximum of a 2 m decline cumulatively at any water supply work.</td><td>1. A cumulative pressure head decline of not more than 40% of the ”post-water sharing plan” pressure head above the base of the water source to a maximum of a 2 m decline, at any water supply work.</td><td>1. (a) Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity; and

(b) No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity.

Redesign of a highly connected(3) surface water source that is defined as a “reliable water supply”(4) is not an appropriate mitigation measure to meet considerations 1.(a) and 1.(b) above.

(c) No mining activity to be below the natural ground surface within 200 m laterally from the top of high bank or 100 m vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a “reliable water supply”.

(d) Not more than 10% cumulatively of the three dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200 m laterally from the top of high bank and 100 m vertically beneath a highly connected surface water source that is defined as a “reliable water supply”.</td></tr>
<tr><td>Less productive porous rock – Permian Coal Measures</td><td>A cumulative pressure head decline of not more than a 2m decline, at any water supply work.</td><td>Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.</td></tr>
</table>

5 REGIONAL SETTING

5.1 Location

The HVO mining complex is located within the Hunter Valley of NSW, and is bound by the Golden Highway to the west, and the New England Highway to the east. The mining and processing activities at HVO are geographically divided by the Hunter River into HVO North and HVO South. HVO North comprises two active pits (Carrington Pit and West Pit), and two inactive pits (Alluvial Lands Pit and North Pit). This report focuses on the Carrington Pit area (the project area) of HVO North (Figure 5.1).

The majority of HVO North is located within the Singleton Local Government Area (LGA), with the exception of the northern most section containing part of the rail loading facilities, which is located within the Muswellbrook LGA.

5.2 Surrounding Land Use

Mine operations and related infrastructure in the surrounding area include Ravensworth Operations, HVO South, Ashton Coal, Warkworth Mine, Wambo Mine and United Colliery. Bayswater Power Station is situated to the north. Of particular relevance to the proposed modification is Ravensworth Operations, located immediately adjacent to the north-east of the HVO North development consent boundary. Ravensworth Operations comprises the existing Ravensworth West Mine, including Cumnock No.1 Colliery, and Narama Mine. As mentioned in Section 2, the proposed modification includes the emplacement of fine reject in the Cumnock void 3, which is encompassed within Ravensworth Operations.

Grazing and cropping land dominates areas to the west. The closest privately owned residences are over 4 km to the west, south-west and south of the fine reject emplacement, and are located within the village of Jerrys Plains and along the Golden Highway.

LEGEND:

- HVO Development Consent Boundary
- Spoil
- Carrington Billabong Area
- Fine Reject Emplacement
- Palaeochannel Extent
- Proposed Carrington Pit Extent
- Barrier Wall
- Drainage Line / Creek

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Project Area

DATE: 5/6/2013

FIGURE No: **5.1**

5.3 Mining Operations

Dominant features of the HVO North landscape comprise the existing open cut pits, mine-related infrastructure and rehabilitated former mining areas, to the north, east and south.

HVO North commenced mining and development in the 1950s with the operation of the West Pit, an open-cut dragline and truck and shovel operation. The North Pit (an open-cut truck and shovel operation) commenced operation and mining in the late 1970s. Development of the North Pit continued into the 1990s with the extension of the mine into the Alluvial Lands Pit which was approved in 1993. West Pit is still actively mined, whilst mining has ceased in the North Pit and Alluvial Lands Pit. The North Pit and Alluvial Lands Pit are still actively used for fine reject disposal.

The Carrington Pit commenced development and operation in 2000, mining the Broonie and Bayswater Seams. It is understood that the Carrington West Wing (CWW) Proposal was submitted in April 2010 to the DP&I, and has met approval.

In order to create a barrier between the Carrington Pit and the Hunter River alluvium, a barrier wall was constructed in 2010 (Figure 5.1). The purpose of the barrier wall was to:

- enable continued mining at Carrington Pit;
- minimise leakage from the alluvium to the open cut; and
- containment of groundwater following mine closure.

The barrier wall was constructed as a compacted clay buttress wall against the existing levee that extends across the eastern limb of the palaeochannel. The wall was constructed to the base of the Vaux Seam.

The CWW extension comprises a 142 hectare (ha) extension to recover approximately 17 Million Tonnes (Mt) of in-situ coal from the coal reserves in the Broonie, Bayswater, Piercefield and Vaux Coal Seams. It is noted that during the determination process the extension area footprint has been slightly amended and now measures approximately 137 ha. This amendment, however, is inconsequential to the results presented in this report. The approved footprint of the Carrington Pit evaporative sink is proposed to be extended as part of the CWW, to accommodate the additional post-mining groundwater generated from mining within the pit extension area. The construction of a groundwater barrier wall, prior to mining within the pit extension area, is proposed as part of the CWW extension. The barrier would effectively:

- separate freshwater in the Hunter River from saline water in areas disturbed by mining;
- prevent pit inflows from the alluvium as the pit migrates from the northern areas, southwards towards the Hunter River; and
- prevent the exchange of water between the pit and the alluvium, post closure.

All mines within HVO North are open cut (box-cut) operations, and typically involve truck and shovel, or dragline, truck and shovel operations. The mines are developed by progressively stripping overburden and interburden material, and placing this material (spoil) either out-of-pit (during initial mining operations) or in-pit as spoil onto pre-mined areas.

5.4 Topography and Drainage

Topography is generally undulating, and ranges from 130 mAHD to 200 mAHD to the north of West Pit and from 50 mAHD to 120 mAHD to its south. A large ridgeline, approximately 220 mAHD, is located between HVO North and the village of Jerrys Plains found to the south-west.

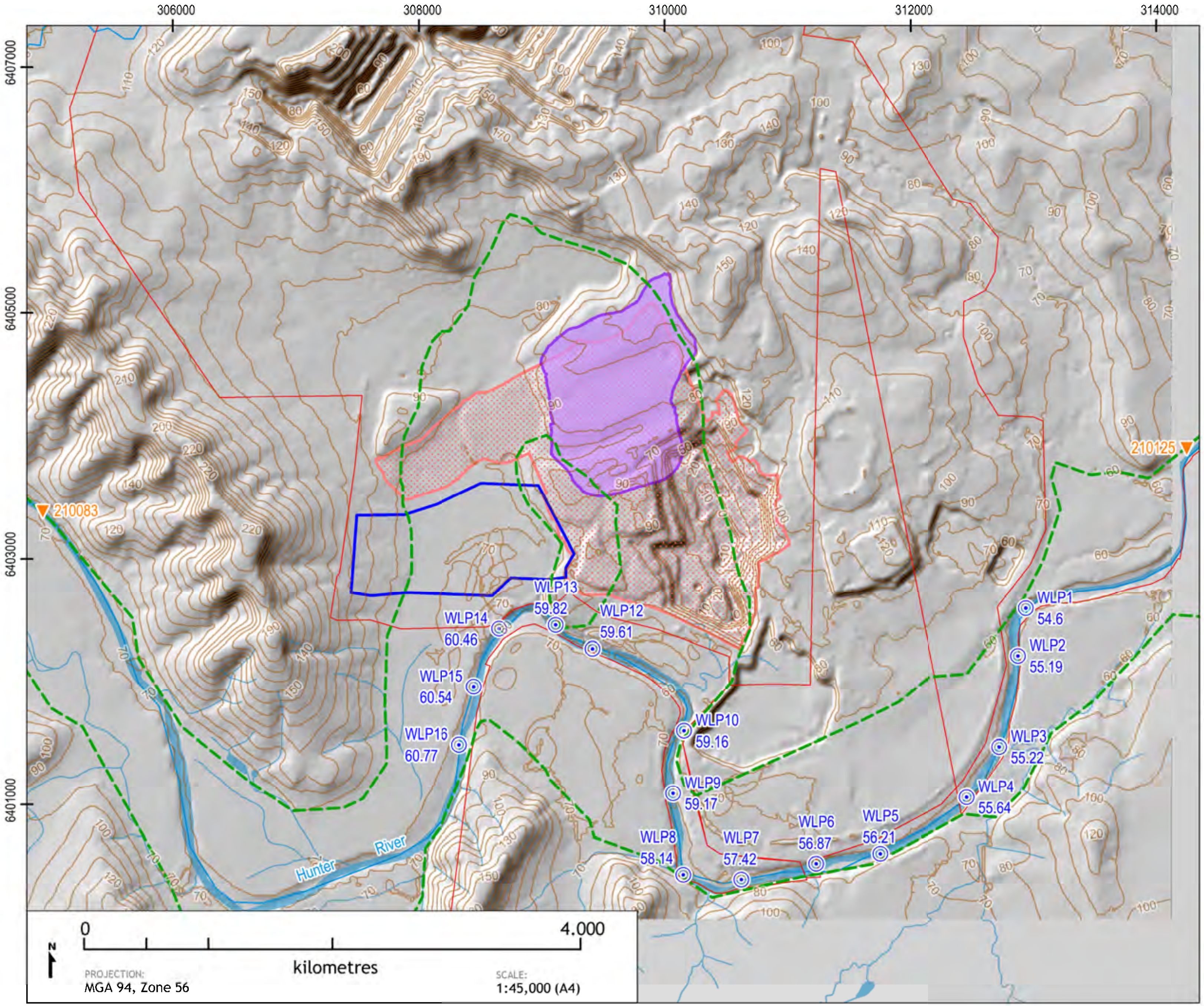
The landscape at HVO North is dominated by the presence of the Hunter River and its associated alluvium, which separates HVO North from HVO South. The elevation of the alluvial flood plain declines from approximately 70 mAHD to the west, down to approximately 63 mAHD east of the project area. The bed level of the Hunter River declines from approximately 63 mAHD to the west, down to approximately 55 mAHD to the east of the project area.

The topography of the area is influenced by the underlying geology, which is comprised of sedimentary coal measures overlain by alluvial sediments in low-lying areas. The outcrop of the coal measures forms a gentle north-westerly trending ridgeline, on which the mine pits are located. Along the ridgeline, the topography has been heavily modified by mining activities, with spoil rising up to about 150 mAHD. A palaeochannel of the Hunter River loops across the project area and is intersected by the Carrington Pit (Figure 5.2). The Carrington Pit has largely been in-filled with spoil and a levee wall constructed along the southern end, across the eastern limb of the palaeochannel. Flat alluvial plains extend from the levee to the Hunter River, which flows towards the east.

NOW collects real time stream flow data via the Hunter Integrated Telemetry System (HITS). There are two NOW gauging stations on the Hunter River in close proximity to HVO North:

- Station 210083 upstream of HVO North at Liddell (60.96 mAHD at zero gauge); and
- Station 210125 downstream of HVO North (50.33 mAHD at zero gauge).

HVO also collects monthly stream elevation data from 15 stations along the Hunter River. Stations WLP2, WLP5, WLP9, WLP12 and WLP13 are located along the Hunter River, south of the project area. The location of the NOW and HVO stream gauges is shown in Figure 5.2.



LEGEND:

- HVO Development Consent Boundary
- Fine Reject Emplacement
- CWW
- Carrington Mined Area
- Palaeochannel Extent
- 10m Topographic Contours (HVO 2011 - mRL)
- HVO Stream Gauge (River Level 12/12/11 - mRL)
- NOW Stream Gauge

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Site Topography & Stream Gauges

DATE:
5/6/2013

FIGURE No:
5.2

5.5 Climate

The climate in the vicinity of HVO North is mostly temperate, and is characterised by hot, wet summers and mild, dry winters. Climate monitoring data collected by the Bureau of Meteorology (BoM) was obtained for Jerrys Plains Station, which is located about 7 km to the north-west of Carrington. The Jerrys Plains Station (061086) has 125 years of rainfall data dating from 1884 to present. A summary of average temperature, rainfall and evaporation is shown in Table 3.

Table 3: CLIMATE AVERAGES: JERRYS PLAINS STATION 061086

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Mean max temp (ºC)	31.8	30.9	28.9	25.3	21.3	18	17.4	19.4	22.9	26.2	29.1	31.2	25.2
Mean min temp (ºC)	17.2	17.1	15	11	7.4	5.3	3.8	4.4	7	10.3	13.2	15.7	10.6
Mean rainfall (mm)	76.8	72.8	58.8	44.3	40.8	48	43.5	36.5	42	52.2	61.1	67.9	644.5
Mean evaporation (mm)	220.1	168	155	120	89.9	60	71.3	80.6	111	164.3	195	204.6	1639.8
Evap minus rainfall	143.3	95.2	96.2	75.7	49.1	12	27.8	44.1	69	112.1	133.9	136.7	995.1

The average annual rainfall is 645 mm, with January being the wettest month with 77 mm. The mean annual evaporation rate is 1,640 mm/year, and the mean monthly evaporation for each month of the year exceeds mean monthly rainfall, with the highest moisture deficit occurring during summer.

Recent rainfall years have been put into historical context using the Cumulative Rainfall Departure (CRD) method. This method is a summation of the monthly departure of rainfall from the long-term average monthly rainfall. A rising trend in the CRD plot indicates periods of above average rainfall, whilst a falling slope indicates periods when rainfall is below average.

The CRD graph for the period 1900 to present is shown in Figure 5.3. The CRD indicates that the area experienced a period of generally below average rainfall from 1994 until 2001, and from 2006 to 2007. Above average rainfall has been recorded since 2007, which is reflected in the rising slope of the CRD.

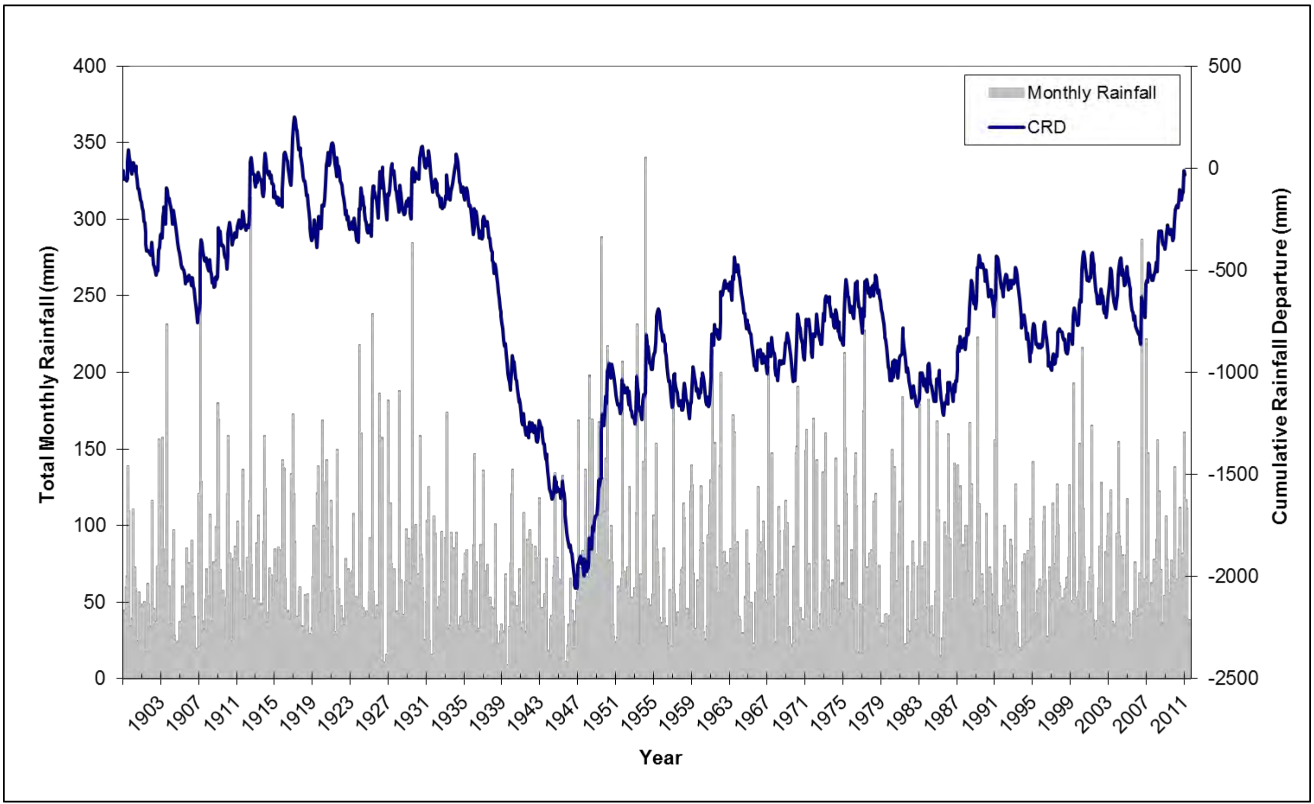


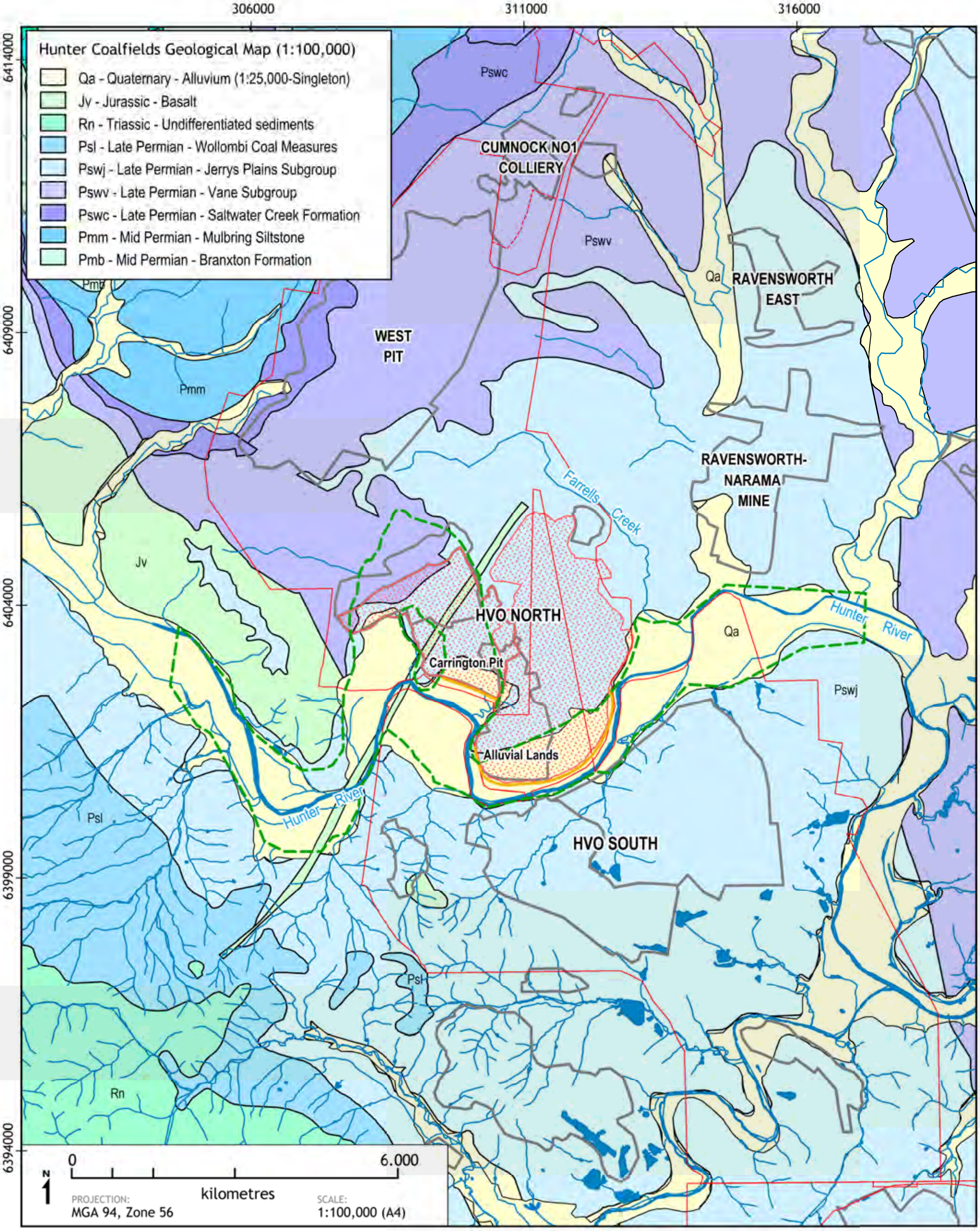
Figure 5.3: Cumulative Rainfall Departure Graph – Jerrys Plains Post Office (Station 061086)

5.6 Geology

5.6.1 Basin Geology

The project area falls under the Hunter Valley Coalfields, which form part of the Sydney Basin. The Sydney Basin is approximately 350 km long and 100 km wide, and is comprised of Permian and Triassic sedimentary units that have undergone multiple phases of deformation and faulting. The geology of the project area is dominated by the Muswellbrook Anticline to the west, and the Bayswater Syncline to the east. Both fold structures trend in a north to north-west direction, with the Bayswater Syncline truncated by the Antienne Thrust Fault located north of Lake Liddell.

Figure 5.4 shows the 1:100,000 scale regional geological map published by Department of Mineral Resources (Glen & Beckett, 1993). The Quaternary Alluvium in Figure 5.4 has been digitised based on 1:25,000 Geology Maps of Singleton (McIlveen, 1984), Muswellbrook (Summerhayes, 1983), Jerrys Plains (Sniffin & Summerhayes, 1987) and Doyles Creek (Sniffin *et al*, 1988).



LEGEND:

- HVO Development Consent Boundary
- Proposed Boundary Extension
- Mine Area
- Spoil
- Barrier Wall
- Palaeochannel Extent
- Drainage Line / Creek

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Regional Geology

DATE: 5/6/2013

FIGURE No: **5.4**

5.6.2 Stratigraphy

The stratigraphic sequence within the project area comprises of unconsolidated Quaternary Alluvium, palaeochannel alluvium and Permian bedrock sediments (Figure 5.5). The Quaternary Alluvium overlies both the palaeochannel and Permian sediments and consists of clay, silt and sand. The palaeochannel deposits are contained within an ancient river meander that intersects the Permian sediments north of the Hunter River (Figure 5.6). The palaeochannel alluvial sediments consist of silt, sand and gravel. The Permian sediments comprise coal seams with interbedded sequences consisting of sandstone, siltstone, tuffaceous mudstone, and conglomerate.

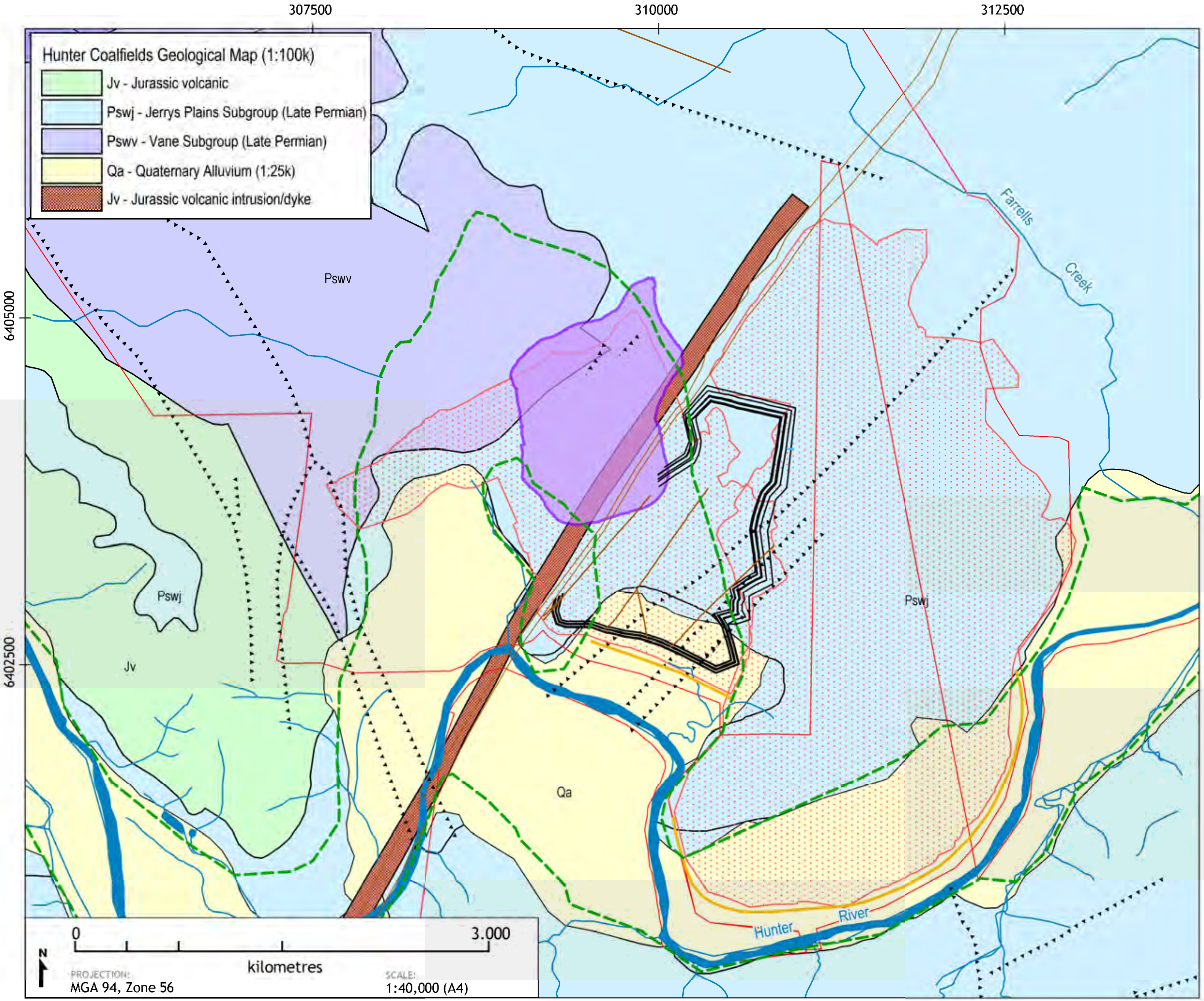
The main economic sequence targeted at Carrington Pit is the Permian Jerrys Plains Subgroup (Burnamwood Formation) of the Wittingham Coal Measures, which is underlain by the Archerfield Sandstone and the Vane Subgroup. Old workings near Carrington Pit, which have since been infilled with spoil, targeted the Burnamwood Formation and extended to the base of the Vaux Coal Seam. The current workings at Carrington Pit target the Broonie and basal Bayswater Coal Seams. The base of the Bayswater Coal Seam occurs from approximately 50 mAHD to the north, to -10 mAHD to the south near the Hunter River.

<table>
<tr><td rowspan="29">SINGLETON SUPER GROUP</td><td rowspan="29">WITTINGHAM COAL MEASURES</td><td colspan="3">DENMAN FORMATION</td></tr>
<tr><td rowspan="19">JERRYS PLAINS SUBGROUP</td><td>MOUNT LEONARD FORMATION</td><td>WHYBROW SEAM</td></tr>
<tr><td colspan="2">ALTHORP FORMATION</td></tr>
<tr><td rowspan="4">MALABAR FORMATION</td><td>REDBANK CREEK SEAM</td></tr>
<tr><td>WAMBO SEAM</td></tr>
<tr><td>WHYNOT SEAM</td></tr>
<tr><td>BLAKEFIELD SEAM</td></tr>
<tr><td colspan="2">SAXONVALE MBR</td></tr>
<tr><td rowspan="2">MOUNT OGILVIE FORMATION</td><td>GLEN MUNRO SEAM</td></tr>
<tr><td>WOODLANDS HILL SEAM</td></tr>
<tr><td colspan="2">MILBRODALE FORMATION</td></tr>
<tr><td rowspan="3">MOUNT THORLEY FORMATION</td><td>ARROWFIELD SEAM</td></tr>
<tr><td>BOWFIELD SEAM</td></tr>
<tr><td>WARKWORTH SEAM</td></tr>
<tr><td colspan="2">FAIRFORD FORMATION</td></tr>
<tr><td rowspan="5">BURNAMWOOD FORMATION</td><td>MOUNT ARTHUR SEAM</td></tr>
<tr><td>PIERCEFIELD SEAM</td></tr>
<tr><td>VAUX SEAM</td></tr>
<tr><td>BROONIE SEAM</td></tr>
<tr><td>BAYSWATER SEAM inc. RAVENSWORTH</td></tr>
<tr><td colspan="3">ARCHERFIELD SANDSTONE</td></tr>
<tr><td rowspan="7">VANE SUBGROUP</td><td colspan="2">BULGA FORMATION</td></tr>
<tr><td rowspan="6">FOYBROOK FORMATION</td><td>LEMINGTON - WYNN SEAM</td></tr>
<tr><td>PIKES GULLY - BENGALLA SEAM</td></tr>
<tr><td>ARTIES - EDENGLASSIE SEAM</td></tr>
<tr><td>LIDDELL – RAMROD COOK SEAM</td></tr>
<tr><td>BARRET SEAM</td></tr>
<tr><td>HEBDEN SEAM</td></tr>
<tr><td colspan="3">SALTWATER CREEK FORMATION</td></tr>
</table>

Figure 5.5: Generalised Stratigraphic Table

5.6.3 Structural Geology

The Permian coal measures are stratified (layered) sequences that dip towards the south-west. Several faults and dykes intersect the Permian strata, including a significant north-east trending fault zone east of Carrington Pit, a north-east trending dyke through Carrington Pit, and a southerly trending fault zone on the western side of the palaeochannel (Figure 5.6).



HVO North Modification
Fine Reject Emplacement
Groundwater Assessment (G1591B)

Local Site Geology

DATE:
5/6/2013

FIGURE No:
5.6

6 FIELD INVESTIGATION PROGRAM

6.1 Groundwater Monitoring Network

The existing groundwater monitoring network within the Carrington Pit area is comprised of 64 monitoring bores. The majority of bores are constructed with 50 mm nominal diameter (ND) PVC with slotted screen intervals; however, bore diameters do range from 25 mm ND to 400 mm ND. Figure 6.1 shows that most of the bores are located along the Hunter River and at the southern end of the palaeochannel.

A summary of the target lithology for the monitoring bores is summarised in Table 4.

Table 4: TARGET LITHOLOGIES OF THE EXISTING MONITORING BORE NETWORK

Target Lithology	Number of Bores
Palaeochannel	29
Hunter River Alluvium	8
Overburden	2
Broonie Coal Seam	4
Bayswater Coal Seam	5
North Void Spoil	16

Over the 2011 monitoring period, groundwater levels in only 53 of the 64 monitoring bores were monitored, due to blockages or damage to bores. Monitoring bore groundwater levels are generally measured quarterly, and groundwater quality is tested annually for palaeochannel alluvial bores. Appendix A details the bore construction details for the existing groundwater monitoring network at the Carrington Pit.

As part of this proposed modification, several new groundwater monitoring bores and vibrating wire piezometers (VWPs) were constructed. The bores targeted spoil material, alluvial and palaeochannel sediments and Permian strata with the intention to establish baseline groundwater conditions surrounding the fine reject emplacement. In particular, a number of these monitoring bores (GW_106, GW_107 and GW_108) were installed around the perimeter of the proposed fine reject emplacement footprint. The locations of all monitoring bores are shown in Figure 6.1, with the construction details and hydrogeological data summarised in Table 5 and Table 6 respectively.

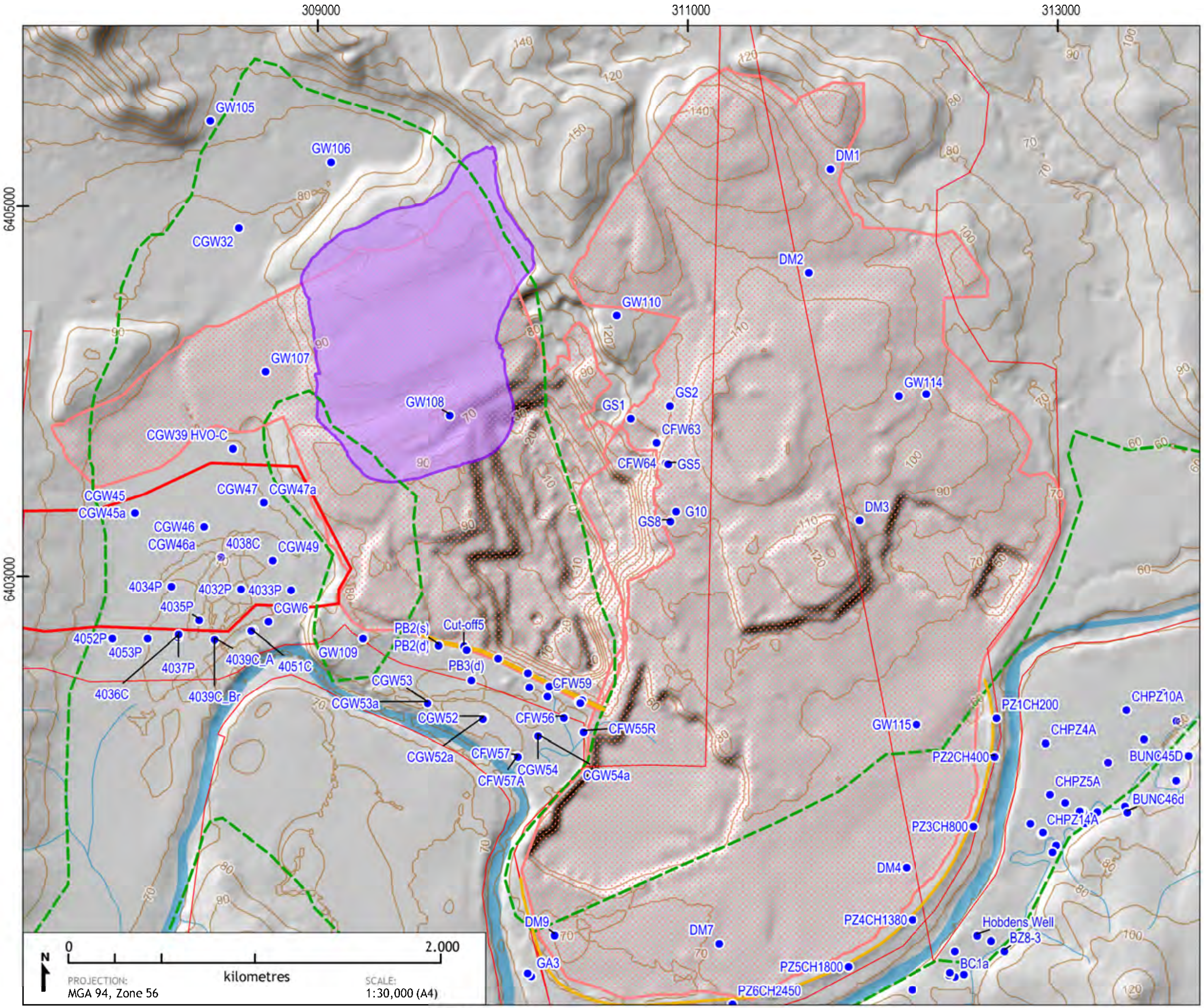
Table 5: RECENTLY DRILLED MONITORING BORES - CONSTRUCTION DETAILS

Bore ID	Easting (m)	Northing (m)	Elevation (mAHD)	Hole Depth (mbGL)	Screened Interval (mbGL)	VWP Sensor Depth (mbgl)			Screened Lithology
						1	2	3	
GW_103	306,770	6,404,605	108	126	N/A	25.5	64.5	119.5	Barrett
GW_105	308,445	6,405,445	99	168	N/A	33	103.5	154	Barrett
GW_106	309,090	6,405,225	84	30	24 – 27	N/A	N/A	N/A	Quaternary Alluvium
GW_107	308,740	6,404,105	73	30	24 – 27	N/A	N/A	N/A	Spoil

Table 5: RECENTLY DRILLED MONITORING BORES - CONSTRUCTION DETAILS									
Bore ID	Easting (m)	Northing (m)	Elevation (mAHD)	Hole Depth (mbGL)	Screened Interval (mbGL)	VWP Sensor Depth (mbgl)			Screened Lithology
						1	2	3	
GW_108	309,725	6,403,870	89	61.5	52.5 – 58.5	N/A	N/A	N/A	Spoil
GW_109	309,260	6,402,680	79	96	N/A	TBA	TBA	TBA	Bayswater
GW_110	310,615	6,404,405	115	102	N/A	38	63	93	Bayswater
GW_114	312,120	6,403,975	108	33	27 – 30	N/A	N/A	N/A	Spoil
GW_114a	312,268	6,403,985	108	120	111 - 114	N/A	N/A	N/A	Bayswater
GW_115	312,215	6,402,220	68	30	22.2 – 28.2	N/A	N/A	N/A	Spoil

Notes: mbGL – metres below ground level
maGL – metres above ground level
Coordinate Projection – MGA94, Zone 56
TBA – to be advised

Table 6: RECENTLY DRILLED MONITORING BORES - GROUNDWATER LEVELS							
Bore ID	Elevation (mAHD)	Total Depth (mbGL)	Screen Interval (mbGL)	SWL (mbGL)	SWL (mAHD)	Hydraulic Conductivity (m/day)	Screened Lithology
GW_103	108	126	N/A	N/A	N/A	N/A	Barrett
GW_105	99	168	N/A	N/A	N/A	N/A	Barrett
GW_106	84	30	24 – 27	22.86	~61.1	1.6 – 3.0	Quaternary Alluvium
GW_107	73	30	24 – 27	dry	dry	TBA	Spoil
GW_108	89	61.5	52.5 – 58.5	dry	dry	TBA	Spoil
GW_109	79	96	N/A	N/A	N/A	N/A	Bayswater
GW_110	115	102	N/A	N/A	N/A	1.45×10^{-1}	Bayswater
GW_114	108	33	27 – 30	27.04	~81	0.671	Spoil
GW_114a	108	120	111 - 114	88.07	~19.9	0.145	Bayswater
GW_115	68	30	22.2 – 28.2	TBA	TBA	TBA	Spoil



LEGEND:

- Monitoring Bore
- 10m Topographic Contours (HVO 2011- mRL)
- HVO Development Consent Boundary
- Fine Reject Emplacement
- Previously Mined Area
- CWW
- Palaeochannel Extent
- Barrier Wall

HVO North Modification
Fine Reject Emplacement
Groundwater Assessment (G1591B)

Monitoring Bore Locations

DATE:
5/6/2013

FIGURE No:
6.1

6.2 Groundwater Monitoring

Groundwater level data has been collected for the Carrington Pit area since 2001, with data-loggers installed from 2009. The long-term hydrographs are included in Appendix B.

The groundwater level and quality data for each recognised groundwater system is discussed in detail in Section 7 below.

7 HYDROGEOLOGICAL REGIME

The hydrogeological setting of the project area comprises of the following three main groundwater systems:

- the Quaternary Alluvium along the Hunter River;
- the palaeochannel; and
- the Permian formations.

The project area also includes several mined out areas that have been in-filled with spoil. The hydrogeological characteristics of the alluvial, palaeochannel and Permian formations, as well as the spoil pits, are detailed in Section 7.1 to Section 7.3 below.

7.1 Alluvium and Palaeochannel

7.1.1 Distribution

The extent of the Quaternary Alluvium is shown in Figure 5.6. The alluvium is broadly categorised into the sediments associated with the Hunter River and the sediments associated with a palaeochannel that extends north from the Hunter River into the Carrington Pit area.

The palaeochannel alluvium is located north of the Hunter River and extends into the vicinity of the existing Carrington Pit (Figure 7.1). The depositional environment of the palaeochannel was dominated by flood surge events, resulting in deposition of gravels contiguously with silts and clays.

The fine reject emplacement will be located on an area that has been mined and filled with spoil. Prior to mining, the topmost 10 m to 20 m of the subject area was part of a former meander of the Hunter River, known as a palaeochannel. A remnant of palaeochannel alluvium remains to the north of the backfilled Carrington Pit which is effectively isolated from the remainder of the palaeochannel alluvium to the south. The spoil that has been used to backfill the Carrington Pit hydraulically connects the dissected alluvium to the north and the in-situ alluvium to the south.

7.1.2 Hydraulic Parameters

Several studies undertaken by MER (2003, 2005 and 2010a) have found that the hydraulic conductivity of the alluvium is high, ranging from 1 m/day to 100 m/day, with higher values observed along the western limb of the palaeochannel arm (Figure 7.2).

7.1.3 Regional and Local Recharge, Discharge and Groundwater Flow

Hunter River Alluvium

The groundwater levels in the Hunter River alluvium are approximately 56 mAHD to 61 mAHD flowing west to east, and are of a similar level to that observed in the Hunter River. The groundwater levels in the palaeochannel alluvium are approximately 60 mAHD to 63 mAHD and flows from the north and west to the south-east, toward the existing Carrington Pit. Figure 7.1 shows the groundwater level contours and observed groundwater heads in the alluvium and palaeochannel alluvium.

The groundwater levels in the underlying Permian strata are influenced by depressurisation, resulting from mining of the Carrington Pit. The hydrologic conditions within the Permian groundwater systems are discussed in greater detail in Section 7.2.1. Certain areas of the Permian strata exhibit lower groundwater levels than the alluvium, whilst other areas show groundwater levels that are of equal or greater elevation than the alluvium. However, in general, there is currently a downward vertical gradient from the alluvial groundwater system to the Permian formations.

The profile of the Hunter River alluvium is predominantly sandy and recharge to the Hunter River alluvium is expected to be dominated by direct rainfall infiltration. Localised recharge to the alluvium also occurs via lateral seepage through the banks of the Hunter River, during periods of high flows. The Hunter River is expected to receive a baseflow component of flow from the Quaternary Alluvium during periods of low rainfall. Groundwater flow in the alluvium is from west to east across the project area, following the Hunter River drainage system. In general, the Hunter River is assessed to be a discharge mechanism for the regional groundwater systems.

Palaeochannel – Western Limb

Prior to mining, groundwater flow within the alluvium deviated north from the Hunter River into the western limb of the palaeochannel. This groundwater then flowed back toward the Hunter River, along the eastern limb of the palaeochannel. Mining has subsequently changed the pattern of groundwater flow within the palaeochannel, and has involved the backfilling of the Carrington Pit with spoil material.

The hydrographs for monitoring bores located on the western limb of the palaeochannel (within 200 m of the Hunter River) appear to correlate to monthly changes in stream flow elevations (Appendix B). During 2011, alluvial groundwater levels were below the Hunter River elevations for most of the year, indicating potential recharge of the alluvium from the Hunter River. However, during March and June 2011, the level in the Hunter River declined to or below groundwater levels, indicating a period where alluvial groundwater may have discharged into the Hunter River. Groundwater levels for bore 4040P (Figure 6.1) appear to be the most responsive to changes in surface water flow, likely related to the proximity to the Hunter River and potentially high connectivity to the river.

Monitoring has shown that the palaeochannel alluvium has a very low rate of recharge during periods of low to moderate rainfall, due to the presence of the impermeable clays that act as an aquitard (MER, 2010a). However, higher rates of leakage have been documented within the sandy gravels of the basal layer (MER, 2010a). Within 200 m of the Hunter River, the palaeochannel shows evidence of localised recharge / discharge directly to and from the Hunter River. However at a greater distance from the Hunter River (>200 m), the palaeochannel is believed to be recharged by upward seepage from the underlying coal measures, which explains the higher salinity that is observed in the majority of palaeochannel sediments.

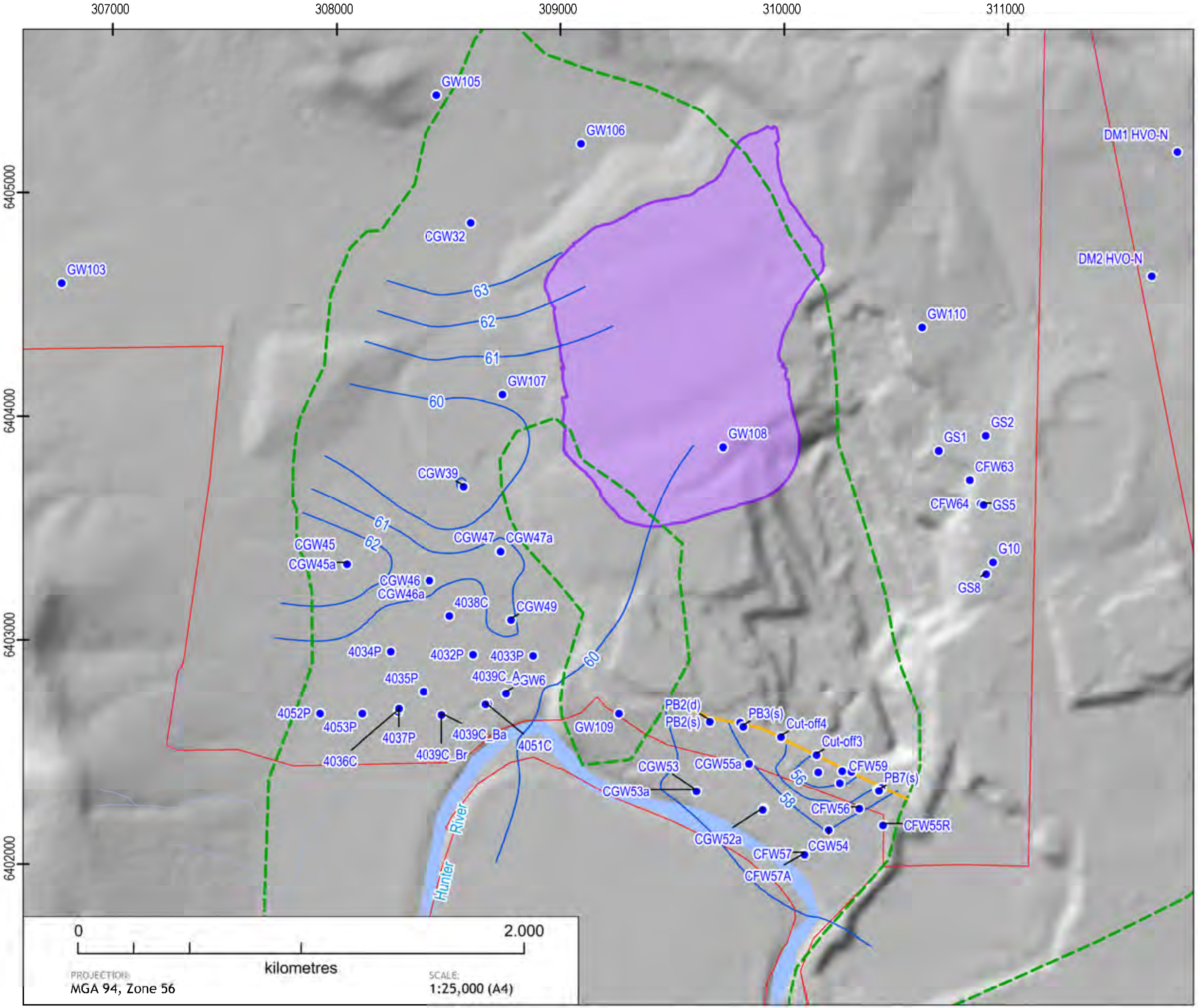
In the vicinity of the Carrington Pit, localised downward leakage occurs from the palaeochannel alluvium to the Permian formations and spoil.

Palaeochannel – Eastern Limb

In March 2010, a barrier wall was constructed across the eastern limb of the palaeochannel, approximately 450 m north of the Hunter River. Nine monitoring bores are located within the palaeochannel alluvium, between the Hunter River and barrier wall. The hydrographs for bores located within 250 m of the Hunter River record a gradual rise in groundwater levels over 2011. The hydrographs also appear to correlate with monthly changes in stream flow elevations and rainfall. Alluvial groundwater levels were generally recorded at or just below Hunter River levels (WLP12), indicating potential recharge of the alluvium from the Hunter River.

Groundwater levels within bores located over 250 m north of the Hunter River, and within 150 m of the barrier wall, were generally well below Hunter River levels of around 59 mAHD to 60 mAHD (WLP12). This indicates that the alluvial groundwater is likely to be recharged from the Hunter River. CFW55R and CFW55A, located north and west of the Carrington Billabong respectively, recorded relatively stable to slightly rising groundwater levels over 2011 of up to 58.4 mAHD (CFW55A) and 58.8 mAHD (CFW55R). This corresponds with predicted recovery of groundwater levels at the Billabong area of around 58.7 mAHD, following construction of the barrier wall (MER, 2010b).

Monitoring bore GW_106 was drilled into the palaeochannel alluvium immediately north of the fine reject emplacement footprint. This bore encountered 27 m of alluvial sediments. The groundwater level in the monitoring bore was measured at approximately 61 mAHD with a hydraulic conductivity value measured between 1 m/day to 3 m/day. The laboratory measured EC of the groundwater at GW_106 was reported at 10,900 µS/cm.



LEGEND:

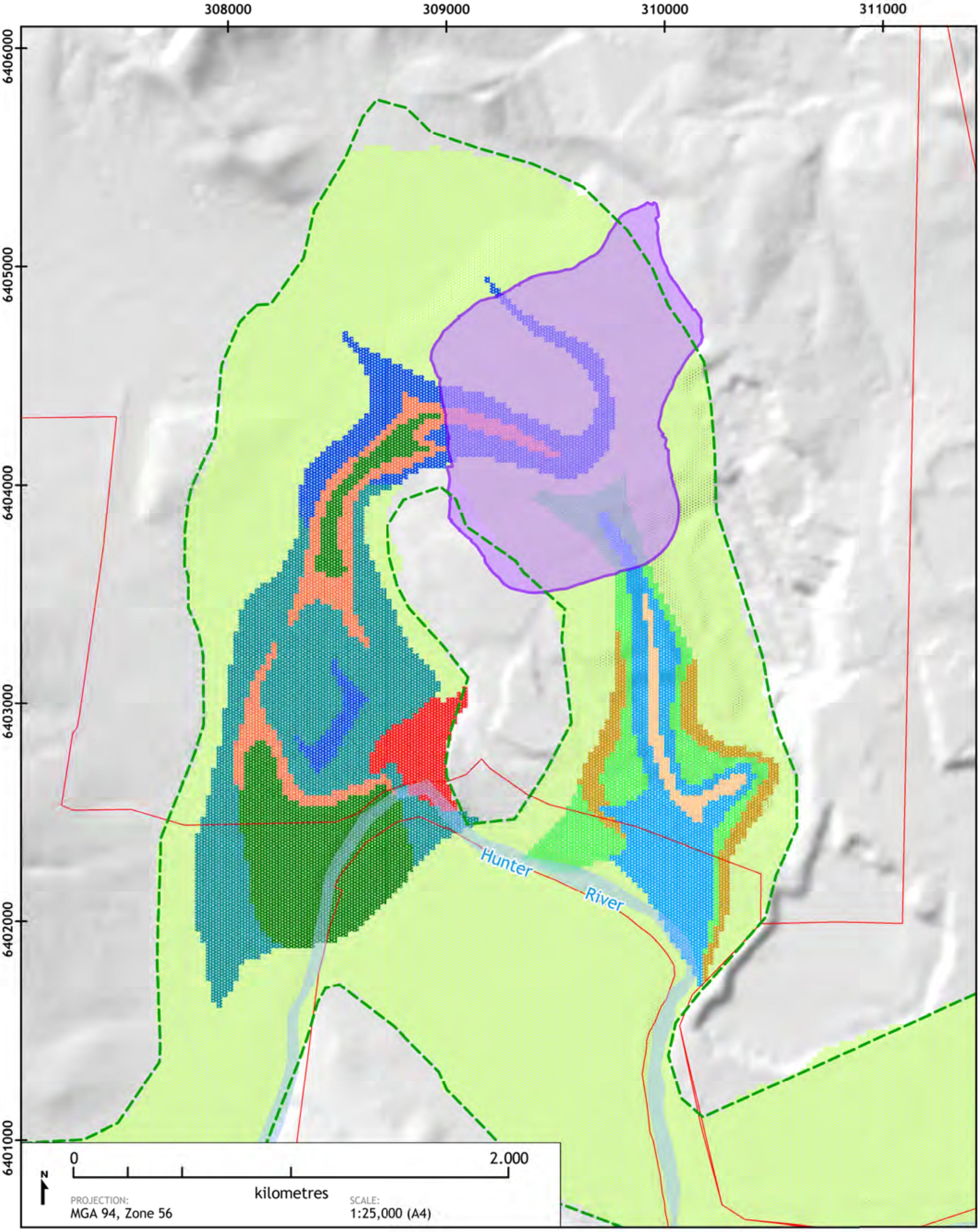
- Monitoring Bore
- 1m Groundwater Level Contours (mAHD)
- Barrier Wall
- Palaeochannel Extent
- HVO Development Consent Boundary
- Fine Reject Emplacement

HVO North Modification -
Fine Reject Emplacement
Groundwater Assessment (G1591B)

Observed Groundwater Levels in the Palaeochannel

DATE:
5/6/2013

FIGURE No:
7.1



LEGEND:

Permeability (m/day)

1	15
5	25
6	30
7	50
12	80

Fine Reject Emplacement

HVO Development Consent Boundary

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Pre-mining Palaeochannel Permeability Distribution (after MER, 2010b)

DATE: 5/6/2013

FIGURE No: **7.2**

7.2 Coal Seams

7.2.1 Distribution

The Permian formations occur as a regular layered south-westerly dipping sedimentary sequence, which can be categorised into the following hydrogeological units:

- hydrogeologically "tight" and hence very low yielding to essentially dry sandstone, siltstone and conglomerate that comprise the majority of the Permian interburden/overburden;
- low to moderately permeable coal seams, typically ranging in thickness from 2.5 m to 10 m, which are the prime water bearing strata within the Permian sequence.

The coal seams are generally separated from the alluvium by a weathered zone/interburden; however, Groundsearch Australia (2008) found the seams sub-crop beneath the alluvium in several areas near northern portions of HVO South.

7.2.2 Hydraulic Parameters

The hydraulic conductivity of the low yielding interburden/overburden has been recorded between 1×10^{-4} m/day and 1×10^{-5} m/day (Rust PPK, 1997, MER, 2005 and MER, 2010a). The low to moderately permeable coal seams have recorded horizontal hydraulic conductivity (K_{xy}) values of between 4×10^{-3} m/day and 5×10^{-1} m/day (Rust PPK, 1997 and MER, 2005). MER (2010a) summarised the indicative range of hydraulic parameters for the Permian strata and these are reproduced below in Table 7.

Table 7: INDICATIVE RANGE OF PERMIAN HYDRAULIC PARAMETERS

Lithology	Kxy Range (m/day)	Bulk Porosity (%)	Effective Porosity (%)
Permian Sandstones	$5 \times 10^{-6} – 5 \times 10^{-4}$	1 - 18	0.01 - 5
Permian Siltstones	$5 \times 10^{-7} – 1 \times 10^{-4}$	1 - 15	0.01 - 1
Permian Claystones and shales	$5 \times 10^{-8} – 1.3 \times 10^{-6}$	1 - 15	0.01 - 0.1
Coal seams - dull	$1 \times 10^{-4} – 1 \times 10^{-1}$	0.1 - 2	0.1 - 2
Coal seams – dull and bright	$1 \times 10^{-3} – 1 \times 10^{-1}$	0.1 - 3	0.1 - 3

7.2.3 Regional and Local Recharge, Discharge and Groundwater Flow

Long-term hydrographs for bores screened within the Permian coal measures are shown in Appendix B.

Figure 7.3 shows the groundwater level contours for the Permian strata. It is evident from the contours that the Carrington Pit has depressurised the surrounding Permian formations up to a distance of at least 1 km from the active pit. This depressurisation has occurred as a result of seepage to the open cut pit.

Hydrographs for the Permian monitoring bores located south of Carrington Pit, on the eastern limb of the palaeochannel, show a decline in groundwater levels over 2011. This reflects the depressurisation of the Permian coal measures from mining within the southernmost section of Carrington Pit.

Hydrographs for Permian bores (standpipe piezometers and vibrating wire piezometers) located on the western limb of the palaeochannel indicate that groundwater levels within the coal seams began to recover in 2010. The recovery of the coal seams reflects the progression of the mine further to the east, with backfilling of the void with spoil.

Locally the Permian coal seams are expected to be recharged where they subcrop; however, the amount of geological disturbance of the landscape from mining will have temporarily impacted the recharge mechanisms and flow patterns of the coal seams. Locally, the Quaternary Alluvium has a downward vertical gradient to the Permian strata, which has been induced by depressurisation. Pre-mining, upward vertical hydraulic gradients were reported from the Permian strata into the alluvium. This still occurs in the remnant section of the palaeochannel alluvium and this discharge mechanism explains the groundwater quality that is observed in this area of the alluvium.

7.3 Spoil

7.3.1 Distribution

The historical Carrington Pit and North Void are previously mined areas that extend across the project area (Figure 7.4) and are currently backfilled with spoil. This spoil comprises a mix of Permian interburden and overburden material that is generated as waste in the open cut coal mining process. This waste material is typically backfilled into the disused portion of an active pit.

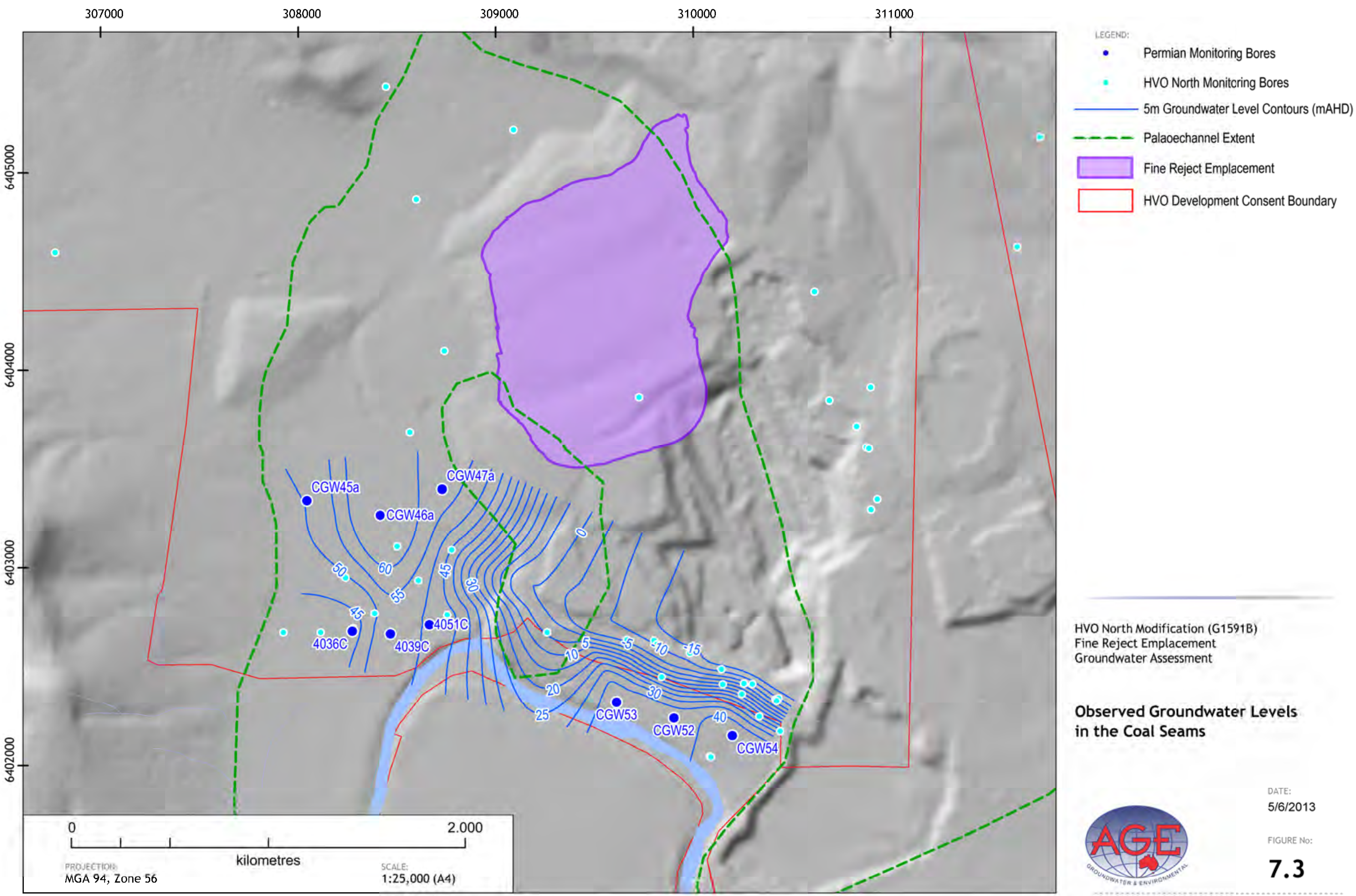
7.3.2 Hydraulic Parameters

Mackie (2009) recorded the hydraulic conductivity of spoil material within the Upper Hunter Valley, between 1 m/day and 10 m/day, with a drainable porosity of 20%. Recent drilling and testing carried out by AGE indicates that the spoil within the Carrington Pit has a hydraulic conductivity of 1 m/day to 3 m/day.

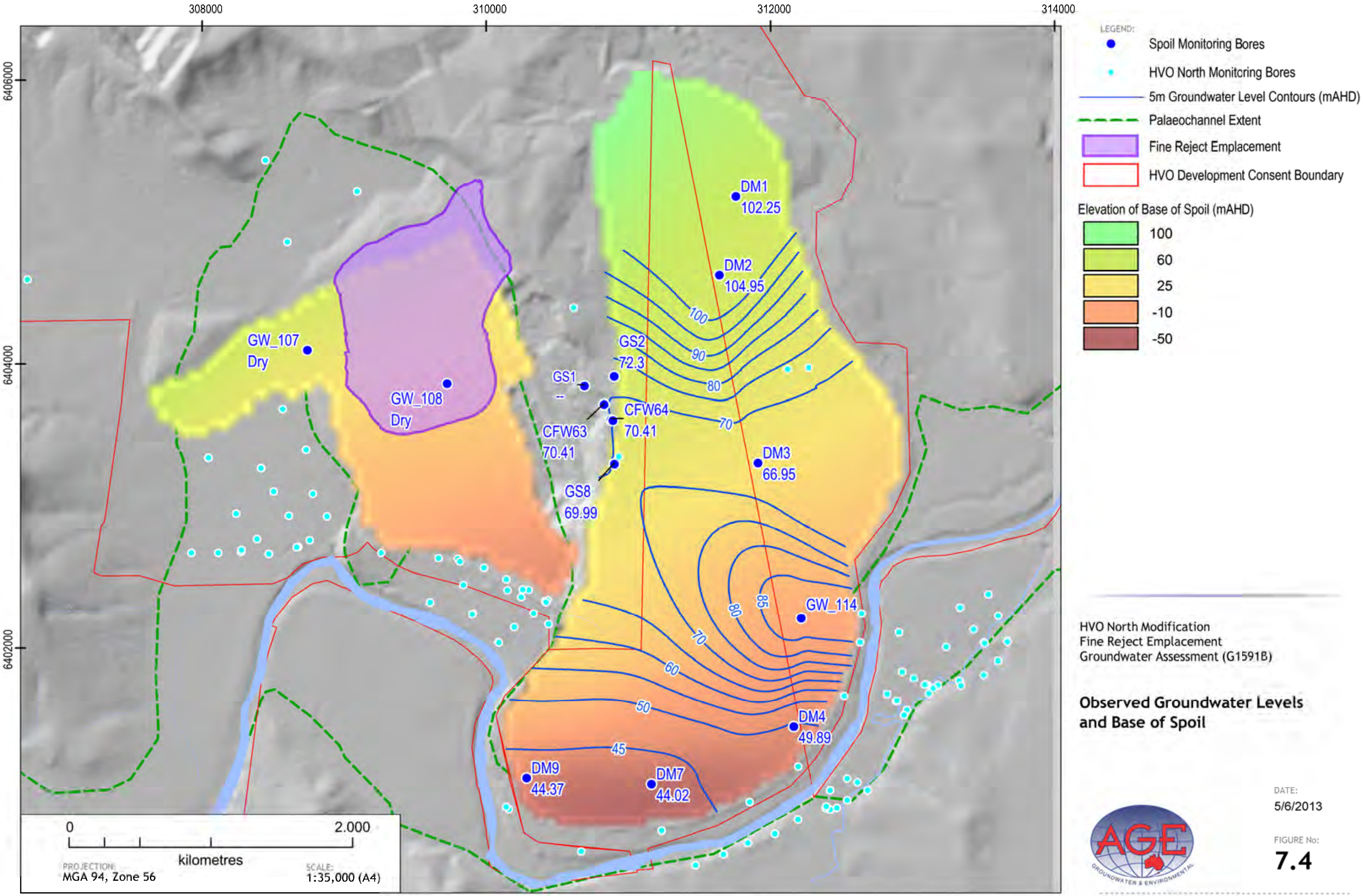
7.3.3 Regional and Local Recharge, Discharge and Groundwater Flow

Groundwater levels within the spoil ranges between 50 m and 59 mAHD within the North Void. Current water volumes stored within the North Void have been estimated at 16,250 ML, with an estimated total water storage capacity of 19,500 ML (Water Solutions, 2010). Recent drilling by AGE in the spoil of Carrington Pit GW_107 and GW_108 has identified that the material is effectively dry. This suggests that drainage of this material is occurring, likely to be towards the active Carrington Pit workings.

The rate of recharge from rainfall within the North Void spoil has been recorded at 7 mm/hr to 9 mm/hr, with rates declining as the soil moisture front wetted up (Mackie, 2009). Recharge modelling undertaken by Mackie (2009) indicated that long-term recharge could equate between 1% and 5.5% of annual rainfall percolated into spoil (deep recharge), assuming a maximum infiltration capacity of 10 mm/hr.



307000
308000
309000
310000
311000
6405000
6404000
6403000
6402000
LEGEND:
Permian Monitoring Bores
HVO North Monitoring Bores
5m Groundwater Level Contours (mAHD)
Palaeochannel Extent
Fine Reject Emplacement
HVO Development Consent Boundary
CGW45a
CGW46a
CGW47a
4036C
4039C
4051C
CGW53
CGW52
CGW54
0
2.000
kilometres
PROJECTION:
MGA 94, Zone 56
SCALE:
1:25,000 (A4)
HVO North Modification (G1591B)
Fine Reject Emplacement
Groundwater Assessment
Observed Groundwater Levels
in the Coal Seams
DATE:
5/6/2013
FIGURE No:
7.3



HVO North Modification
Fine Reject Emplacement
Groundwater Assessment (G1591B)

Observed Groundwater Levels and Base of Spoil

DATE: 5/6/2013

FIGURE No: **7.4**

8 GROUNDWATER USE

8.1 Groundwater Users

A search of the NOW database of registered bores (Pinneena) found that there are 192 registered bores within 10 km of the project area. The registered bores include approximately 77 mine bores, 66 stock and irrigation bores, 14 NOW monitoring bores, three industrial bores, and one bore used for town water supply (GW059178). The closest privately owned bores are located approximately 2.5 km south of Carrington Pit, and the bores are potentially constructed within the Hunter River alluvium (recorded depths of 9 m to 25.5 m) and are used for domestic, stock and irrigation purposes.

8.2 Groundwater Quality

Water quality samples were collected twice over the 2011 monitoring period at several alluvial bores. These results for the alluvial bores, as well as results for the North Void spoil bores and the recently drilled monitoring bores, are detailed in Figure 8.1 as a Cl/SO_4 scatterplot. The full chemical analyses are summarised in Appendix C.

The Cl/SO_4 scatterplot allows for the different groundwater systems to be differentiated in terms of their anion ratios. The groundwater within the palaeochannel alluvium exhibits the lowest salinity, with chloride concentrations of around 500 mg/L and sulphate concentrations of approximately 100 mg/L. The Hunter River has chloride and sulphate concentrations reported at 241 mg/L and 45 mg/L, respectively. The water quality of the palaeochannel alluvium located close to the Hunter River is comparable to these concentrations. Whilst there are limited Permian groundwater analyses available for assessment, the results available show a typical chloride concentration of 4,000 mg/L to 5,000 mg/L, with sulphate concentrations of 500 mg/L to 1,000 mg/L. Analyses from monitoring bores within the northern most portion of the palaeochannel alluvium plot within the Permian Cl/SO_4 grouping. This demonstrates that the original palaeochannel alluvium contained groundwater of similar composition to Permian groundwater.

The groundwater analyses from monitoring bores constructed within the spoil show an increased ratio of sulphate concentration compared to chloride concentrations. The spoil bores show typical chloride concentrations of 300 mg/L to 5,000 mg/L with sulphate concentrations of 500 mg/L to 3,000 mg/L.

Water analyses of representative fine reject seepage cannot be compared to groundwater in this method, as chloride is not routinely measured for existing tailings dam 29N (DM6). However, Table 8 shows that DM6 has a sulphate concentration of 850 mg/L that is consistent with the concentrations observed in the North Void spoil and Carrington Pit spoil.

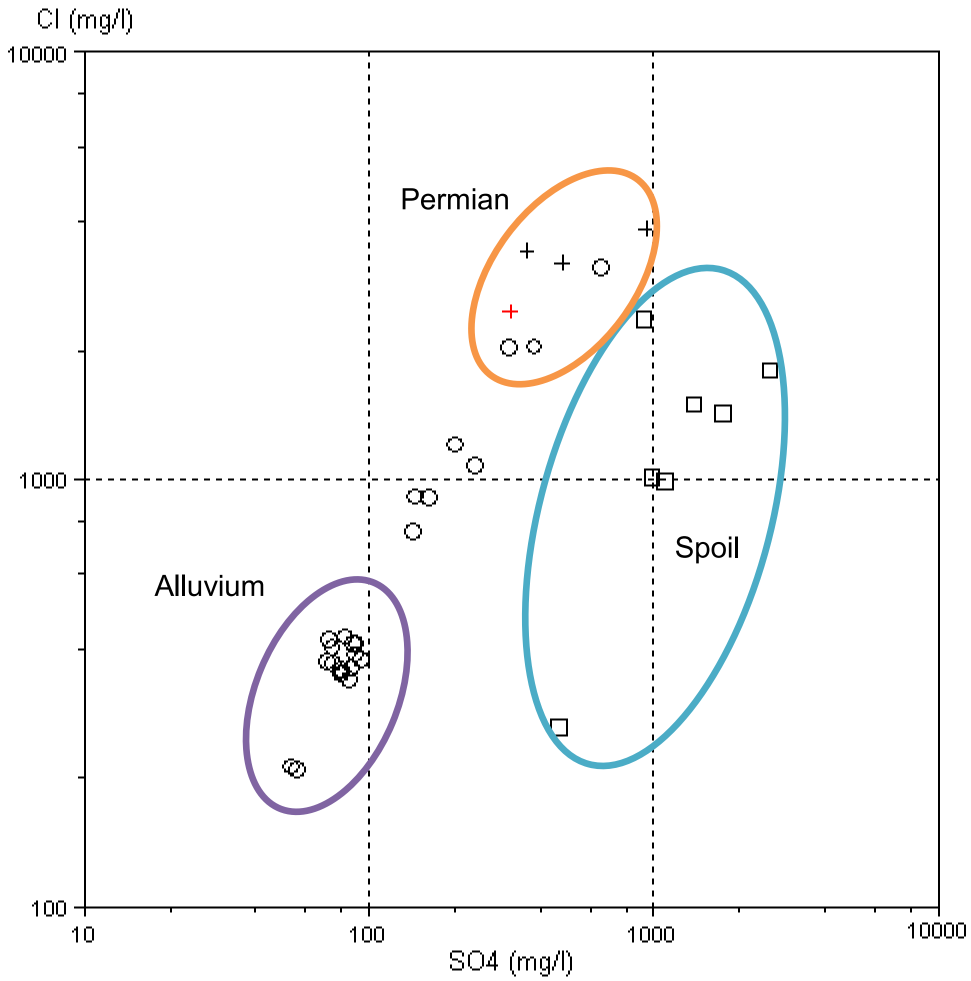


Figure 8.1: Cl/SO$_4$ Scatter Plot of Groundwater Quality Results

Table 8 summarises the water quality for the main groundwater systems, the Hunter River and fine reject leachate. The water quality results indicate that the Hunter River and alluvium have the lowest electrical conductivity (EC of 200 µS/cm to 4,000 µS/cm), while the palaeochannel, coal measures and spoil all exhibit brackish to saline water quality. Tailings Dam 29N leachate is also slightly brackish to moderately saline, with a high concentration of sodium and sulphate.

Table 8: WATER QUALITY DATA													
Analyte	**Units**	**LOR**	**GW114**	**GW114**	**GW106**	**GW115**	**04BH**	**(WLP3)**	**Alluvium†**	**Palaeo-channel‡**	**Permian Coal Measures***	**Spoil****	**Dam 29N/ DM6**
Lithology			Coal	Spoil	Alluvium	Spoil	Coal	Hunter River (surface water)	Alluvium	Palaeo-channel	Permian Coal Measures	Spoil	Fine Reject
pH Value	pH Unit	0.01	7.34	7.56	7.29	7.84	7.5	-	6.3 - 8.1	6.9 - 7.6	7.3 - 7.6	6.9-8.7	8.6-8.9
Electrical Conductivity @ 25°C	µS/cm	1	12,300	8,240	10,900	5,580	8,130	1,420	200 – 4,000	1,700-11,400	3,000 - 8,000	2,000-7,500	1,000 – 6,000
Total Dissolved Solids @180°C	mg/L	10	6,830	5,230	5,940	3,640	4,680	-	-	-	-	-	-
Suspended Solids (SS)	mg/L	5	32	624	139	77	107	-	-	-	-	-	-
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	-	-	-	-	-	-
Carbonate Alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	-	-	-	-	1,500	515
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	690	832	967	734	806	114	-	-	-	-	-
Total Alkalinity as $CaCO_3$	mg/L	1	690	832	967	734	806	-	-	-	-	600	483
Sulfate as SO_4 - Turbidimetric	mg/L	1	938	1,750	652	986	314	45	-	153	-	-	854
Chloride	mg/L	1	3,840	1,430	3,140	1,010	2,460	241	-	-	-	-	-
Calcium	mg/L	1	240	140	170	91	259	17	-	-	-	-	43
Magnesium	mg/L	1	559	403	393	164	294	24	-	80	-	-	99
Sodium	mg/L	1	1,700	1,240	1,470	1,090	1,190	174	-	234	-	-	1,240
Potassium	mg/L	1	40	48	237	29	11	-	-	3.2	-	-	27
Arsenic	mg/L	0.001	0.005	0.011	<0.001	0.006	0.005	-	-	0.01	-	-	0.007
Barium	mg/L	0.001	0.118	0.104	0.119	0.074	0.347	-	-	0.22	-	-	0.09
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-
Cadmium	mg/L	0.0001	<0.0001	0.0003	0.0002	0.0001	<0.0001	-	-	-	-	-	-

Table 8: WATER QUALITY DATA

Analyte	Units	LOR	GW114	GW114	GW106	GW115	04BH	(WLP3)	Alluvium†	Palaeo-channel‡	Permian Coal Measures*	Spoil**	Dam 29N/ DM6
Cobalt	mg/L	0.001	0.008	0.11	0.007	0.027	0.002	-	-	-	-	-	-
Chromium	mg/L	0.001	<0.001	0.008	<0.001	<0.001	<0.001						
Copper	mg/L	0.001	0.002	0.003	0.005	0.01	0.001	-	-	-	-	-	-
Manganese	mg/L	0.001	0.207	1.24	0.17	0.147	0.071	-	-	3.36	-	-	0.017
Nickel	mg/L	0.001	0.014	0.13	0.007	0.039	0.003	-	-	-	-	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-	-
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-
Zinc	mg/L	0.005	0.055	0.141	0.043	0.156	0.013	-	-	0.15	-	-	-
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	0.79	-	-	0.45	-	-	<0.05
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-	-	-	-
Aluminium	mg/L	-	-	-	-	-	-	0.17	-	35	-	-	0.1
Boron	mg/L	-	-	-	-	-	-	-	-	0.1	-	-	0.07
Selenium	mg/L	-	-	-	-	-	-	-	-	-	-	-	0.02
Total Anions	meq/L	0.01	142	93.4	121	63.7	92	-	-	-	-	-	-
Total Cations	meq/L	0.01	133	95.3	111	66.2	89.2	-	-	-	-	-	-
Ionic Balance	%	0.01	3.17	0.99	4.59	1.9	1.59	-	-	-	-	-	-

Notes: † Based on water quality data for PZ1CH200, PZ2CH400, PZ3CH800, PZ4CH138, PZ5CH180, PZ6CH245 and HV3

‡ Based on water quality data for 4053P, 4037P, 4035P, 4034P, 4032P, CGW51A, CFW59, CFW55R, CFW57 and CGW32.

* Based on water quality data for CGW46A,CGW47, CGW49 and CGW52.

** Based on water quality data for DM7 and DM9.

It is anticipated that the potential water seepage for the fine reject emplacement will exhibit a similar water quality to Dam 29N. Seepage loss from the fine reject emplacement into the palaeochannel, spoil and coal measures is not anticipated to drastically alter the water chemistry, as the salinity is already high in the receiving water sources. However, release of seepage water into the alluvium and surface water features could potentially result in an increased salinity and sulphate concentrations. ANZECC (2000) provide guidelines that indicate if EC exceeds 9,000 µS/cm the water would be unsuitable for most farming practices, and an EC in excess of 1,500 µS/cm could greatly impact on aquatic life within surface water features (i.e. Hunter River and Farrells Creek). While the ANZECC (2000) guidelines do not include sulphate, they do suggest that adverse effects to stock could be expected if the concentration of sulphate exceeds 1,000 mg/L.

The ANZECC trigger levels for EC are:

- Freshwater: 0 -1,500 µS/cm
- Poultry: < 3,000 µS/cm
- Cropping: < 5,000 µS/cm
- Horses: < 5,000 µS/cm
- Beef cattle: < 9,000 µS/cm

Water quality within the shallow Hunter River alluvium is relatively fresh, with EC levels of up to 1,500 µS/cm. However, the salinity levels within the alluvium appear to increase with depth and distance from the Hunter River, reaching up to 12,000 µS/cm north of Carrington Pit. This increased salinity is likely to be due to sustained upward leakage from the underlying Permian formations (MER, 2005). Water quality within the Permian formations is generally saline (3,000 µS/cm to 12,000 µS/cm) and unsuitable for domestic and stock use.

8.3 Groundwater Dependent Ecosystems

The project area was historically used for cropping and grazing, and mining has been active in the area since the 1950s. As a result of these land use practices, the site has been largely cleared of native vegetation, with only small fragments of remnant vegetation generally localised along the Hunter River and stony rises.

The Federal Government has established the National Atlas of GDEs (GDE Atlas), based on the current knowledge of GDEs across Australia. The atlas shows known GDEs and ecosystems that potentially use groundwater, and is considered the most comprehensive inventory of the location and characteristics of GDEs in Australia. The GDE Atlas, shown in Figure 9.1, indicates that no GDEs are mapped within the project area, but potential GDEs could be localised along the Hunter River and Parnells Creek.

Several environmental surveys have also been conducted across the project area (ERM 2005, Umwelt 2007 and Biosis Research 2010). According to the environmental reports, there are no known threatened aquatic fauna or flora within or near the project area. However, plant communities at risk include the River Red Gum (Carrington Billabong – Threatened Species) and Central Hunter Box communities (Endangered Ecological Community).

A known GDE, Carrington Billabong, is located south of Carrington Pit where the eastern limb of the palaeochannel meets the Hunter River. Known species within the Carrington Billabong area include the River Red Gum (*Eucalyptus camaldulensis*), which is an endangered species under the *Threatened Species Conservation Act 1995*. Water levels around the Billabong area range from 56.8 mAHD to 57.2 mAHD (MER, 2010b). A barrier wall has been constructed north of the Billabong area, to a height of 65 mAHD. Groundwater monitoring has demonstrated that construction of the barrier wall is effective in reducing the loss of alluvial groundwater to the Carrington Pit. As detailed in Section 7.1.3, the groundwater levels within the Billabong area appear to be returning back towards river levels, as predicted by MER (2010b).

The Central Hunter Box plant communities are largely located on the northern side of the project area, and comprise of Ironbark Woodland, Bulloak Forest, and Spotted Gum/Grey Box. The Central Hunter Box plant communities occur on regolith or alluvium overlying Permian lithology. This association may indicate a degree of dependence on groundwater, either via direct access into the Permian formations, or from recharge of groundwater within alluvium/regolith from the underlying Permian formations.

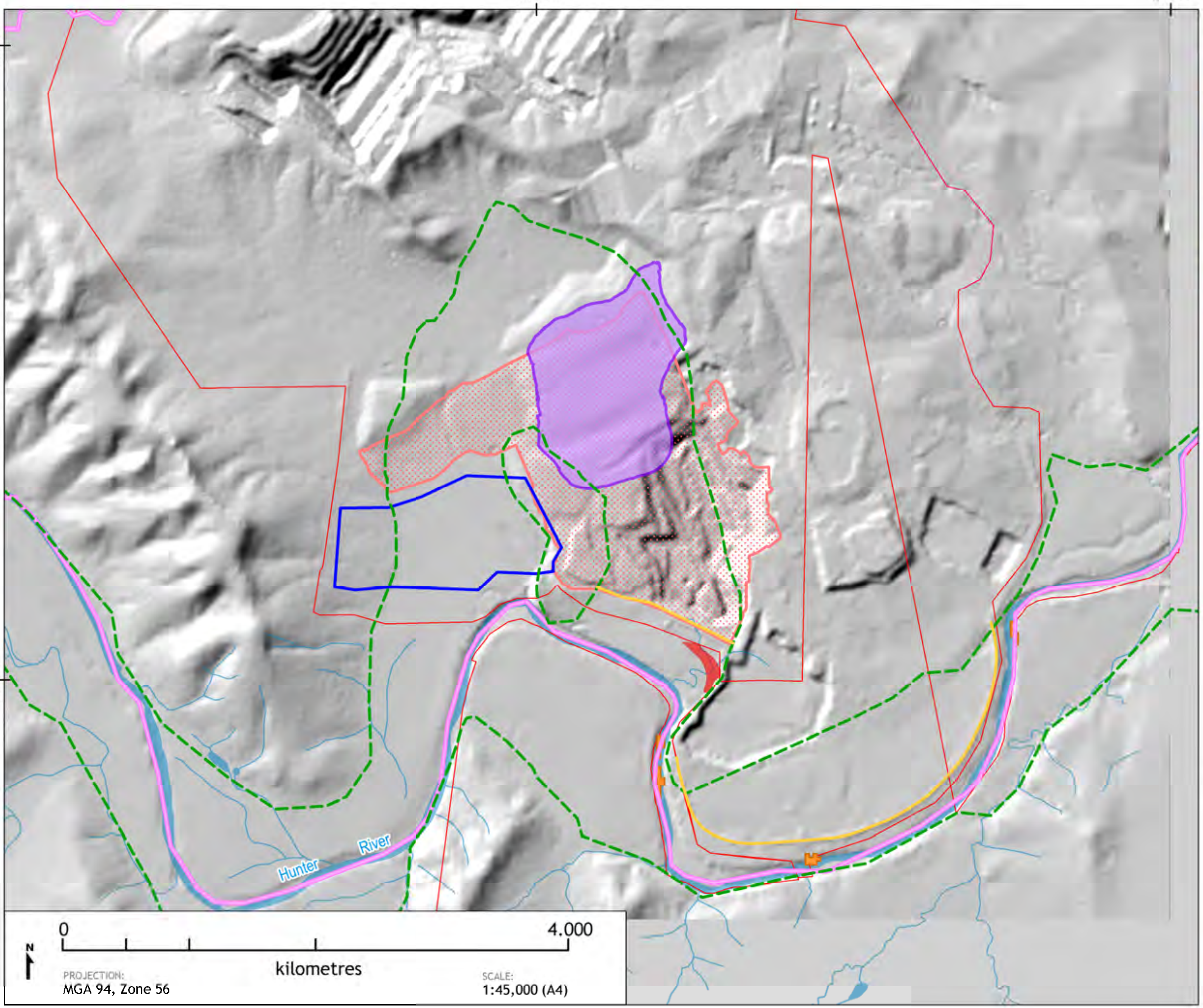
9 SURFACE WATER

HVO North drains to Davis Creek and Emu Creek (both tributaries of Bayswater Creek) to the north, Farrells Creek to the east, Parnells Creek to the west and an unnamed tributary to the south. Bayswater Creek, Farrells Creek and the unnamed tributary drain to the Hunter River. All of the creek catchments have been heavily disturbed by mining. The creeks are shown on Figure 5.2.

Surface water at HVO North is managed in accordance with Coal & Allied's HSEQ Management System. The water management system at HVO North is an integrated system designed to ensure effective separation and management of clean surface water, sediment-laden water, mine water and groundwater. Water can be transferred between all facilities north and south of the Hunter River, with the exception of the Hunter Valley and Newdell train loading facilities. Mine water can be imported into HVO from Liddell Mine to the north and Mount Thorley Warkworth (MTW) to the south. Fresh water can be extracted from the Hunter River at Oaklands and Lemington as a make-up water supply; however, first preference is given to all other sources. Surface water at HVO North is managed using the following infrastructure:

- diversion drains to separate clean and dirty water runoff;
- sediment dams to collect and treat runoff from disturbed areas;
- mine water dams to collect and store runoff affected by coal; and
- pumps and pipelines to transfer water around the mine site as required.

Any deficit in supply has been met by drawing water from Dam 13 at Liddell to the north of West Pit, while surpluses have been generally contained on site or discharged from Parnells Dam to the south of West Pit via the Hunter River Salinity Trading Scheme (HRSTS).



LEGEND:

BOM Atlas of GDEs
- High Potential for GW Interaction
- Moderate Potential for GW Interaction
- Low Potential for GW Interaction
- Carrington Billabong Area
- HVO Development Consent Boundary
- Fine Reject Emplacement
- CWW
- Carrington Mined Area
- Palaeochannel Extent
- Barrier Wall

HVO North Modification - Fine Reject Emplacement Groundwater Assessment (G1591B)

Mapped Groundwater Dependent Ecosystems

DATE:
5/6/2013

FIGURE No:
9.1

10 MINE PLAN

Run-of-mine (ROM) coal often contains overburden and interburden material from above and below the target coal seams. The coal washing process in the CPP processes the ROM coal to generate reject material. Two forms of reject material are produced: coarse and fine. The coarse material is typically hauled to active emplacement areas, whilst the fine reject material is pumped as a slurry from the CPP to fine reject emplacement facilities.

Mine planning has identified that fine reject capacity at HVO North will be reached in approximately quarter one 2015. Current fine reject emplacement occurs in the Alluvial Lands Pit Void at HVO North. Additional storage is required by this time to enable ongoing mining operations at HVO North. In conjunction with the use of the Cumnock void 3, the fine reject emplacement (Figure 10.1) will provide an additional six years of fine reject capacity and is critical to the viability of HVO North and HVO as a whole.

The fine reject emplacement will be constructed in the northern section of the Carrington Pit, occupy an area of approximately 161 ha, and will be on land that has been mined and is predominantly cleared of remnant native vegetation. The emplacement will have a life of approximately five years and will be completed within the existing development consent period, which is currently to 2025.

The emplacement will operate on the principle of gravity settlement of the fine reject in a low-wall, dam environment, with ponded water capture and recycling and fine reject deposited in situ. The NSW Dams Safety Committee (DSC) has issued guidelines in respect of the design, construction and operation of tailings dams, namely DSC3A Tailings Dams. The subject emplacement will be designed, constructed and operated in accordance with the DSC3A. DSC3A cover such issues as consequence assessment of dam failure, flood criteria, seismic capacity, freeboard, operational requirements, surveillance and decommissioning. The DSC has to be provided with a Construction Certificate, Work-As-Executed Drawings and a Construction Report. The proponent will liaise with the DSC as to whether the proposed fine reject emplacement should attain the status of a prescribed dam under the *Dam Safety Act 1978* in which case further requirements would apply.

No engineered design or construction specifications were available for the fine reject emplacement at the time of assessment. For the purposes of assessing the risk to the groundwater environment, a number of assumptions where made with regards to the design of the fine reject emplacement and these assumptions were derived from the design considerations presented by ANCOLD (2011) and ATC Williams (2012):

- The embankments will be constructed from compacted spoil material; and
- Fine reject will be deposited to a height of 119 mAHD, 1 m below the height of the embankment (120 mAHD).

Fine Reject Emplacement
HVO Development Consent Boundary
Spoil
Palaeochannel Extent
Barrier Wall
Carrington Pit Extent
Drainage Line / Creek

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Fine Reject Emplacement

DATE: 5/6/2013

FIGURE No: **10.1**

11 ANALYTICAL SEEPAGE MODEL

The following section details the estimated water seepage from the fine reject emplacement, based on steady state calculations. Seepage was calculated by applying Darcy's Law (Equation 1). Several assumptions were made in order to calculate the flux or seepage (Q_{XY} and Q_Z), which are detailed in Section 11.1 below. Flow loss calculation results are shown and discussed in Section 11.2, and further calculation details are presented in Appendix B.

Darcy's Law:

$$Q = K.i.A \qquad \textit{(Equation 1)}$$

where:

Q	is the amount of water discharged (m^3/day)
K	is the hydraulic conductivity (m/day)
i	is the hydraulic gradient (dimensionless)
A	is the area (e.g. exposed coal seam) (m^2)

11.1 Flow Assumptions

In order to apply Darcy's Law, several assumptions were made to calculate the hydraulic conductivity (K), hydraulic gradient (i) and area (A). These assumptions are detailed in Section 11.1.1 to Section 11.1.3 below.

11.1.1 Hydraulic Conductivity (K)

The steady state calculations were based on an estimated hydraulic conductivity of 8.64×10^{-4} m/day for the embankment wall, and a conductivity of 8.64×10^{-5} m/day for the clay liner. These values are conservative estimates based on standard conductivity values for clay, of between 8.64×10^{-7} m/day to 8.64×10^{-4} m/day (Fetter, 2001).

11.1.2 Hydraulic Gradient (i)

The horizontal hydraulic gradient (i_{xy}) was estimated based on an assumed 1:1 slope ratio in the fine reject emplacement embankment.

In order to calculate the vertical hydraulic gradient (i_z), recent groundwater levels, calculated by MER (March, 2010b) were used. These values equated to an average water level of 65 mAHD and 85 mAHD for the spoil and palaeochannel alluvium, respectively. The water level within the fine reject emplacement was set at the maximum possible level of 119 mAHD, in order to give a conservative/worst case scenario (Table 9). An average depth to the base of the fine reject emplacement was estimated to be around 80 mAHD, with an anticipated 1 m clay liner between fine reject emplacement and underlying aquifers.

Darcy's Law (Equation 2) was used to calculate the vertical hydraulic gradient (i_z) between the fine reject emplacement and the aquifers (spoil and alluvium).

Vertical Hydraulic Gradient Equation:

$$i_z = \frac{\Delta h}{\Delta L} \quad \text{(Equation 2)}$$

where:

- i_z is the vertical hydraulic gradient (dimensionless),
- Δh hydraulic head in the fine reject emplacement (mAHD) minus the hydraulic head in the underlying formation (mAHD),
- ΔL thickness of liner (m), dividing the fine reject from the underlying formation.

Table 9: VERTICAL HYDRAULIC GRADIENTS

Unit	Dam GWL (mAHD)	Depth to Base of Dam (mAHD)	Unit GWL (mAHD)	Depth to Top of Spoil (mAHD)	Depth to Base of Dam minus Depth to Unit ΔL (m)	Hydraulic Head Difference Δh (m)	Vertical Hydraulic Gradient (i_z)
Spoil	119.0	80.0	65.0	79.0	1.0	54.0	54.0
Alluvium	119.0	80.0	85.0	79.0	1.0	34.0	34.0

Note: GWL = Groundwater Level

11.1.3 Area (A)

The area (A) used to calculate leakage from the fine reject into the spoil and alluvial aquifers (Q_z) was based on the area of each aquifer type intersected by the proposed fine reject emplacement footprint. The area of spoil and palaeochannel alluvium to underlie the fine reject emplacement is estimated to be around 0.50 km^2 and 0.11 km^2 respectively. The embankment wall was estimated to extend approximately 3.7 km, and to have an average height of 40 m.

11.2 Analytical Model Results

The horizontal seepage from the proposed fine reject emplacement has been calculated using Darcy's Law (see Appendix D for calculations) and the results are shown in Table 10. The results for the analytical steady state model indicate that the fine reject emplacement could produce up to 2,784 m^3/day of seepage. However, after accounting for rainfall and evaporative loss, it is calculated that 703 m^3/day of seepage may occur from the fine reject emplacement.

Table 10: ANALYTICAL SEEPAGE RESULTS

Unit	Total Seepage (ML/day)	Total Seepage (m^3/day)
Spoil	2.33	2333
Alluvium	0.32	323
Embankment	0.13	128
TOTAL	**2.78**	**2784**
Rainfall (640mm/year) input	1.33	1332
Evaporation (1,640mm/year)	3.41	3412
TOTAL	**0.70**	**703**

This is considered a conservative or worst case estimate, as the calculations are based on a maximum hydraulic head of 119 mAHD within the fine reject emplacement. This maximum head will only occur during the final stages of fine reject deposition and over the life of the fine reject emplacement the hydraulic head in the fine reject is likely to be significantly less than 119 mAHD.

The calculations also assume that a 1 m clay liner is constructed in the base of the fine reject emplacement. Whilst a clay liner is not planned to be constructed within the fine reject emplacement at this stage, the clay liner represents the reduction in hydraulic conductivity which occurs in the fine reject over time. This settlement and consolidation leads to reduced porosity and hydraulic conductivity within the fine reject and occurs due to the compression of material under increased hydraulic and pressure loading. This results in a reduction in vertical hydraulic conductivity within the fine reject which has greater effect toward the base of the profile.

The analytical results have been compared against the HVO North site water balance for the existing in-pit fine reject facility. The water balance calculates that there is a total of 3,977 m^3/day that is discharged to the existing facility. However, the water balance assumes there is approximately 2,320 m^3/day decanted from the existing facility and pumped back to the CHPP. This results in approximately 1,657 m^3/day of water that remains in the existing facility. Some of this water will be evaporated (139 m^3/day) and the remainder (1,519 m^3/day) is either retained in the fine reject or is lost through seepage to groundwater. The water balance model estimates that 326 m^3/day is retained in the existing facility leaving 1,193 m^3/day as seepage. The results of the analytical seepage assessment are lower than the site water balance, due to variations in size, underlying aquifer types (i.e. spoil), and groundwater conditions (i.e. in-pit compared to out-of-pit facilities).

12 SEEP/W

Two-dimensional (2D) sectional models of the original fine reject emplacement have been developed using SEEP/W. SEEP/W is used extensively in the mining industry for assessing seepage through artificial embankments, fine reject emplacement facilities and water impoundments. It is an industry standard, two-dimensional, finite element, numerical seepage modelling package.

12.1 Modelling Objectives

The two-dimensional sectional models have been generated for an east-west and north-south section through the fine reject emplacement with the objective of predicting seepage estimates within and surrounding the fine reject emplacement footprint. These seepage rates have been transferred over to the existing 3D MODFLOW-SURFACT model to assess the regional implications of this seepage.

12.2 Model Development

Assessment of the seepage rates from the original fine reject emplacement design to the Quaternary palaeochannel sediments has been carried out by generating an east-west section and a north-south section to represent the original design of the fine reject emplacement embankments, fine reject and basal spoil or sediments.

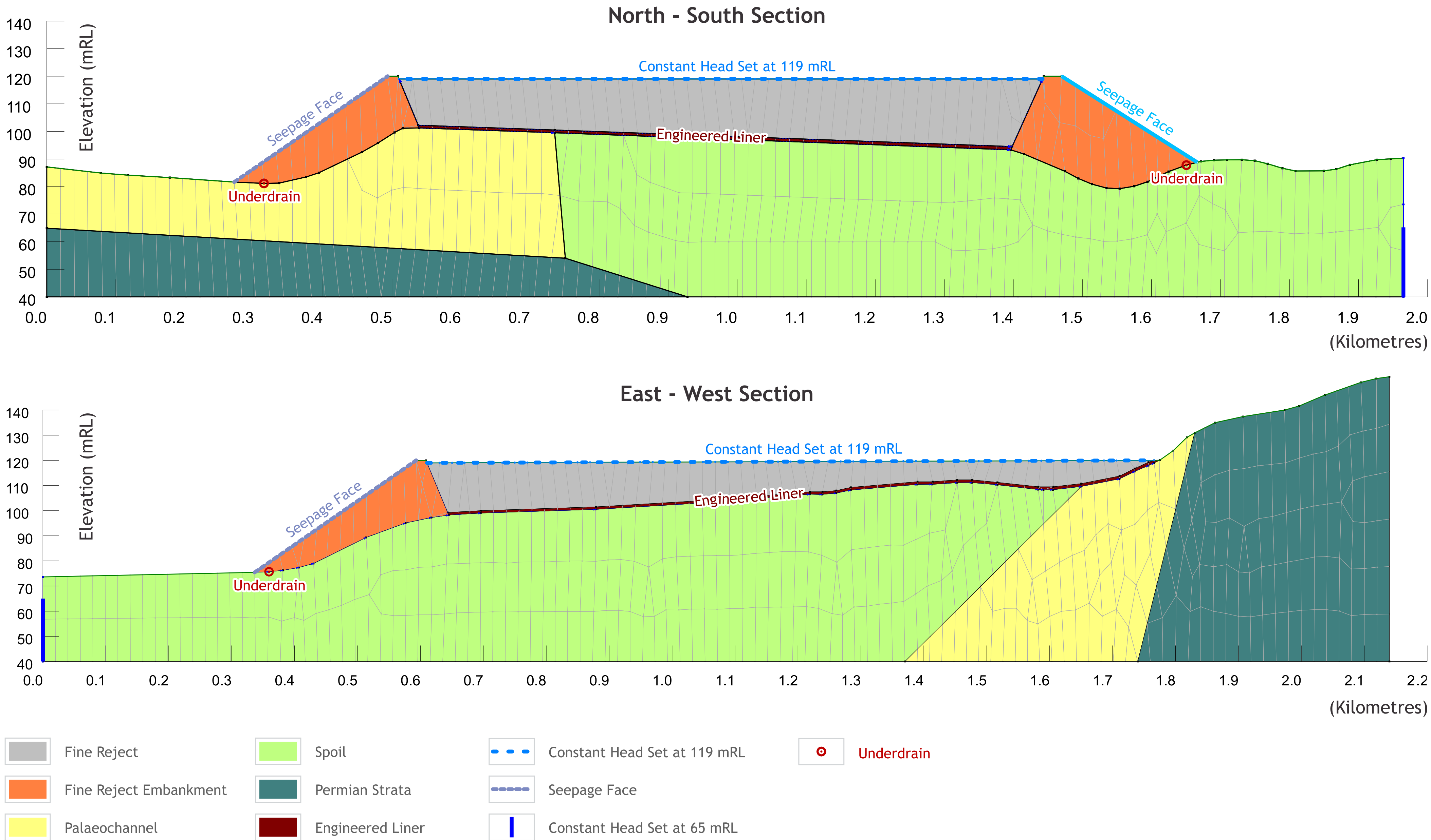
The model configuration for the east-west section is shown in Figure 12.1 and includes the following:

- an east-west model cross-section viewed from the south over a section width of 2,100 m;
- surface topography derived from the surveyed data sloping to the west from an elevation of 150 mAHD in the east to 74 mAHD to the west;
- constant heads representing sub-regional groundwater levels of 65 mAHD on the western boundary;
- constant heads representing saturated fine reject of 119 mAHD on the top of the emplacement;
- a nominal thickness of 1 m for an engineered liner at the base of the fine reject emplacement;
- a zero flux boundary with potential seepage face review along the slope of the embankment representing seepage that would report at the toe of the embankment; and
- a zero pressure node under the embankment to simulate an underdrain.

The sectional model contains six different material types with individual hydraulic conductivity properties. The north-west sectional model (Figure 12.1) is configured similarly to the east-west model, with comparable material types and boundary conditions. Both models include low permeability clay layer at the base of the fine reject emplacement, which represents the engineered liner. The north-south model contains the following different boundary conditions:

- a north-south model cross-section viewed from the west over a section width of 2,000 m;
- surface topography derived from the surveyed data sloping to the west from an elevation of 88 mAHD in the north to 90 mAHD to the south;
- constant heads representing sub-regional groundwater levels of 65 mAHD on the southern boundary;
- constant heads representing saturated fine reject of 119 mAHD on the top of the emplacement;
- a nominal thickness of 1 m for an engineered liner at the base of the fine reject emplacement;
- a zero flux boundary with potential seepage face review along the slope of the embankments representing seepage that would report at the toe of the embankment; and
- a zero pressure node under the embankments to simulate an underdrain.

The sectional models do not include provision for underdrainage, and are based on the original fine reject emplacement design. Results were output for each matrix type (i.e. alluvium and spoil) as unit volumes (m^3) per day, per metre. As the results were output as a per metre unit, they were updated with the revised design by multiplying the area of the underlying aquifer (i.e. alluvium and spoil) and the surface area of the embankment wall by the corresponding seepage rate (per metre). The spoil within the revised fine reject emplacement is estimated to cover an area of 0.50 km^2, and the palaeochannel alluvium is estimated to cover approximately 0.11 km^2. The surface area of the fine reject emplacement wall was calculated from the length (approximately 3.7 km) multiplied by an estimated average wall height of 40 m (total area = 0.15 km^2).



Seep/W Model Sections

Figure 12.1

As the SEEP/W models were run in a steady state solution, the main aquifer parameter incorporated into the 2D model is hydraulic conductivity of the geological materials, and these are summarised in Table 11. These representative values were estimated based on the following:

- Spoil – the value for the backfilled spoil area was based upon hydraulic parameters included in the existing 3D numerical flow model developed by MER (2010b).
- Alluvium – the deeper palaeochannel alluvium in the emplacement footprint is demonstrated, by MER (2010a), to have hydraulic conductivity values of over 5 m/day. However, the palaeochannel is known to comprise a surficial clay-dominant layer, which inhibits surface water recharge into the palaeochannel. Whilst there is no direct hydraulic conductivity measurement for this surficial clay layer, a value of 0.00864 m/day has been adopted, which falls within the range for clayey/silty sands (Fetter, 2001).
- Permian Basement – in this instance the Permian basement material represents the Archerfield Sandstone which underlies the Bayswater Coal Seam that has been mined as part of the Carrington Pit development. MER (2010a) reported horizontal hydraulic conductivity values in the order of 5×10^{-4} m/day and 5×10^{-6} m/day for Permian sandstones and 1×10^{-4} m/day and 5×10^{-7} m/day for Permian siltstones (Table 7). A value of 8.64×10^{-3} m/day has been adopted in the SEEP/W modelling, which is higher than those values reported by MER (2010a).
- Embankment – it is understood that the embankment material will be sourced from spoil and reworked and compacted into an engineered structure suitable for the containment of the fine reject. Whilst design or specifications of the embankment were not available at the time of assessment, a value of 8.64×10^{-4} m/day has been adopted for this modelling.
- Fine reject – the hydraulic conductivity of fine reject varies in both horizontal and vertical directions due to the layered way most fine reject are deposited. A value of 0.0864 m/day has been applied for the sectional model.
- Liner – whilst an engineered liner is not part of the design or specifications for the fine reject emplacement given the steady state analysis used in the SEEP/W modelling, it was considered important to allow for a low hydraulic conductivity layer at the base of the fine reject. This low permeability layering would form over time within the fine reject emplacement as a result of compaction and compression of the sediments. An accepted hydraulic conductivity value for liners is typically 1×10^{-9} m/sec (8.64×10^{-5} m/day) and this value has been adopted for this modelling.

Table 11: BASECASE MODEL AQUIFER PARAMETERS

Geology	Hydraulic Conductivity (m/day)
Palaeochannel Alluvium	0.00864 (8.64×10^{-3})
Spoil	1.0
Permian Basement	0.00864 (8.64×10^{-3})
Embankment	0.000864 (8.64×10^{-4})
Fine Reject	0.0864 (8.64×10^{-2})
Liner	0.0000864 (8.64×10^{-5})

It is important to note that the vertical hydraulic conductivity of the material types were set at 1:1 of the horizontal hydraulic conductivity. This is considered to be a worst case / conservative approach.

12.3 Model Predictions

Using the base-case 2D model parameters, the steady state seepage rate from the north-south fine reject emplacement model was predicted to be 859 m^3/day (314 ML/year), and 777 m^3/day (284 ML/year) for the east-west sectional model. There is an approximate 10% variation between the two model results, predominantly from seepage into the palaeochannel alluvium. This variation is a function of the higher hydraulic head above the alluvium, within the north-south model.

Both the 2D and analytical model are based on a constant head of 119 mAHD within the fine reject, and do not account for inflow fluxes, rainfall and evaporation. However, the results from the SEEP/W 2D model are believed to be more refined, as they give a more realistic representation of the movement of water within and between different medium.

The 2D model found that the rate of seepage from the proposed fine reject emplacement into the alluvium would be around 0.00047 m^3/day/m, and around 0.0014 m^3/day/m into the spoil (based on the north-south model results).

12.3.1 Model Sensitivity

A number of sensitivities were carried out for each 2D model section, to assess the effect of various hydraulic conductivity values and constant head values on the total seepage rate (Table 12). The range of sensitivities values reflect a one order of magnitude difference (plus and minus) to the assumed hydraulic conductivity values, as well as variations to site specific boundary conditions and emplacement construction.

The results indicate that the presence and properties of the liner have the greatest impact on predicted seepage rates. Predicted seepage rates more than doubled when the hydraulic conductivity of the liner was increased by one order of magnitude (8.64×10^{-6} m/day). Conversely, seepage rates decreased to around a quarter of baseline levels with a one order of magnitude (10%) reduction in hydraulic conductivity for the clay liner (8.64×10^{-6} m/day) and spoil (1.0×10^{-1} m/day).

The western embankment (east-west model) shows greater sensitivity to variations in the hydraulic conductivity than the north-south model. Seepage results for increased embankment hydraulic conductivity (8.64×10^{-3} m/day) resulted in seepage rates more than doubling (277%) in the western embankment, compared to a 69% increase for the combined northern and southern embankment walls. The results indicate that the western embankment wall (expressed in the east-west model) potentially has higher hydraulic gradients and hydrostatic pressure, due to general topography and geometry of the fine reject emplacement.

Table 12: SENSITIVITY ANALYSIS SUMMARY					
Base-case Seepage		E-W Model		N-S Model	
		777 m^3/day		859 m^3/day	
Units		m^3/day	*% of base-case*	m^3/day	*% of base-case*
Site Specific	No Liner (Alluvial Properties - 8.64 x 10^{-3} m/day)	2203	283%	2353	274%
	Fine Reject Constant Head Reduced (115 mAHD)	503	65%	739	86%
	Pit Constant Head Reduced (50 mAHD)	720	93%	872	102%
	Alluvium K increased (5m/day to demonstrate absence of upper clay-rich units)	716	92%	1262	147%
Sensitivity	Alluvium K +1 OM (8.64 x 10^{-2})	784	101%	962	112%
	Alluvium K – 1 OM (8.64 x 10^{-4})	770	99%	832	97%
	Spoil K +1 OM (1.0 x 10^{1})	819	105%	1098	128%
	Spoil K - 1 OM (1.0 x 10^{-1})	266	234%	250	29%
	Basement K +1 OM (8.64 x 10^{-2})	816	105%	909	106%
	Basement K -1 OM (8.64 x 10^{-4})	795	102%	849	99%
	Embankment Wall +1 OM (8.64 x 10^{-3})	2151	277%	1455	169%
	Embankment Wall – 1 OM (8.64 x 10^{-5})	678	87%	756	88%
	Liner K + 1 OM (8.64 x 10^{-4})	1880	242%	1846	215%
	Liner K – 1 OM (8.64 x 10^{-6})	230	30%	285	33%
	Fine Reject K + 1 OM (8.64 x 10^{-1})	810	104%	859	100%
	Fine Reject K - 1 OM (8.64 x 10^{-3})	731	94%	764	89%

Notes: OM = Order of Magnitude (x 10)

13 3D NUMERICAL GROUNDWATER MODEL

13.1 Modelling Objectives

The CWW has been assessed and approved by the NSW Department of Planning and Infrastructure (DP&I). Therefore, the groundwater modelling was run with the CWW extension included.

The objectives of the predictive model were to:

- estimate groundwater seepages to the open cut void resulting from the fine reject emplacement;
- predict the zone of influence of mounding and the level and rate of mounding at specific locations;
- predict the magnitude of any drainage from the alluvium into the underlying Permian strata;
- predict the change in groundwater discharges to surface water flows and other groundwater users as a result of the fine reject development;
- indicate potential impact on GDEs (if present); and

- identify areas of potential risk where groundwater impact mitigation/control measures may be necessary.

13.2 Existing Model

The 3D numerical modelling was carried out using the existing CWW model developed by MER (2010b)[1]. The conceptual model presented by MER (2010b), is still considered valid and is consistent with the information and findings of this report.

The fine reject emplacement is proposed to be constructed immediately to the north of the existing Carrington Pit, and hence the existing numerical model has been used to assess the change in groundwater levels and flow that would result from the development. The existing model has been developed in MODFLOW-SURFACT.

The calibration of the existing model is considered to be valid, acceptable and still applicable. It is understood that the calibration objectives achieved an acceptable fit according to the MDBC groundwater modelling guidelines (2000). The model has recently been reviewed by AGE (2012) in accordance with the latest modelling guidelines (Barnett *et al*, 2012) and it was found to be fit for purpose.

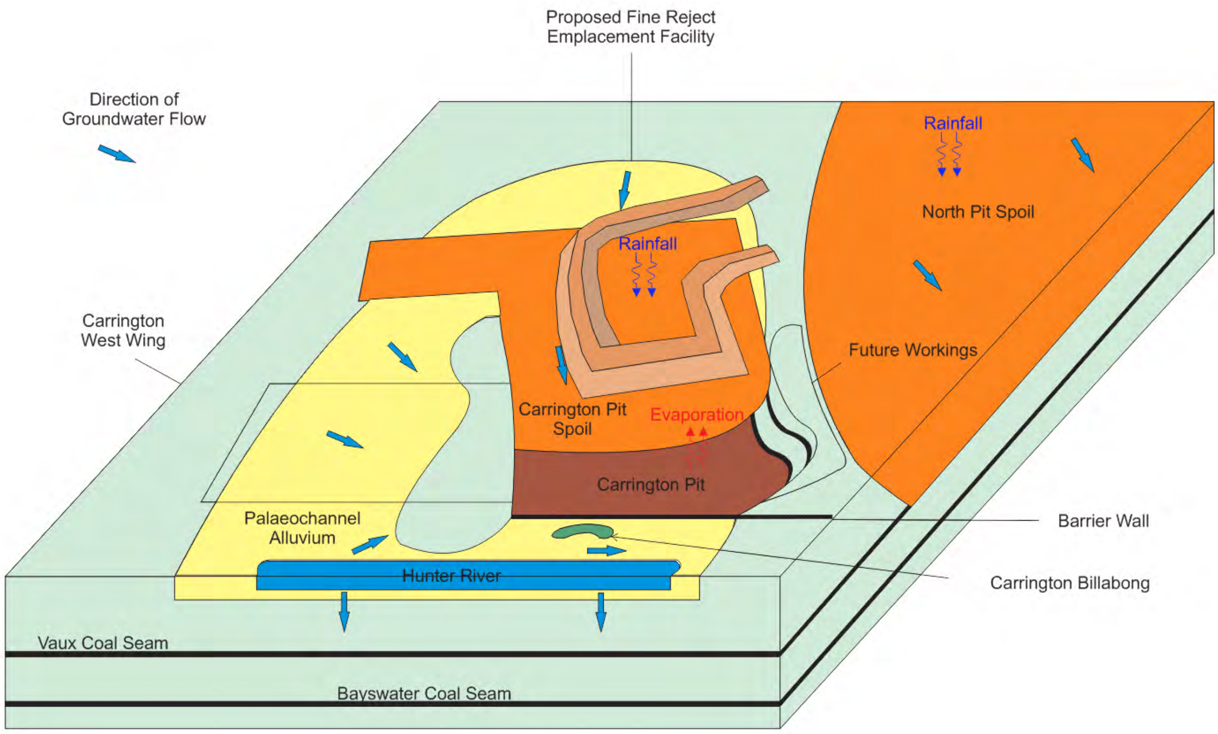


Figure 13.1: Conceptual Model

[1] http://www.riotintocoalaustralia.com.au/3721_carrington_west_wing_3633.asp

13.3 Model Development

13.3.1 Model Geometry and Boundary Conditions

The selection of the regional model boundaries was developed by MER (2010b) and are located far enough from the area to show all potential impacts on groundwater during simulation and prediction. Using these predefined boundaries, the model grid was 10 km wide (E-W) and 9 km long (N-S).

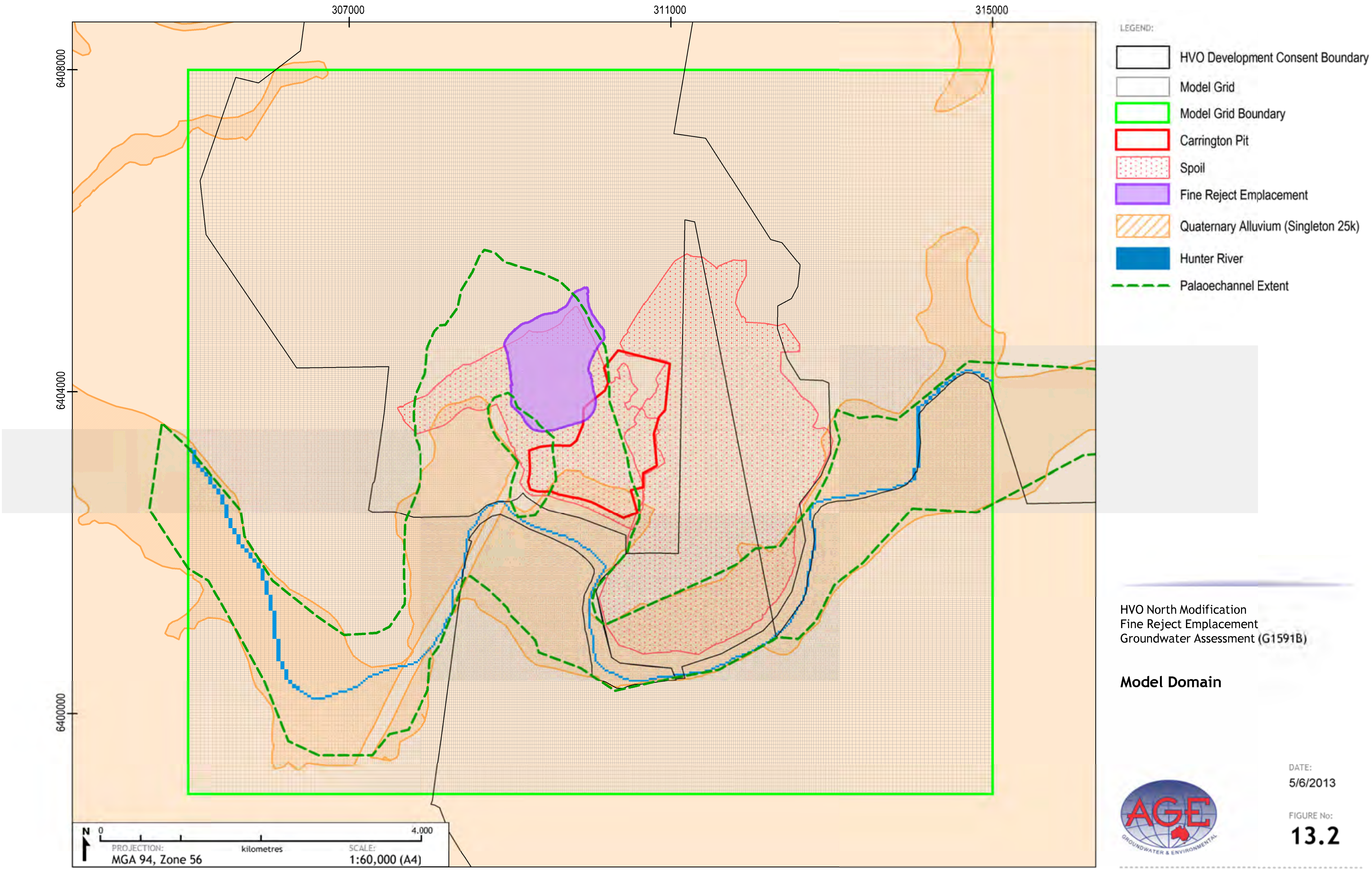
The model has a total area of 110 km^2 and is represented by 96,000 cells per layer (Figure 13.2). Cell size is 50 m x 50 m at the margins of the model, reducing to 25 m x 25 m. This increased grid resolution has been carried out in areas representing existing and proposed pit areas, drainages and alluvium.

13.3.2 Layers

Seven layers are represented in the model and these are summarised below in Table 13. These layers were interpolated from regional stratigraphic horizons, and are considered appropriate for this level of study.

Table 13: MODEL LAYERS

Model Layer	Strata
1	Regolith / Alluvium
2	Permian Coal Measures
3	Permian Coal Measures
4	Permian Coal Measures
5	Permian Coal Measures
6	Bayswater Coal Seam
7	Permian Coal Measures


307000
311000
315000
6408000
6404000
6400000
LEGEND:
HVO Development Consent Boundary
Model Grid
Model Grid Boundary
Carrington Pit
Spoil
Fine Reject Emplacement
Quaternary Alluvium (Singleton 25k)
Hunter River
Palaeochannel Extent
N
0
4,000
kilometres
PROJECTION:
MGA 94, Zone 56
SCALE:
1:60,000 (A4)
HVO North Modification
Fine Reject Emplacement
Groundwater Assessment (G1591B)
Model Domain
DATE:
5/6/2013
FIGURE No:
13.2

13.3.3 Hydraulic Parameters

Table 14 shows the hydraulic properties used in the MER (2005 and 2010a) groundwater models. Table 14 also shows that the Permian aquifers have a relatively low hydraulic conductivity, while the alluvial aquifer has a higher permeability and drainable porosity.

Table 14: HYDRAULIC PROPERTIES – CARRINGTON MODEL

Strata	Kxy (m/day)	Kz (m/day)	Ss (1/m)	Sy
Regolith	1 to 95	1	1×10^{-5}	0.02
Alluvium	10	10	5×10^{-5}	0.05
Shallow PCM (Layers 2 to 5)†	7.78×10^{-4}	7.00×10^{-5}	9.25×10^{-6}	3.33×10^{-3}
Bayswater Seam	6.00×10^{-3}	2.60×10^{-4}	3.00×10^{-6}	0.01
Underlying PCM	3.70×10^{-3}	2.10×10^{-6}	5.00×10^{-6}	0.0026

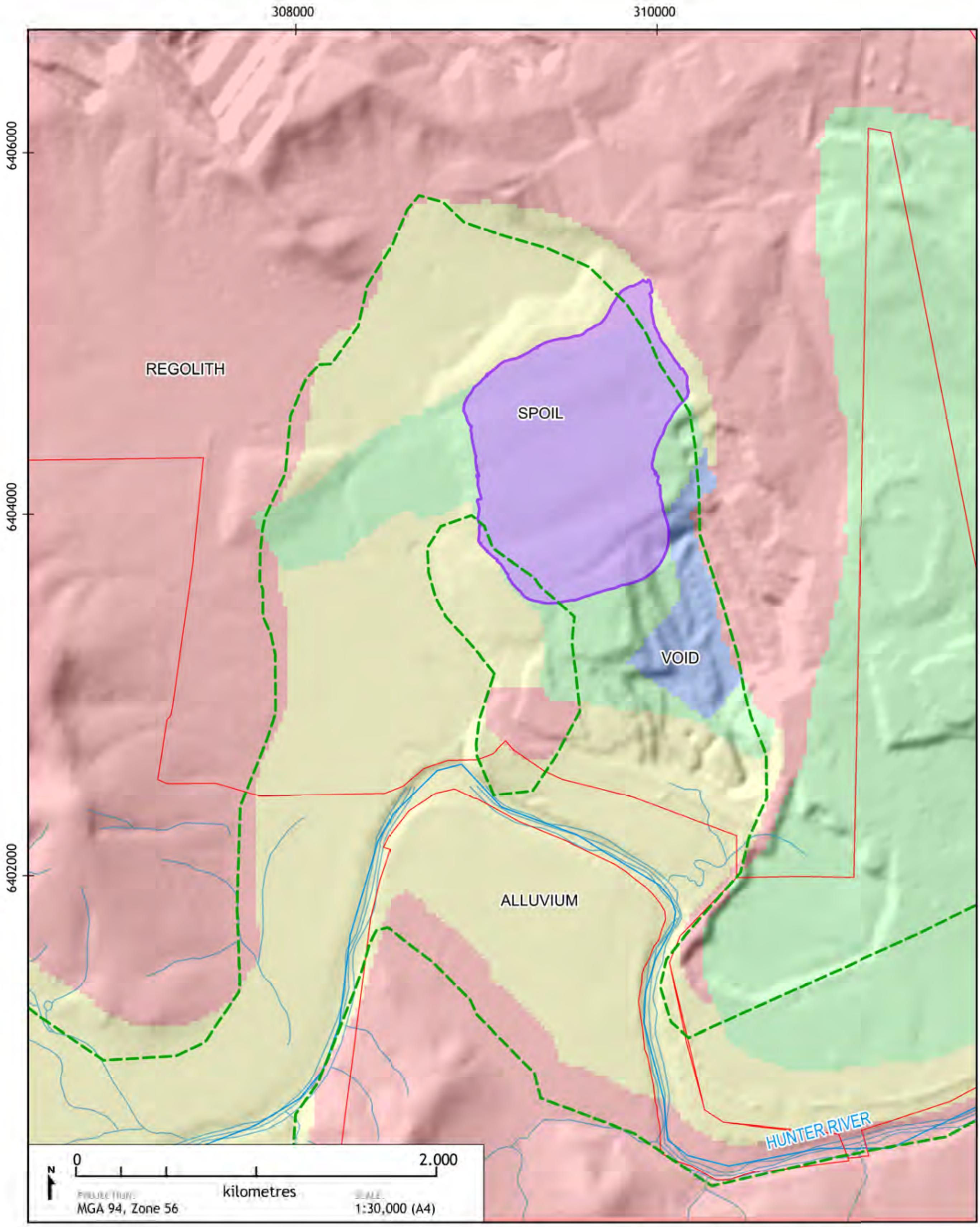
Note: † Average of Permian Coal Measure (PCM) Layers 2 to 5 (MER, 2010a)
K_{xy}: Horizontal permeability
K_z: Vertical hydraulic conductivity
Ss: Specific storage
Sy: Specific Yield (Drainage porosity)

13.3.4 Recharge and Discharge

Groundwater recharge used in the calibrated MER (2010b) model, has been applied in the model domain, which is set at a rate of 80 mm/year in the alluvial materials, and less than 0.1% of average annual rainfall in the hard rock strata. The distribution of the recharge zones is shown in Figure 13.3.

As per the MER (2010b) model, the Hunter River is simulated using river cells set at between 69.2 mAHD in the west of the model domain and 50.8 mAHD in the east of the model domain. A riverbed conductance of 100 m^2/day has been applied to the river cells. Creeks, tributaries and drainage features in the model domain are simulated using drain cells with a conductance value of 100 m^2/day. These drain cells have been applied to allow water to freely drain from the model in zones representing drainage features.

Drainage into the open cut pits is simulated in the model by the use of drain cells. A conductance value of 100 m^2/day has been applied to the drain cells. This is a nominally high value to ensure enough water is removed and the mine workings are dewatered. The distribution of the river and drain cells is shown in Figure 13.4.



HVO Development Consent Boundary
Fine Reject Emplacement
Palaeochannel Extent
Drainage Line / Creek

Recharge Zones (Rate % - mm/yr)
Regolith (0.08% - 0.512mm/yr)
Alluvium (0.8% - 5.12mm/yr)
Spoil (5% - 32mm/yr)
Void (100% - 640mm/yr)

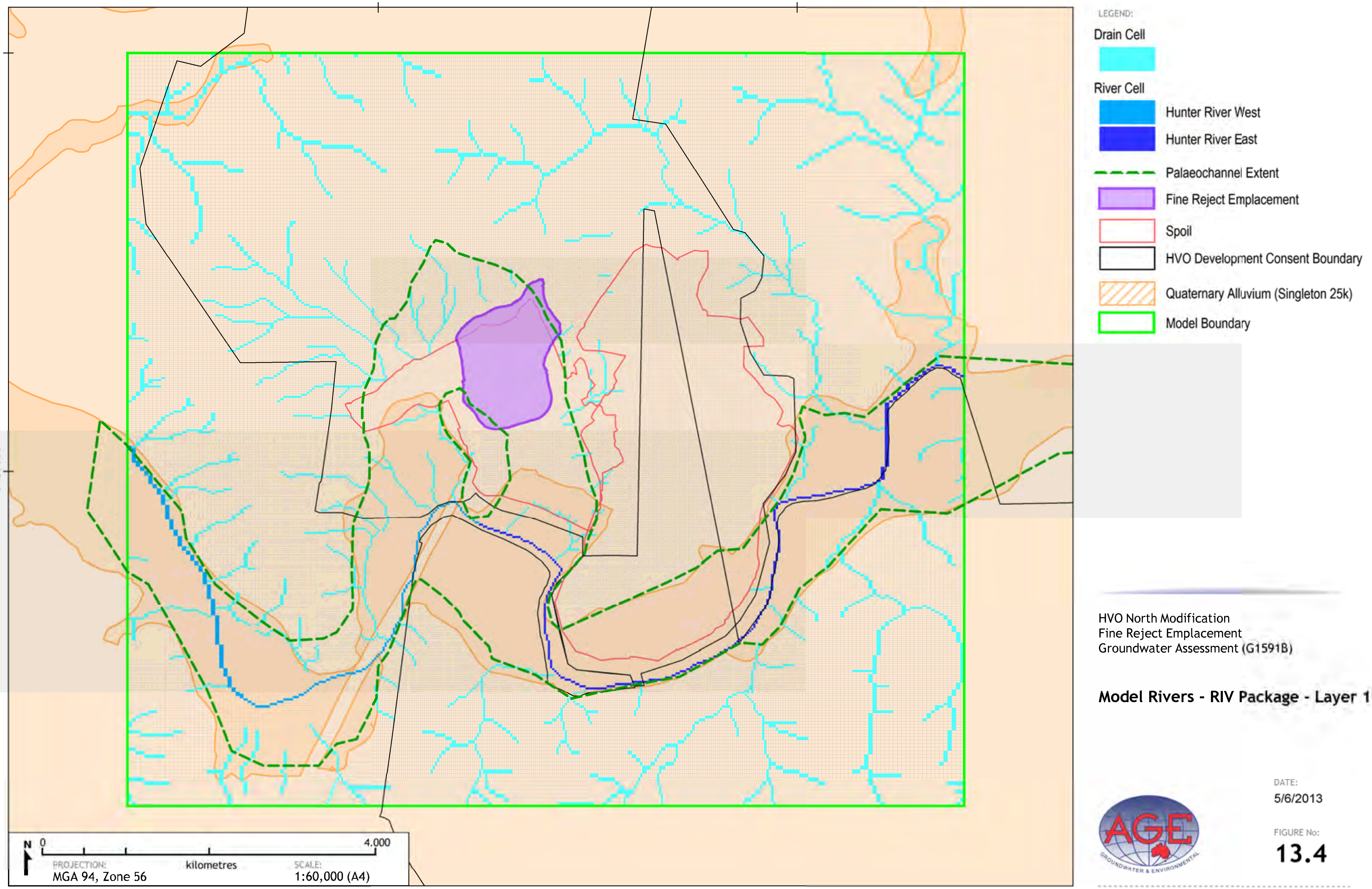
HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Recharge Zones - Layer 1

AGE
GROUNDWATER & ENVIRONMENTAL

DATE: 5/6/2013

FIGURE No: **13.3**



HVO North Modification
Fine Reject Emplacement
Groundwater Assessment (G1591B)

Model Rivers - RIV Package - Layer 1

DATE:
5/6/2013

FIGURE No:
13.4

13.4 Model Calibration

MER (2010b) calibrated the model to both a steady state and transient, or time variant, datasets. Whilst no calibration statistics have been documented as part of the report, the hydrographs for the transient calibration are presented in the MER (2010b) report. The hydrographs show an excellent comparison between observed and modelled data and the observed trends for 32 monitoring bores are well simulated by the model. The existing model was not verified or validated against a revised monitoring dataset.

13.4.1 Sensitivity

MER (2010b) stated the following with regard to model sensitivity "*it is apparent from the adjustments made during the calibration process (over many re-calibrations) that the extent of model dewatering in the alluvium and depressurisation in the hardrock strata is more sensitive to hydraulic conductivities than any other parameter*." No further sensitivities were carried out by MER on the CWW numerical model.

14 PREDICTIVE SIMULATIONS

14.1 Set-up and Assumptions

14.1.1 Staged Timing and Stress Periods

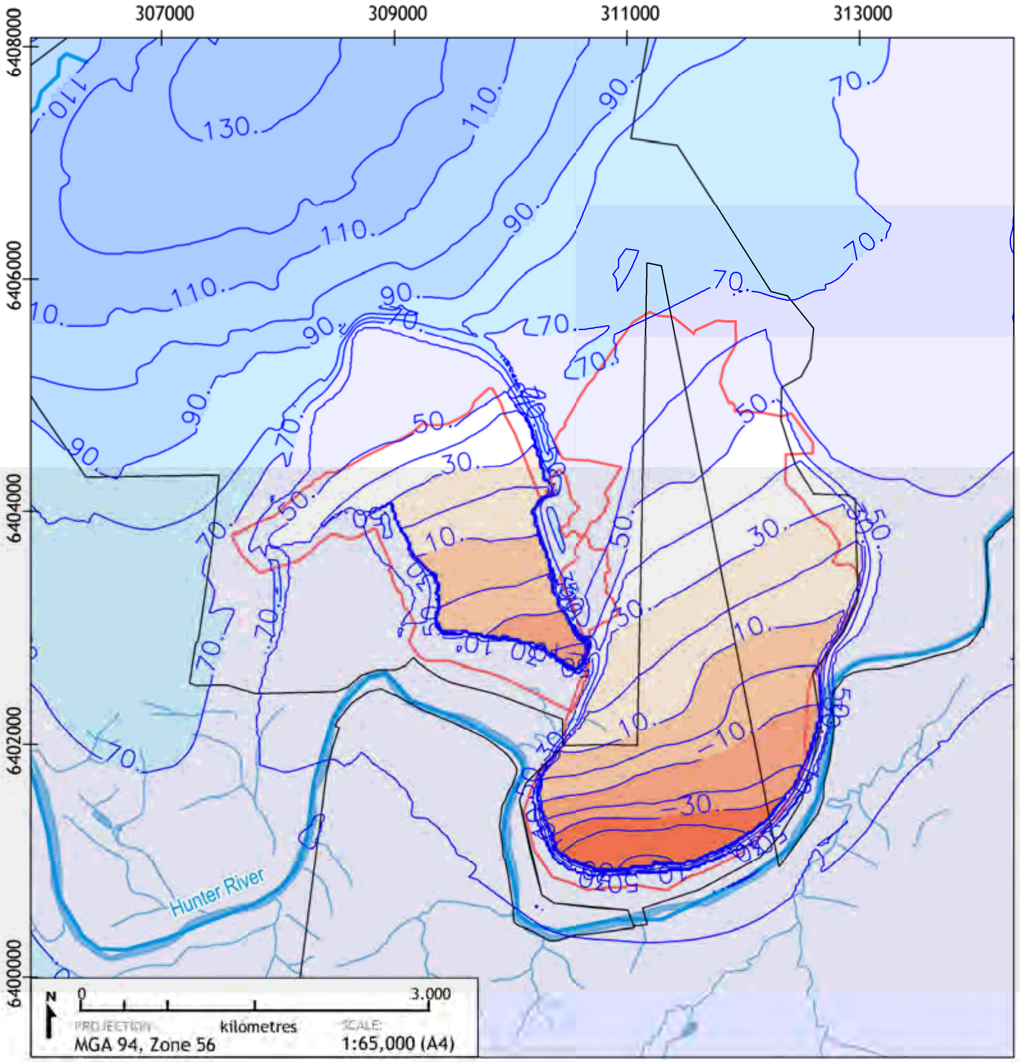
As described under Section 13.1, the transient model was run, to show current approved mine planning (Carrington Pit and CWW). The predictive model (CWW model) was set up in four stages, commencing from 2013, as follows:

- **Stage 1**: 8 quarterly stress periods (each 91.3 days) covering 2 years of mining within the Carrington Pit and commencement of mining for the CWW;
- **Stage 2**: 14 quarterly stress periods (each 91.3 days) covering 3.5 remaining years of mining within the CWW;
- **Stage 3**: 12 quarterly stress periods (each 91.3 days) covering 3 years of the fine reject emplacement being actively used; and
- **Stage 4**: 2 stress periods (91.3 days and 993 days for stress period 1 and 2 respectively) covering approximately 3 years for groundwater recovery.

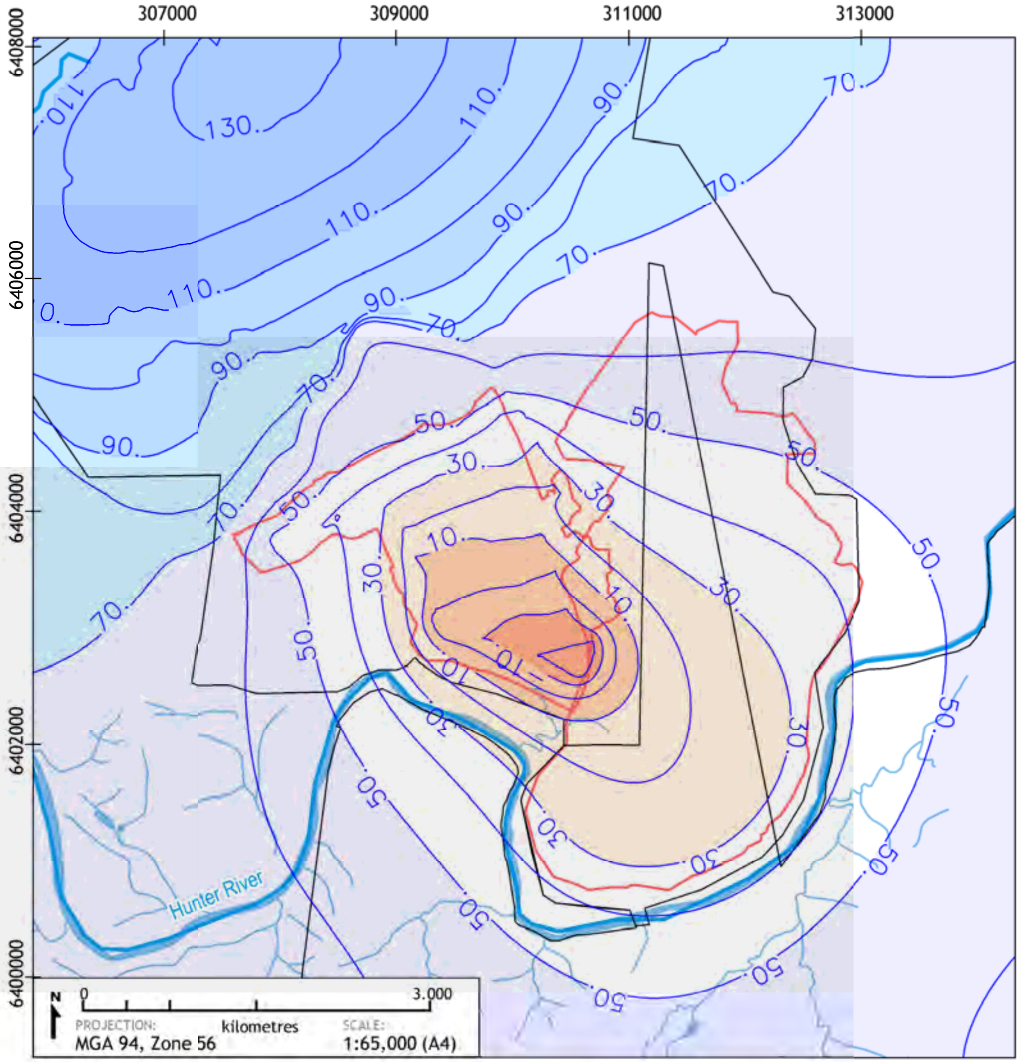
14.1.2 Starting Heads

Precise starting heads were required for the predictive simulation to ensure numerical stability and water budget accuracy. The starting heads used within the transient model were based on the starting heads used within the MER (2010b) model, which represent current groundwater conditions within the project area.

Starting Heads Layer 1



Starting Heads Layer 6



LEGEND

- Groundwater Contour (mAHD)
- HVO Development Consent Boundary
- Spoil
- Drainage Line / Creek

Starting Heads (mAHD)

110 to 135	10 to 30
90 to 110	-10 to 10
70 to 90	-30 to -10
50 to 70	-55 to -30
30 to 50	

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Starting Heads - Model Layers 1 and 6

DATE:
5/6/2013

FIGURE No:
14.1

14.1.3 Recharge

The recharge zones used in the predictive model were based on recharge rates used by MER (2010b). The distribution of the recharge zones is shown in Figure 13.3.

The recharge zones used for the predictive model were as follows:

- Alluvium 0.00047 m^3/day/m 0.8% annual rainfall
- Spoil 0.001408 m^3/day/m 5% annual rainfall
- Regolith 0.000047 m^3/day/m 0.08% annual rainfall
- Void 0.00175 m^3/day/m 100% annual rainfall
- Rehabilitated fine reject 0.1% annual rainfall

The average annual rainfall used was 640 mm/year, as per the MER (2010b) model. Recharge to groundwater from the fine reject emplacement, while it is active, was simulated at a rate of 143.96 m^3/day where the emplacement footprint overlies the palaeochannel alluvium, and 780.82 m^3/day where the footprint overlies spoil. The recharge zones for the fine reject emplacement are shown in Figure 14.2 and the rates are based on the results from the SEEP/W modelling. It was assumed that the fine reject emplacement would be rehabilitated once decommissioned. Recharge within the rehabilitated fine reject emplacement was based on a fixed percentage of 0.1% annual rainfall, which reflects a semi-impermeable clay layer (cap) across the surface of the emplacement.

14.1.4 Evapotranspiration

An evapotranspiration rate of 0.00351 m^3/day was applied within the proposed final void, which has a land surface of 40 mAHD. An extinction depth for the proposed final void of 2 m below the 40 mAHD land surface was applied in the SURFACT EVT package, to simulate the natural decline of evaporation with depth.

14.1.5 Mine Dewatering

The SURFACT Drain package (DRN) represented the drainage of groundwater into the open cut mining areas. Drain cells were assigned a nominal conductance of 100 m^2/day to ensure complete dewatering to the base of the mining area floor during each quarter. The modelled mine progression is shown in Figure 14.3.

Within the Carrington Pit model, drain cells were set in the model down to Layer 6, which represents the base of the Bayswater Coal Seam, the deepest mine formation. Mining was progressed down-dip (from north-west to south-east) over eight quarters. Once a drain boundary condition was applied, it remained active until completion of mining within the pit. Within the transient model, the Carrington Pit drain cells remained active until the start of Stage 2, when the void parameters were assigned.

Within the CWW extension area, the drain cells were set based on strip ratios used by MER (2010b). The mine sequence commenced down to the base of Layer 3 for a year, and then re-commenced the following year down to the base of Layer 6 in the already mined area, as shown in Figure 14.4.

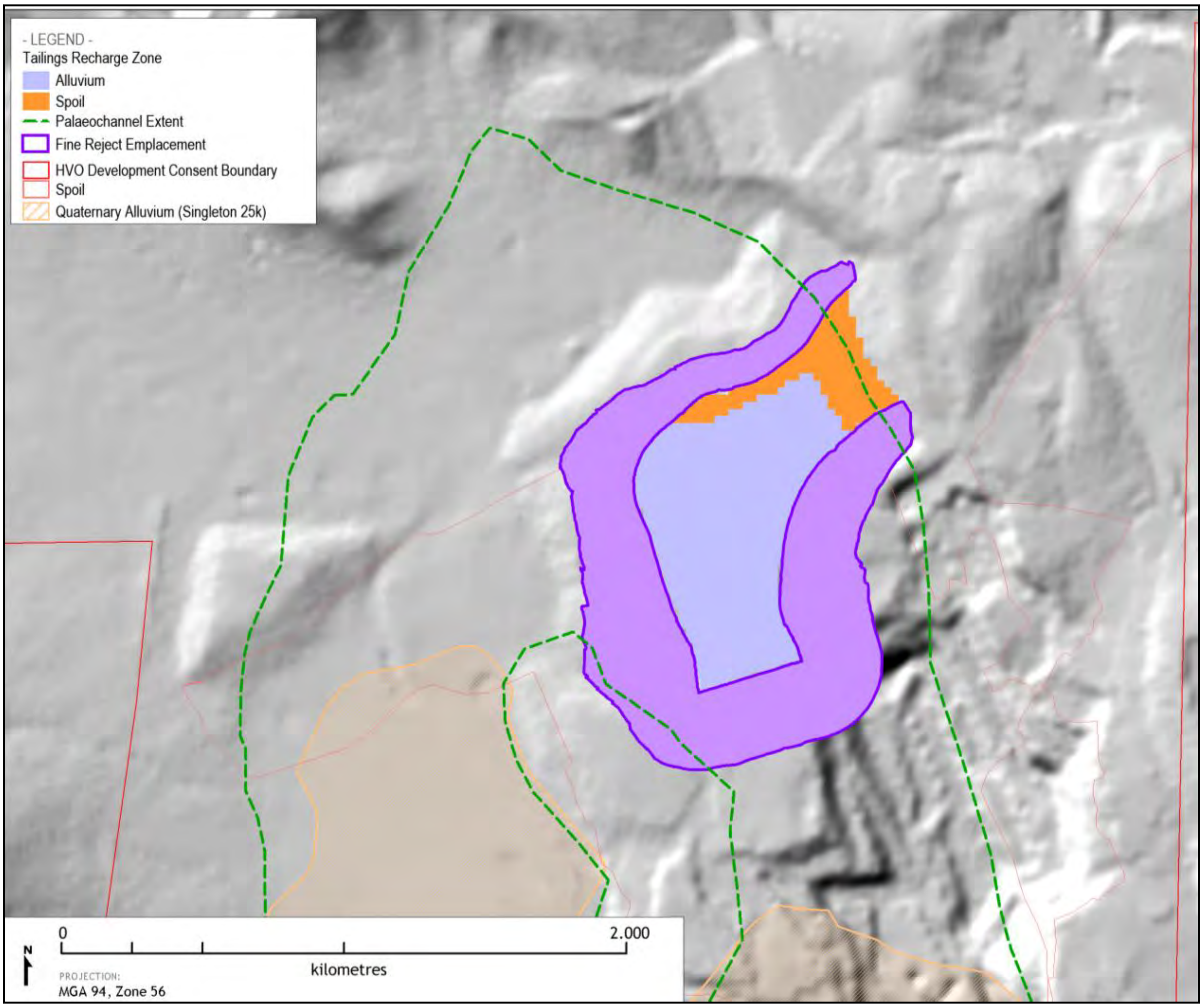
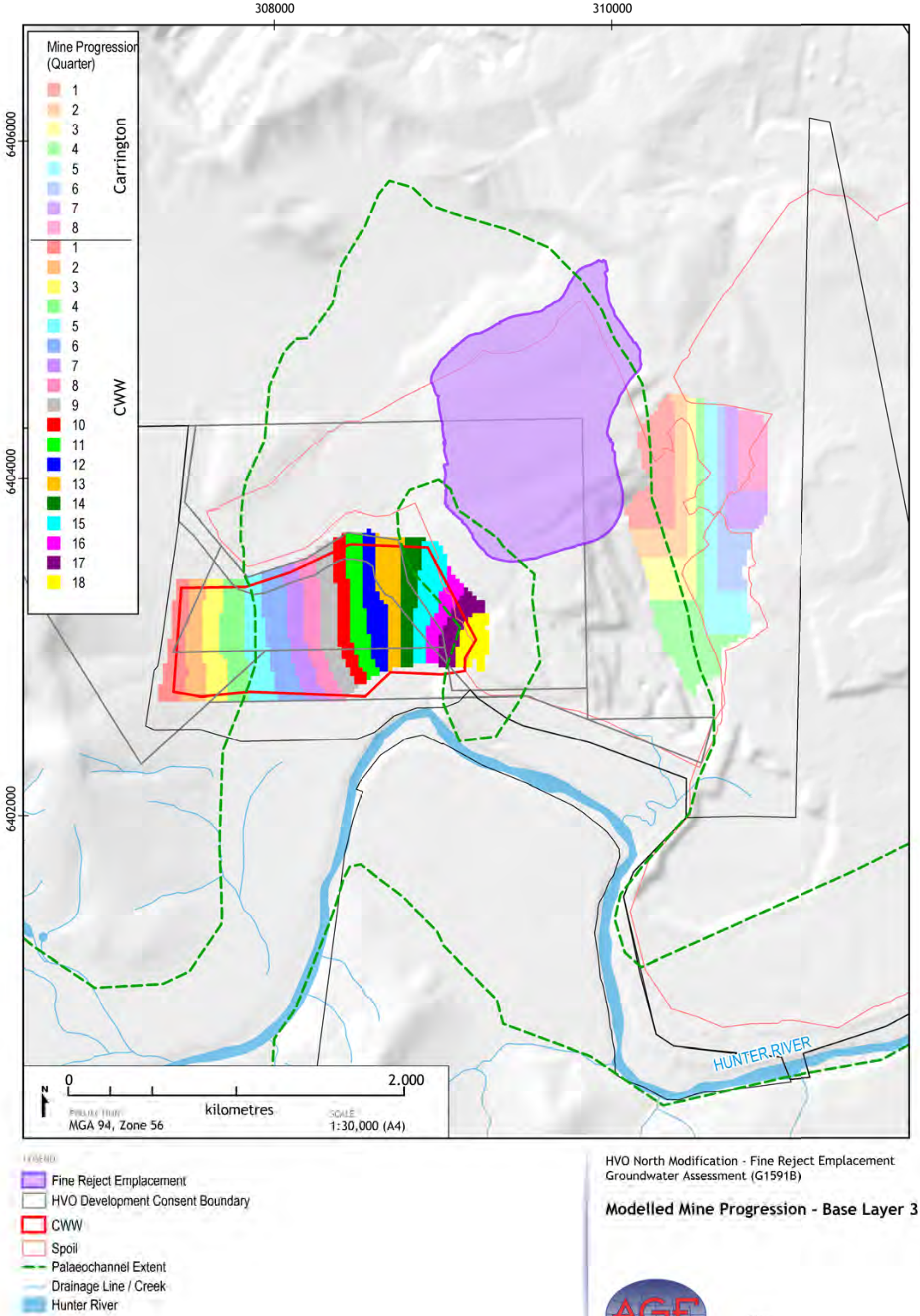


Figure 14.2: Proposed Fine Reject Emplacement Recharge Zones

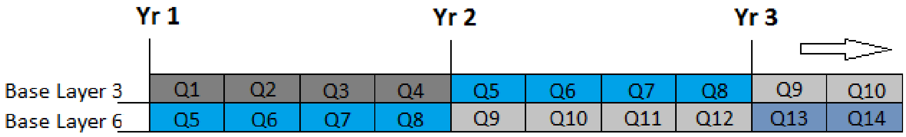


HVO North Modification - Fine Reject Emplacement Groundwater Assessment (G1591B)

Modelled Mine Progression - Base Layer 3

DATE: 5/6/2013

FIGURE No: **14.3**



Note: Yr = Year
Q = Quarter

Figure 14.4: Conceptual Mine Progression

14.1.6 Overburden Backfilling

Pit progression and the placement of spoil within the mining areas were simulated through a spoil rehabilitation process, with spoil emplaced once mining of the complete pit was complete and the dewatering became inactive. This was simulated independently for the two pits (Carrington Pit and CWW extension), with spoil emplacement commencing after two years of mining at the Carrington Pit, and after five years of mining at the CWW extension.

14.2 Piezometric Surface/Water Table Levels

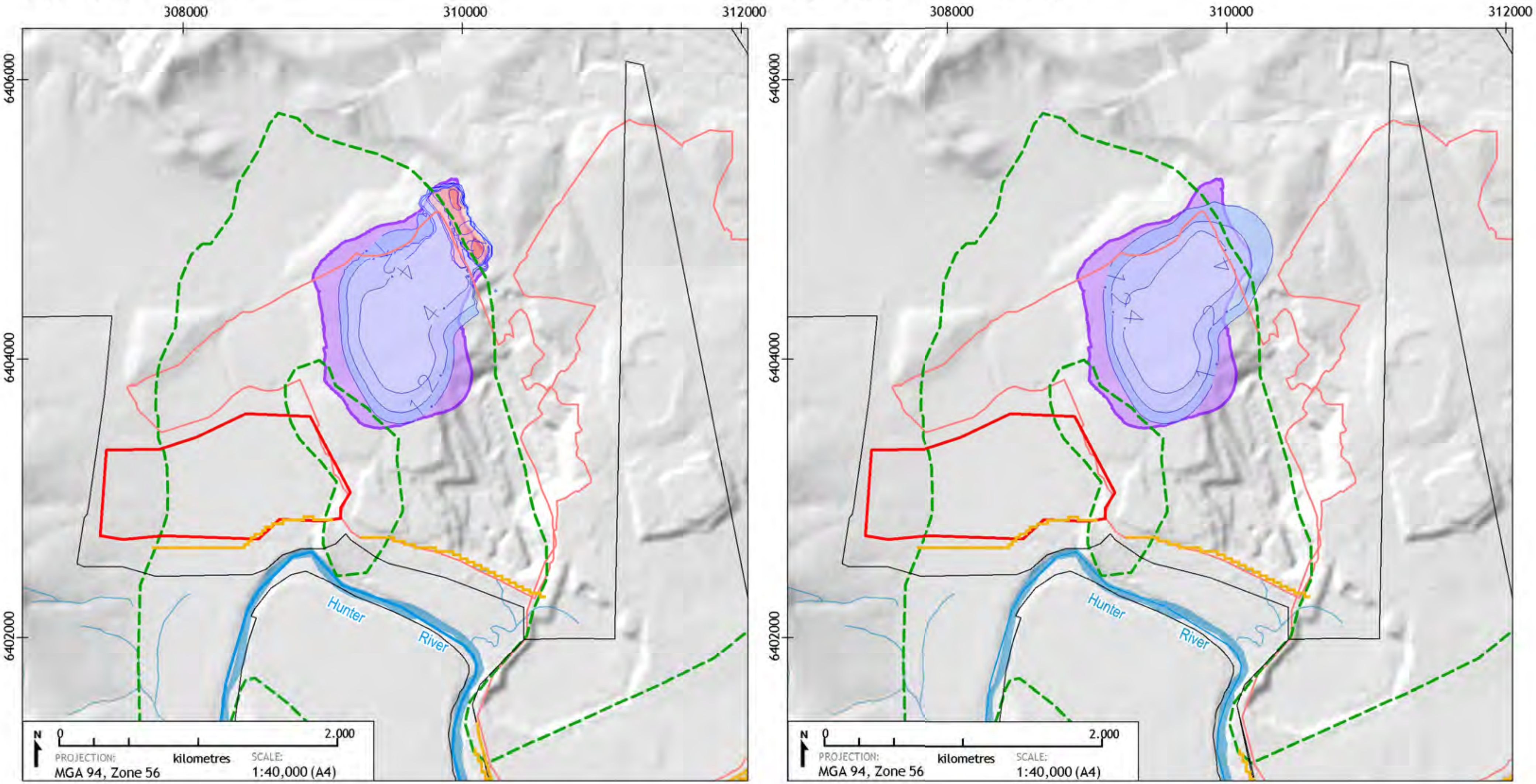
Predicted groundwater levels at the end of life of the proposed fine reject emplacement were compared against groundwater levels from model scenarios with no fine reject emplacement introduced. Comparison of the two groundwater levels shows the predicted change in groundwater levels, as a result of the proposed emplacement.

Figure 14.5 and Figure 14.6 show the predicted change in groundwater levels for the CWW model run, at the end of Stage 2 and Stage 3, respectively. The change in groundwater levels at the end of Stage 2 corresponds with the end of mining within the CWW, and shows the mounding as a result of the fine reject emplacement after 3.5 years of active use. Figure 14.5 shows that mounding will primarily occur within the footprint of the proposed emplacement for the upper alluvial/regolith sequences (Layer 1). The deeper coal measures (Bayswater Seam – Layer 6) exhibits a slightly wider area of mounding, however the mounding is predicted to remain below 5 m.

The change in groundwater levels at the end of Stage 3 corresponds with the end of life for the proposed fine reject emplacement, which highlights the maximum potential water level change from the emplacement. Figure 14.6 shows an increase in extent of the groundwater mounding since Stage 2 (3.5 years later). The mounding contours predicted at the end of Stage 3 show that the head change, as a result of the seepage has migrated further to the south-east. The 1 m contour of mounding in Layer 1 is now 600 m to the south-east of the emplacement footprint, and 450 m to the east. In the deeper coal seam sequences (Bayswater Seam – Layer 6), the mounding has extended 500 m to the south and south-east and 600 m to the east.

The modelling predicts that the head change resulting from the additional seepage is likely to be localised and will generally be within 500 m of the proposed modification. Over time the seepage will migrate to the south-east, toward the open cut pit and final void. This south-easterly migration of the seepage is driven by the flow of groundwater toward the open cut pit, as a result of depressurisation and dewatering.

Layer 1 (Alluvium) - Stage 2 / **Layer 6 (Bayswater Seam) - Stage 2**



LEGEND:

- HVO Development Consent Boundary
- Fine Reject Emplacement
- Barrier Wall
- Palaeochannel Extent
- Spoil
- CWW
- Drainage Line/Creek

Groundwater Mounding (m)

- 40 to 60
- 20 to 40
- 10 to 20
- 4 to 10
- 2 to 4
- 1 to 2

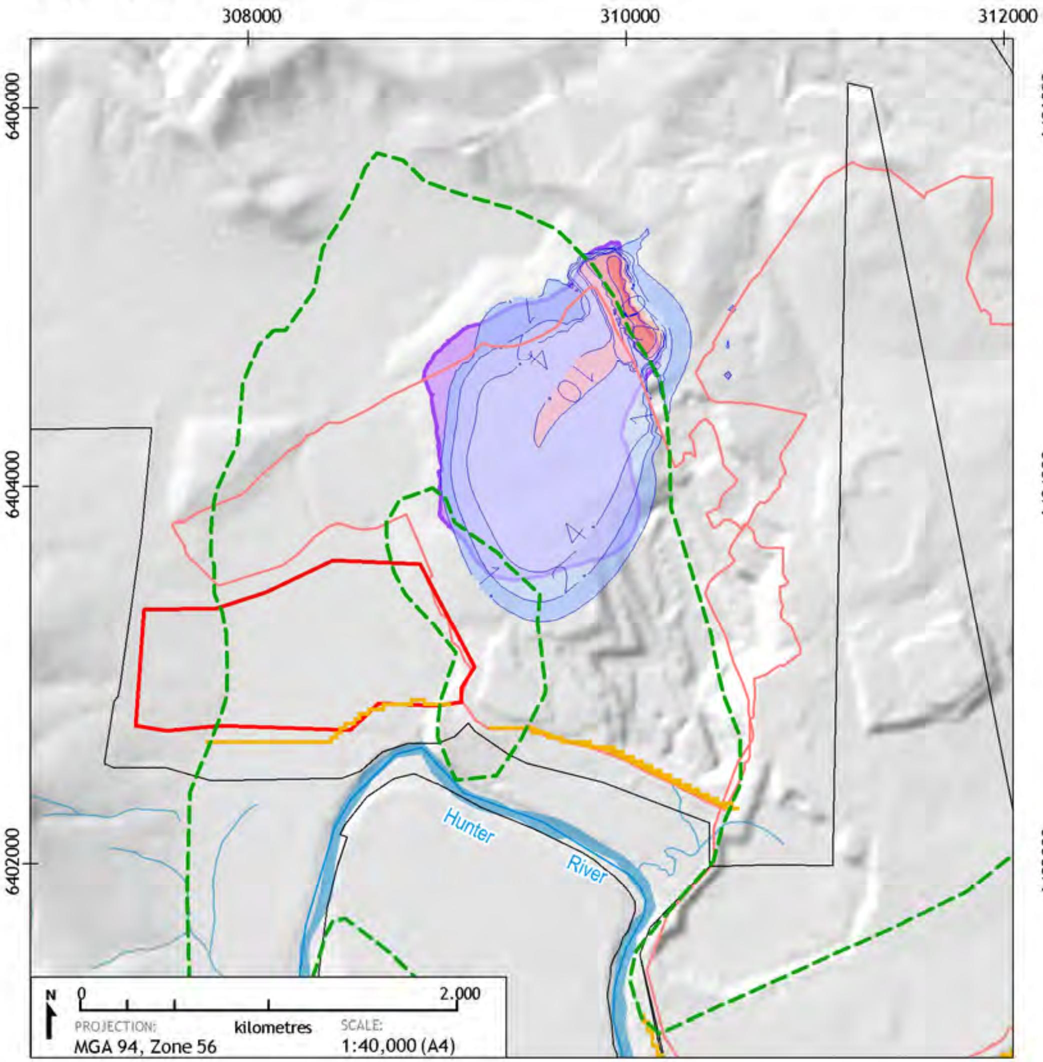
HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Mounding after Stage 2 - Layers 1 and 6

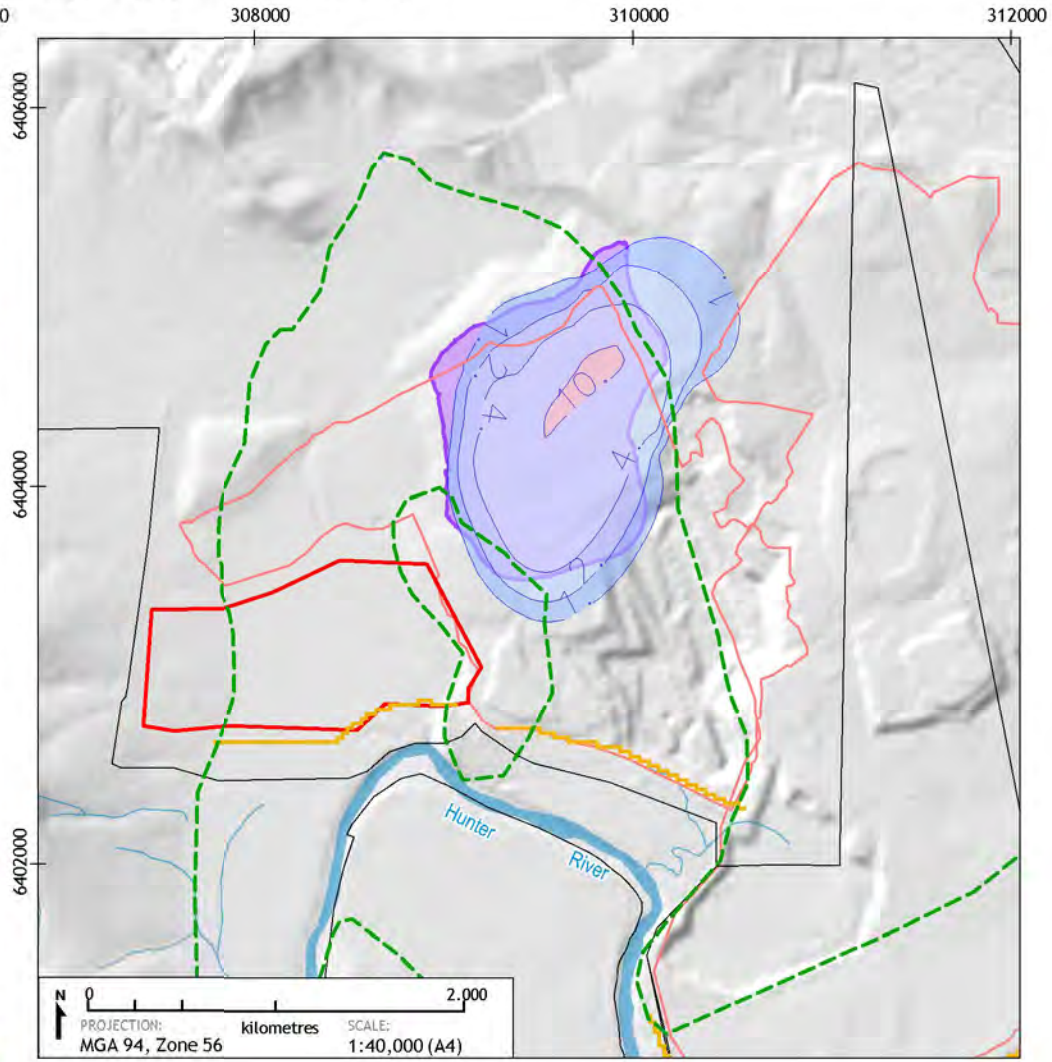
DATE:
5/6/2013

FIGURE No:
14.5

Layer 1 (Alluvium) - Stage 3



Layer 6 (Bayswater Seam) - Stage 3



LEGEND:

- HVO Development Consent Boundary
- Fine Reject Emplacement
- Barrier Wall
- Palaeochannel Extent
- Spoil
- CWW
- Drainage Line/Creek

Groundwater Mounding (m)

- 40 to 60
- 20 to 40
- 10 to 20
- 4 to 10
- 2 to 4
- 1 to 2

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Mounding after Stage 3 - Layers 1 and 6

DATE: 5/6/2013

FIGURE No: **14.6**

14.3 Impact on Groundwater Users

MER (2010b) identified that "*there are no identified private boreholes within 2.5 km of the pit crest that would be impacted in a measureable way. Nearest boreholes are located more than 2.5 km to the south and are constructed in shallow river alluvium. The alluvium would not be impacted by the proposed mining operations*."

The proposed modification would result in a net increase in water to the groundwater system, which will result in the short term increase (mounding) in groundwater levels in the vicinity of the fine reject emplacement. This mounding of groundwater will occur at a predicted maximum distance from the fine reject emplacement of 500 m to the south, 600 m to the east, and 400 m to the west (and Figure 14.6). As this mounding will not extend as far as the nearest private borehole, it is highly unlikely that the proposed modification will result in any impact to neighbouring groundwater users.

14.4 Inflow to Mined Void

ERM Mitchell McCotter (1999) presented predicted seepage inflow rates of 584 ML/year (1.6 ML/day) for the Carrington Pit, whilst MER (2010b) predicted total seepage for the CWW extension at an initial rate of about <0.01 ML/day to a final rate of 0.073 ML/day.

This revised model predicts that the rate of mine inflow for the Carrington Pit and CWW Pit are approximately 0.11 ML/day and 0.15 ML/day respectively (Figure 14.7). The inclusion of the fine reject emplacement in the predictive scenario has a negligible effect on the predicted pit inflow rates. The addition of the fine reject emplacement will locally increase water levels; however, groundwater flow is relatively slow, and it is unlikely that even with the high K values observed within the spoil and the increase in hydraulic heads, that seepage will not report to the open cut pits during active mining. This seepage water is likely to discharge into the void during groundwater level recovery mining has ceased.

The current modelling is predicting slightly higher rates of seepage to the CWW Pit than that predicted by MER (2010b). This is likely due to the way the backfilled spoil has been simulated in the respective models. MER (2010b) did not simulate the backfilling of the mined voids with spoil, rather the mined voids were maintained as drains. The approach adopted by MER (2010b) is considered conservative yet not entirely representative of what will happen in the mining environment. The current model includes backfilling of the spoil into mined out areas (as detailed in Section 14.1.6), which represents a higher volume of recharge entering the groundwater system. The current model results are considered conservative, as the recharge rate applied to the spoil was set at 5% of annual rainfall, which is considered the upper limit of deep recharge into spoil (Mackie, 2009).

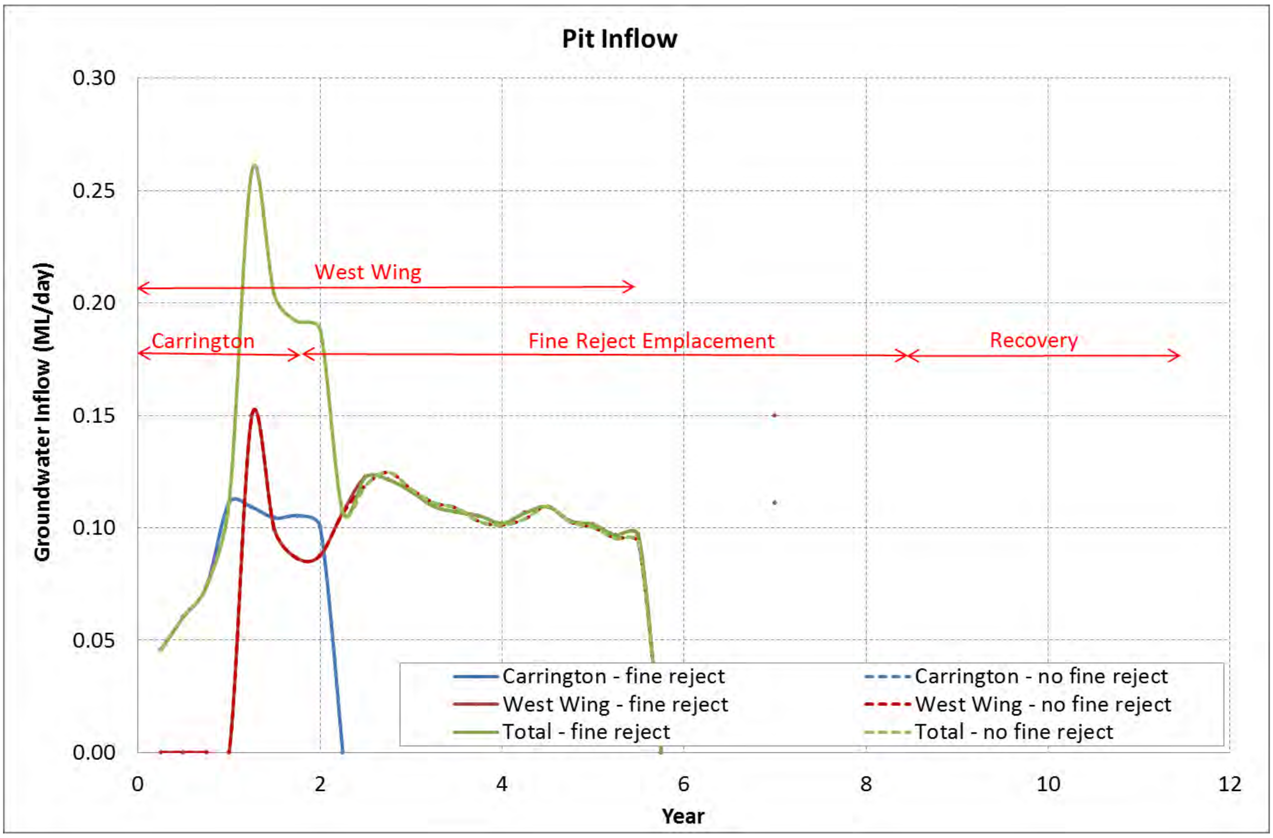


Figure 14.7: Simulated Seepage into Mined Void

14.5 Impact on Alluvium

Figure 14.8 shows the predicted modelled fluxes against time, with and without the proposed modification. The graphs show the predicted flow of groundwater from the model cells representing the alluvium to the regolith. The predicted water budget is also shown for the flow of water from the alluvium to the Permian, and from the alluvium to the spoil.

In the no fine reject model scenario (dashed lines), there is a flow of groundwater from the alluvium to the regolith of up to approximately 0.01 ML/day, and with the emplacement simulated in the model, it is predicted that this flux is reversed with a very minor flux of water from the regolith to the alluvium of 0.001 ML/day to 0.002 ML/day. This is likely to be due to slightly elevated heads in the regolith forcing groundwater back into the alluvium under a higher hydraulic gradient. Once the fine reject emplacement simulation is turned off in the model, the raw modelled fluxes return to those predicted pre-emplacement.

Groundwater flow from the alluvium to the model cells representing the Permian is predicted to be approximately 0.12 ML/day. With the application of fine reject, the flux from the alluvium to the Permian remains virtually identical, with only very minor changes noticeable in Figure 14.8.

Groundwater flow from the model cells representing the alluvium to the spoil model cells is predicted to be approximately 0.05 ML/day, with this flux decreasing slightly over the no fine reject scenario (to 0.02 ML/day). This gradual reduction occurs as a result of dewatering of the alluvium from mining. With the addition of fine reject, this flux from the alluvium to the spoil increases to approximately 0.07 ML/day.

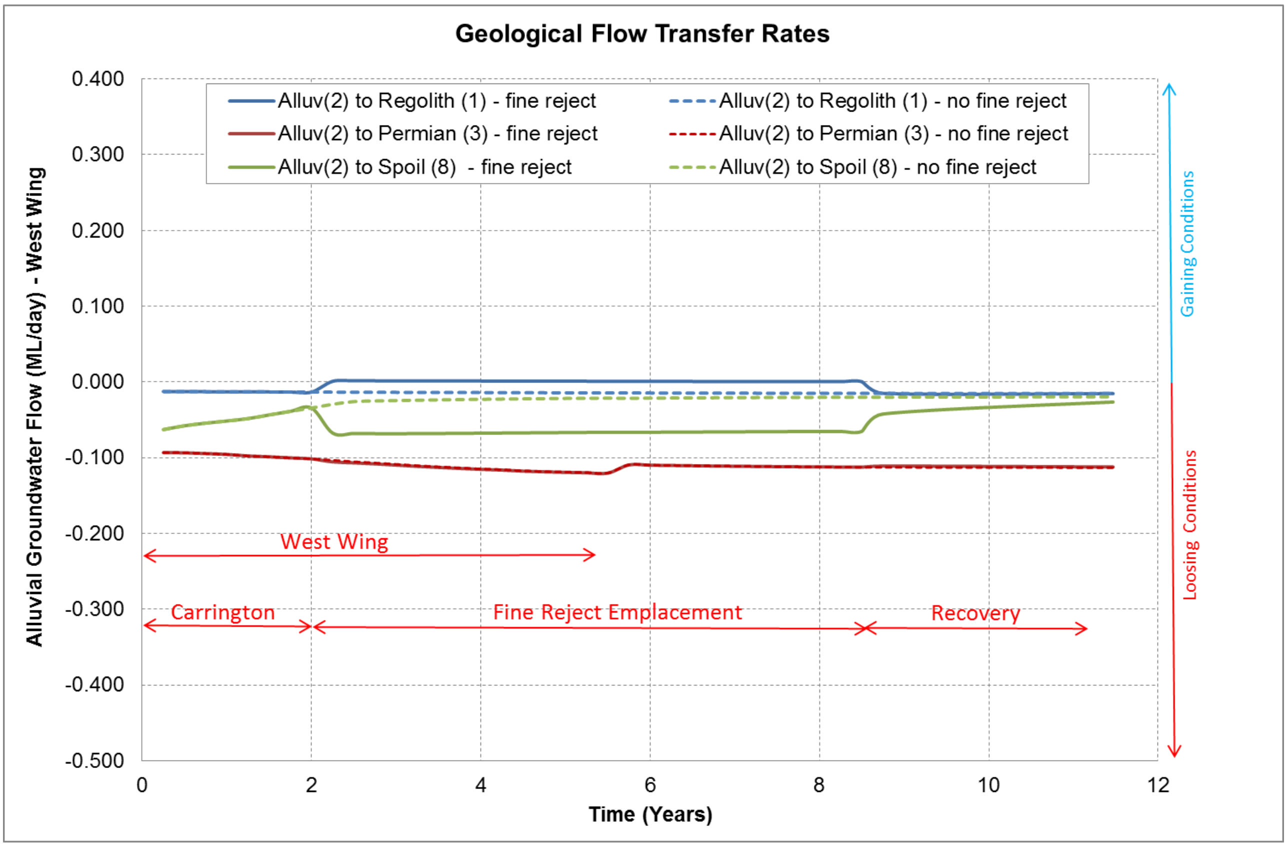


Figure 14.8: Simulated Net Flow to Alluvium

Figure 14.9 shows the net change in these predicted model fluxes for the CWW model. The net change was determined by subtracting the modelled flows in the no fine reject emplacement predictive model from a model scenario that included the emplacement.

Figure 14.9 shows that as a result of the emplacement, there is a net change in the flux from the alluvium to the regolith and from the alluvium to the spoil. The application of fine reject results in a net change in flow (0.02 ML/day) from the regolith back to the alluvium. This is likely to be due to slightly elevated heads in the regolith forcing groundwater back into the alluvium under a higher hydraulic gradient.

During the application of fine reject emplacement, there is predicted to be a maximum change in flow from the alluvium to the spoil of 0.05 ML/day. Once the fine reject emplacement is decommissioned, the net change in flow steadily reduces from 0.05 ML/day to 0.02 ML/day. There is no appreciable change in flux from the alluvium to the Permian strata predicted.

It should be noted that the simulated seepage from the fine reject emplacement is 0.859 ML/day; however, the maximum predicted net change in flow is only 0.05 ML/day. This is because a large component of this seepage will not flow far from the footprint area and will result in a change in storage in both the alluvium and spoil beneath the emplacement. This change in storage is expressed as localised mounding of the water table.

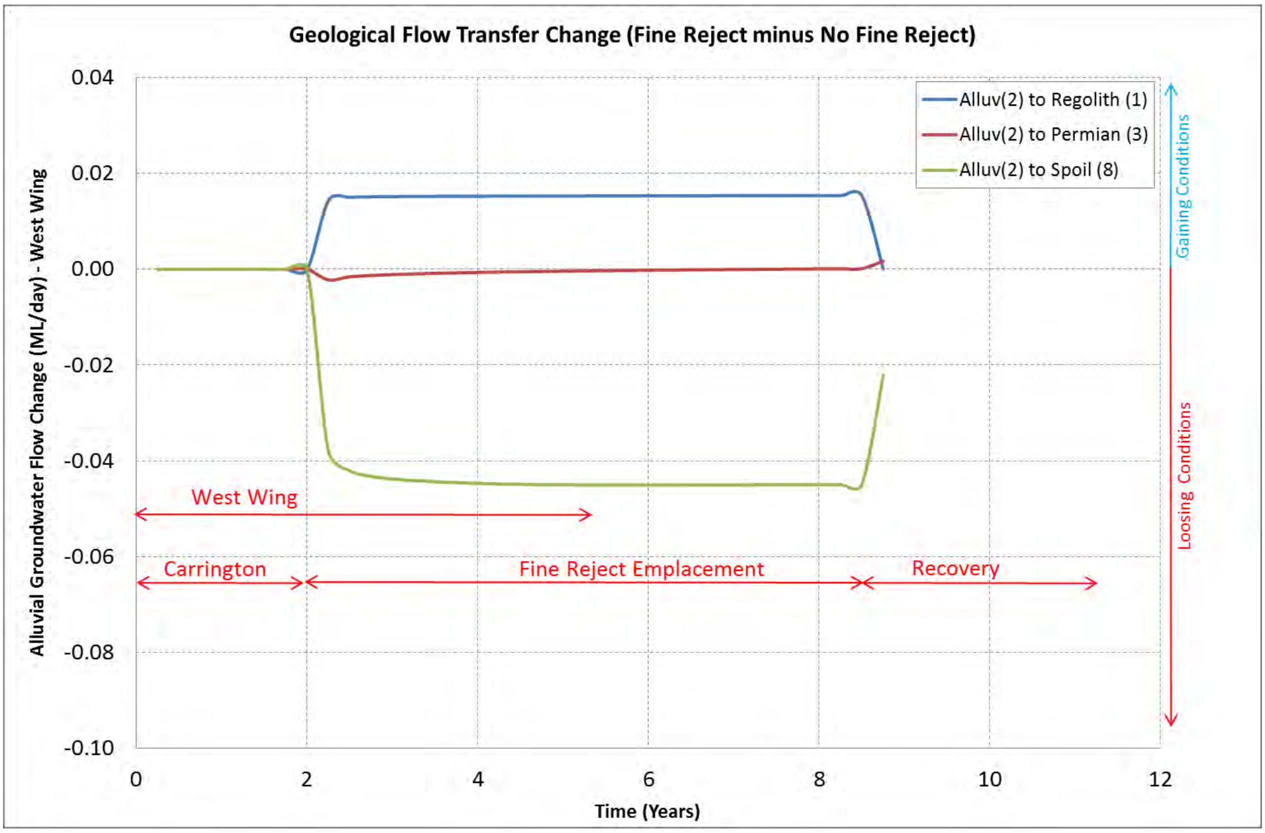


Figure 14.9: Simulated Net Flow Change to Alluvium

14.6 Impact on Surface Water Flow

The model suggests that in general the Hunter River is a losing river, that is, the river leaks water to the underlying strata. MER (2010b) predicted that the impact on the Hunter River (in terms of baseflow, leakage losses) was up to approximately 0.05 ML/day (0.002 ML/day to 0.048 ML/day). For the current modelling the predicted change in Hunter River leakage for the two scenarios are shown in Figure 14.10. As detailed in Figure 14.10, the total length of the Hunter River within the model domain has been segregated into two zones – a 'East' zone and a 'West' zone with the division of the two located coincident with the division of the eastern and western limbs of the palaeochannel.

The predicted water budgets on the Hunter River indicate that the net leakage steadily increases from 0.09 ML/day and 0.07 ML/day for the east and west zones respectively, to rates of 0.1 ML/day and 0.09 ML/day after decommissioning of the fine reject emplacement. The slight increase in leakage is explained through the longer term depressurisation of the Permian strata and Quaternary Alluvium as a result of open cut mining at HVO North. The net river leakage flow rates are slightly higher than those predicted by MER (2010b). This is likely due to the increase in recharge through the spoil and into the groundwater system, and the use of a recharge rate of 5% of annual rainfall for the spoil.

Figure 14.11 shows the net change in river leakage as a result of the fine reject. The net change for the numerical model is predicted to be negligible (less than 3 L/day).

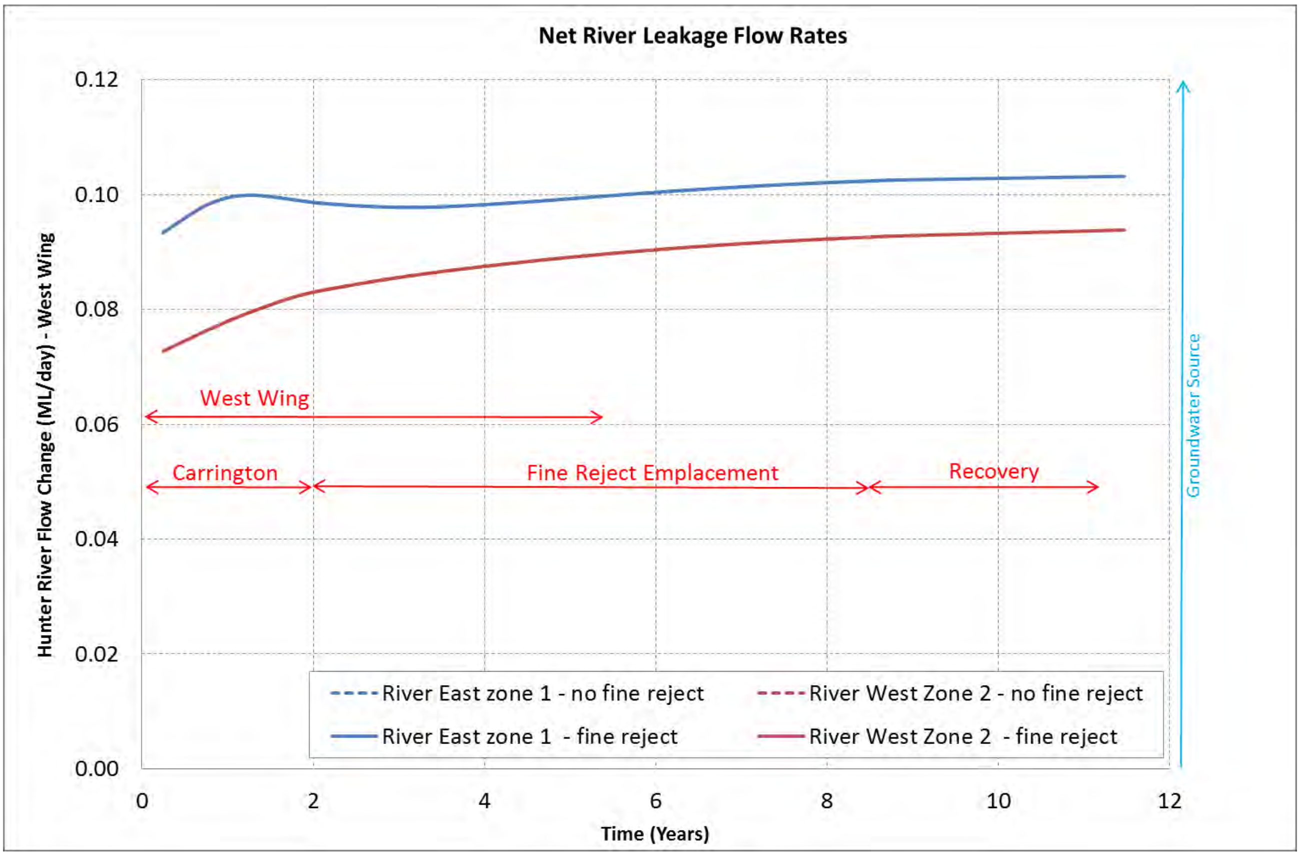


Figure 14.10: Surface Water Budgets

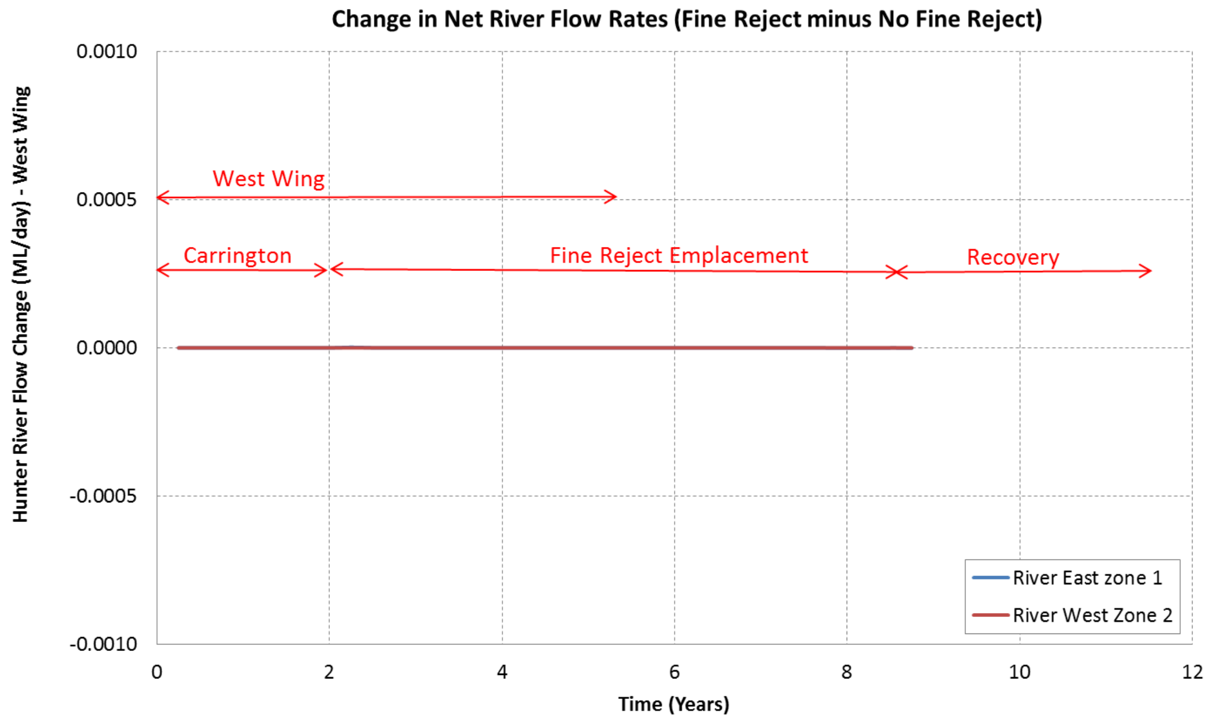


Figure 14.11: Net Change in Surface Water Flow

14.7 Groundwater Dependent Ecosystems

The only GDE identified within the vicinity of HVO North is the Carrington Billabong River Red Gums (Umwelt, 2007). Groundwater monitoring is specifically carried out in this area to monitor any drawdown or depressurisation within the alluvial sediments as a result of mining. The presence of the artificial barrier wall in this location has mitigated any potential impact to the GDE from mining. In this regard, the barrier wall is considered to be effective.

The proposed modification will have the effect of adding water into the local groundwater budget. However, this addition of water is localised to an area some 500 m surrounding the emplacement footprint. In between the fine reject emplacement and the Carrington Billabong lies the Carrington Pit and the barrier wall. The Carrington Pit is effectively a localised sink and the barrier wall is an artificial structure designed to impede groundwater flow. Therefore, the presence of the pit, the barrier wall and the localised extent of mounding from the fine reject emplacement means that there would not be any impact to the Carrington Billabong from the proposed modification.

14.8 Mining Phase Water Budget Summary

Figure 14.12 shows the changes to key component water budgets over the predictive timeframe for the CWW model. Recharge to the model domain dominates the model water budget averaging 1.7 ML/day. After the fine reject emplacement is decommissioned in Year 8.5, the recharge to the model is maintained by additional recharge to the final void and the backfilled spoil.

Drains representing pit dewatering are the main mechanism removing water from the models. The numerical model predicted an average rate of groundwater loss from the drain cells of 0.15 ML/day, with a maximum rate of 0.34 ML/day. This flux reduces to 0.001 ML/day after completion of active mining, which represents groundwater loss through drain cells representing surface water features (i.e. creeks and rivers). The change in modelled budgets for the river cells is less than 0.0039 ML/day for the CWW model.

Evapotranspiration steadily increases to a maximum rate of 7.5×10^{-5} ML/day (75 L/day) at the end of the model scenario. Evapotranspiration is simulated from the Carrington Pit final void once water levels begin to recover post mining.

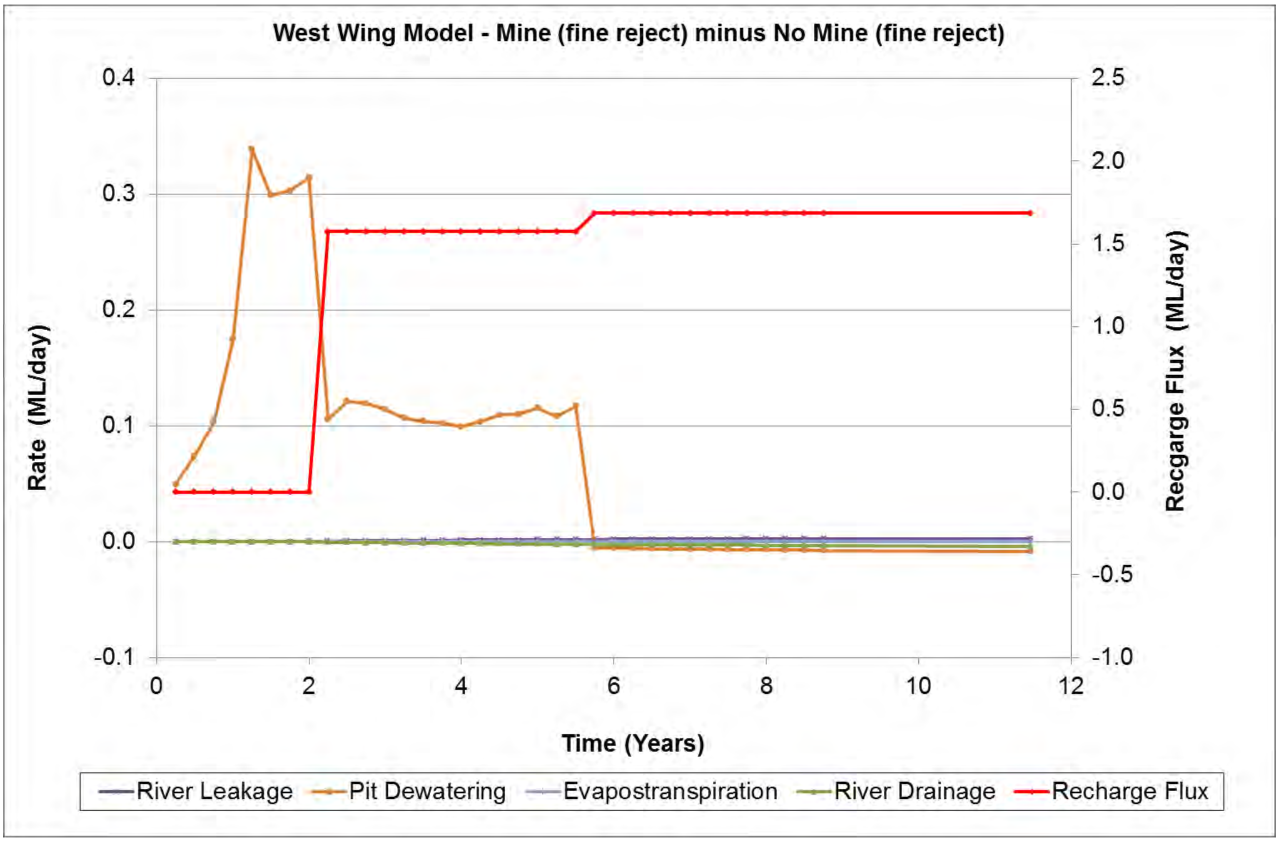


Figure 14.12: Predicted Water Budget

14.9 Groundwater Recovery

Modelling carried out by MER (2010b) predicts that "*after more than 50 years of recovery, the long term open void water level is designed to stabilise at about 40mAHD*". Current approval is for a 65 ha evaporative sink after mining, with the CWW extension to take this to between 85 ha to 100 ha in size. The final void simulated within the current model covered an area of 100 ha, and was located within the proposed Carrington Pit.

The seepage from the fine reject emplacement is likely to reduce after decommissioning and active deposition and decant stops. Subsequent to decommissioning, recharge to groundwater within the emplacement footprint is highly likely to reduce to rates approaching those occurring pre-mining. The seepage rate from the fine reject emplacement is likely to reduce to background recharge rates soon after decommissioning (Year 6 of operation) and hence the seepage is unlikely to influence either the final void water level or the approximate time taken to stabilise.

14.10 Sensitivity Analysis

Parameter sensitivity was explored through additional model scenario runs and varying key parameters values. These parameters were considered potentially sensitive to the model with impacts on predictive inflows and model fluxes. The sensitivity analysis assesses the following parameter ranges:

- a ±1 order of magnitude change in horizontal and vertical hydraulic conductivity of all model layers (excluding void and spoil);

- a ±1 order of magnitude change in specific storage and a ±50% change in specific yield of all model layers (excluding void and spoil): equating to a change in the storativity (storage coefficient); and
- a ±50% change in recharge (excluding void and spoil).

The sensitivity analyses focus on the impact of the introduction of fine reject emplacement has on the groundwater environment. The sensitivity of the predicted pit inflow rates from the parameters changes have also been analysed. Table 15 summarises the key model outputs resulting from changes in the model parameters.

Table 15: SUMMARY OF SENSITIVITY ANALYSES

Parameter	**Average Daily Pit Inflow (ML/day)**	**Maximum Daily Pit Inflow (ML/day)**	**Average Change in Alluvial/Spoil Flow (ML/day)**	**Max Change in Alluvial/Spoil Flow (ML/day)**	**Average Change in Hunter East Streamflow Loss (ML/day)**	**Max Change in Hunter East Streamflow Loss (ML/day)**
Baseline	0.12	0.26	-0.04	-0.05	0.00	0.00
hc/vhc +1mag	0.50	0.84	-0.02	-0.03	0.00	0.00
hc/vhc -1mag	0.05	0.08	-0.04	-0.05	0.00	0.00
SS +1 mag/SY +50%	0.16	0.34	-0.04	-0.04	0.00	0.00
SS -1 mag/SY -50%	0.10	0.18	-0.05	-0.05	0.00	0.00
recharge +50%	0.13	0.26	-0.04	-0.04	0.00	0.00
recharge -50%	0.12	0.25	-0.04	-0.05	0.00	0.00

Notes: hc – Horizontal and Vertical Hydraulic Conductivity
SY – Specific Yield
SS – Specific Storage

14.10.1 Predictive Mine Inflow Rates

Figure 14.13 summarises the sensitivity of the predicted mine inflow rates to changes in hydraulic conductivity, storage and recharge rates. The predicted mine inflow seepages are most sensitive to changes in the horizontal and vertical hydraulic conductivity rates. Increasing the hydraulic conductivity by an order of magnitude raises the predicted inflow by between 0.2 ML/day to 0.65 ML/day during the mining phase from the base-case.

Varying the aquifer storage parameters of the country rock and alluvium results in a moderate change on the predicted mine inflow seepages. An order of magnitude change to the specific storage, and a 50% change in specific yield generally induces a minor change of ±0.03 ML/day in the predicted mine inflow from the base-case model results. Varying the recharge rates has a minimal impact on the predicted inflow rates to the mine.

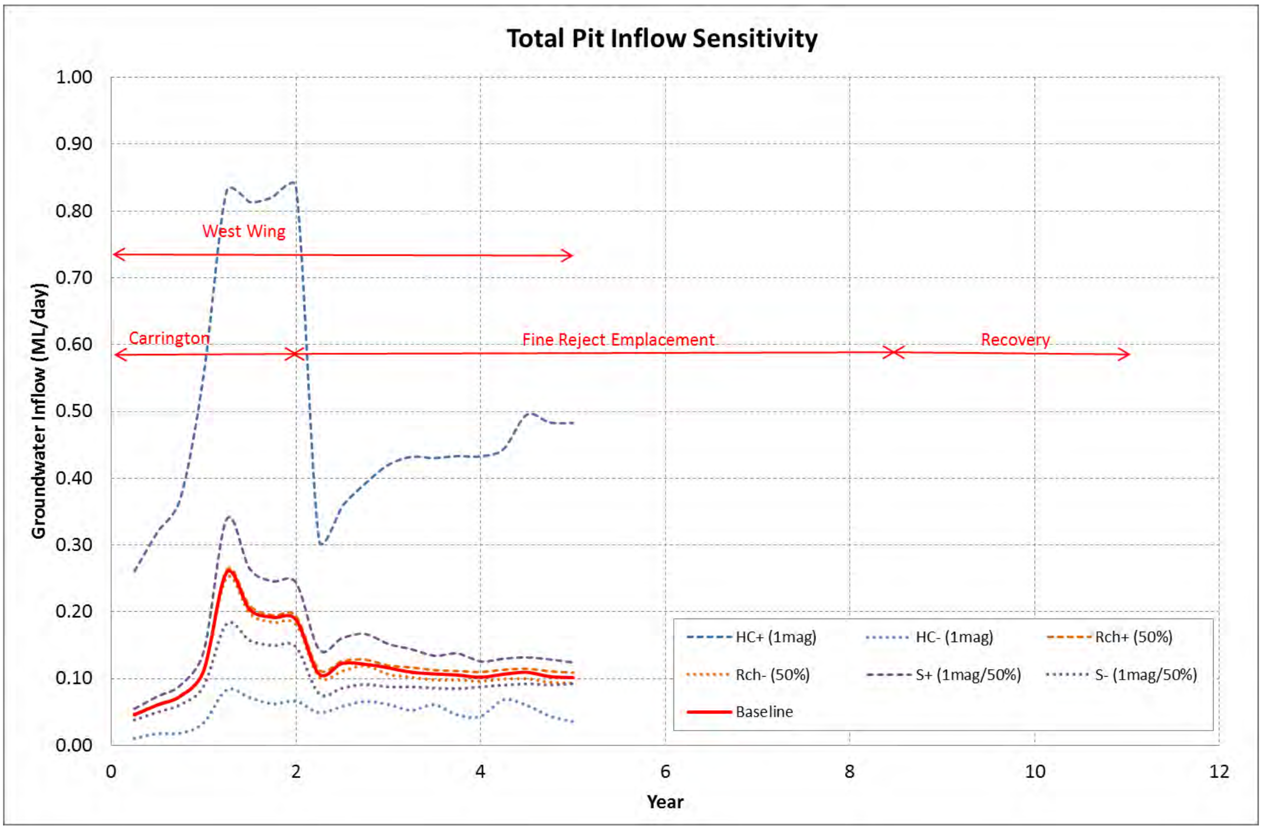


Figure 14.13: Sensitivity Analysis – Pit Inflows

14.10.2 Alluvial Transfer Flow

Another key model prediction is the change to the transfer rate of water from the alluvium to the adjacent spoil. The base-case model predicts that the application of fine reject seepage will increase the rate of groundwater flow from the alluvium to the spoil by up to 0.05 ML/day. The sensitivity analysis assessed the sensitivity of this prediction to changes in hydraulic conductivity, storage, and recharge.

Figure 14.14 presents the sensitivity analyses on the reduction in groundwater flow from the alluvium to the spoil in response to fine reject seepage. Varying the hydraulic conductivity rates, storage properties and recharge rates result in very minor changes to the base-case model predictions. Increasing the hydraulic conductivity by an order of magnitude decreases the predicted seepage from alluvium to spoil by up to 0.03 ML/day. While changes to storage parameters and recharge rate only varied the predicted transfer of water from the alluvium to the spoil by up to 0.002 ML/day.

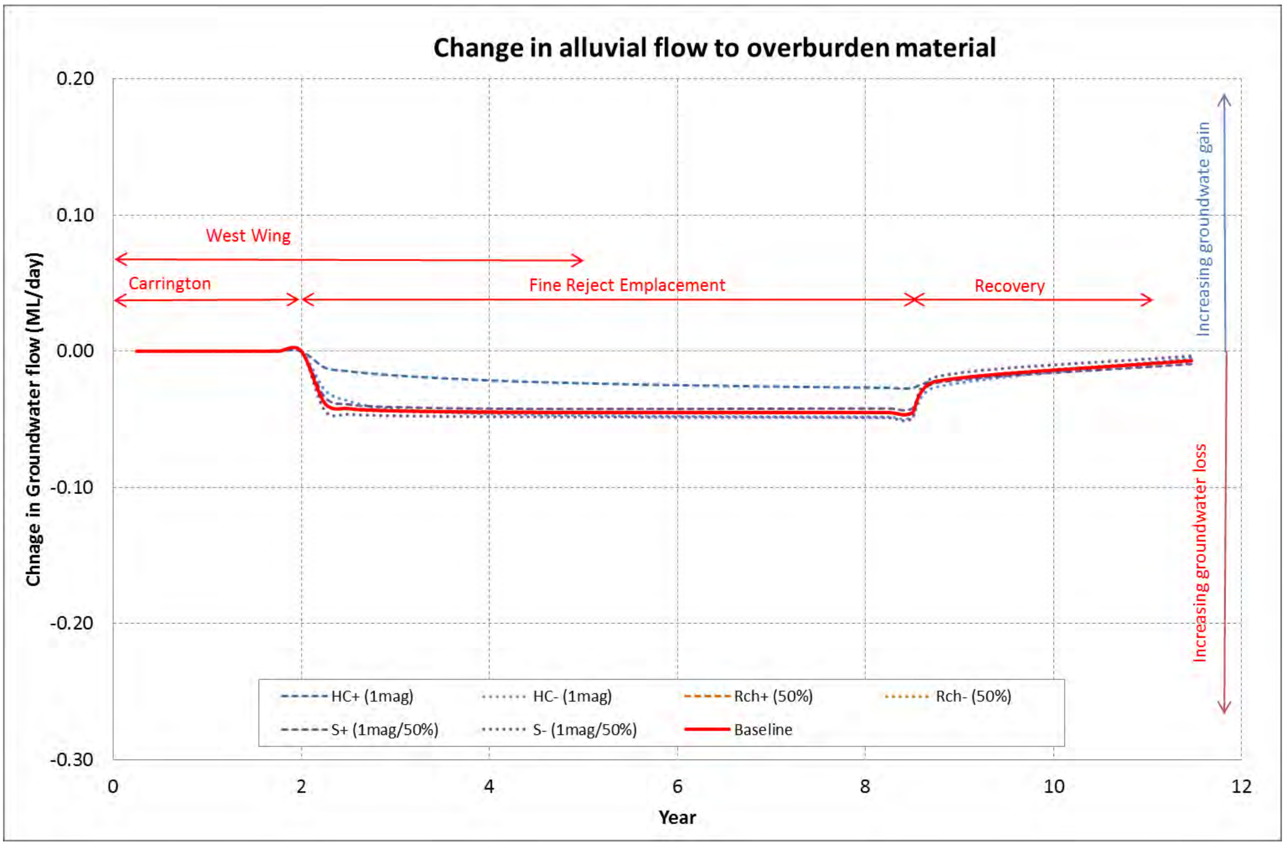


Figure 14.14: Sensitivity Analysis – Layer Fluxes

14.10.3 Hunter River Net Groundwater Leakage

The last key prediction analysed in the sensitivity analysis was the change in net leakage from the Hunter River to the underlying groundwater systems. The base-case model predicts that the fine reject emplacement will have a negligible impact on groundwater transfer to and from the Hunter River. Figure 14.15 presents the sensitivity of the predicted Hunter River net leakage to hydraulic conductivity, storage and recharge.

The sensitivity analysis indicates that by varying the hydraulic conductivity rates, storage properties and recharge rates, results in negligible impact on the predicted change in net river leakage. The change is predicted to be less than 18 m^3/day.

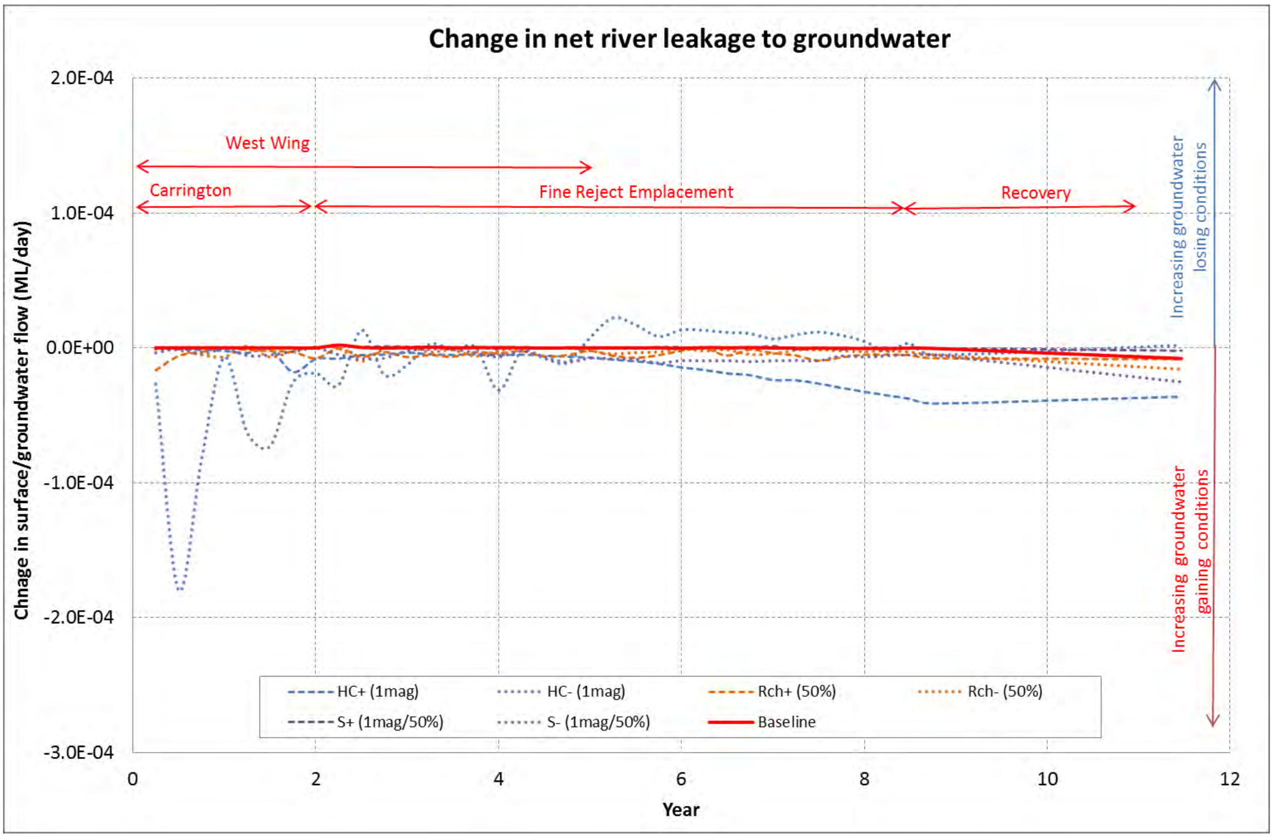
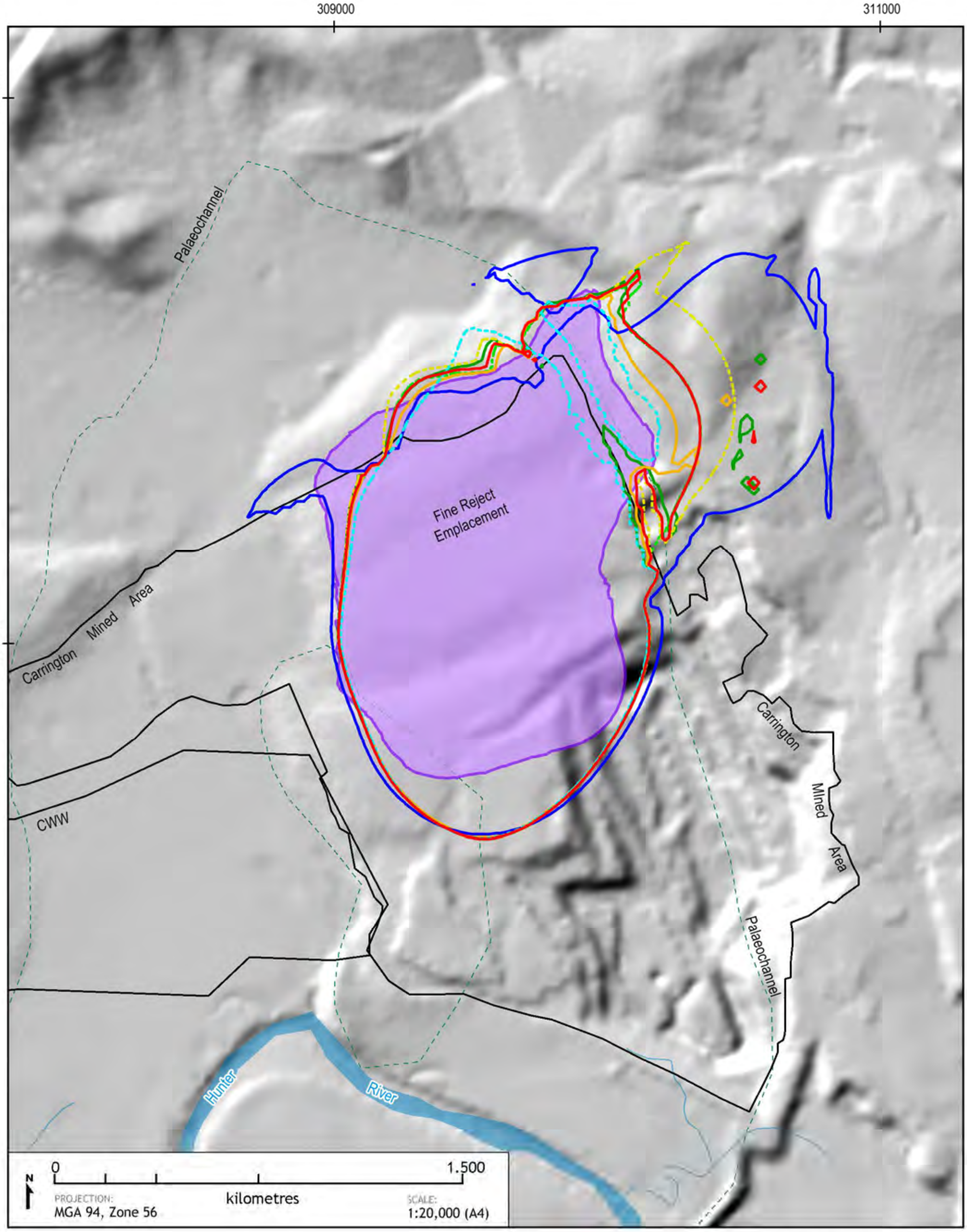


Figure 14.15: Sensitivity Analysis – River Leakage

14.10.4 Zone of Groundwater Mounding

The sensitivity of the model predictions is also presented in terms of the predicted groundwater mounding that will occur in the spoil, alluvium and regolith. Figure 14.16 presents a snap shot where groundwater mounding is most extensive from the mining areas at Year 8.5 (Stage 3).

Groundwater mounding within Layer 1 is most sensitive to changes in hydraulic conductivity. Figure 14.16 shows that the 1 m mounding contour extends from a distance of 500 m to 600 m for the base-case model prediction, to a maximum distance of 500 m to 800 m when the model hydraulic conductivity is increased by an order of magnitude. The extent of groundwater mounding in model Layer 1 is relatively insensitive to changes in storage and recharge.



LEGEND:

- Baseline
- Hydraulic Conductivity - 1 Magnitude
- Hydraulic Conductivity +1 Magnitude
- Recharge -50 Percent
- Recharge +50 Percent
- Fine Reject Emplacement
- Storage -1 Magnitude
- Storage +1 Magnitude

HVO North Modification - Fine Reject Emplacement
Groundwater Assessment (G1591B)

Sensitivity Analysis (Stage 3, Layer 1)
1m Mounding Contours

DATE: 03/01/2013

FIGURE No: **14.16**

14.11 Limitations

Development, calibration and the results of predictive simulations from any groundwater model are based on available data characterising the groundwater system under investigation. It is not possible to collect all the data characterising the whole aquifer system in detail, and therefore various assumptions are made during development of all groundwater models. A number of assumptions were made during development of the groundwater model. This report presents these assumptions and the results of their impact on the simulation are discussed. Where an assumption was necessary, a conservative approach was taken, such as adopting model parameters from plausible ranges, so that the model would likely over predict changes and impacts and therefore be representative of the worst-case scenario.

It is important for the reader to understand that a model can only approximate natural phenomenon that occurs in groundwater systems. Although it is well calibrated, there remain limitations for long-term predictive use. The CWW model should follow an evolutionary path and be updated as more data (particularly in the areas proposed for mining) becomes available.

The numerical model has been developed as a conservative impact assessment tool and is not required to include complex geological structure. The model adopts a conservative approach and is based upon a sound conceptual model and a suitable steady state and transient calibration. The model is considered to be more than suitable for predicting impacts of the proposed modification.

15 SUMMARY

The analytical assessment predicted that the fine reject emplacement could produce up to 703 m^3/day of seepage after accounting for rainfall and evaporative loss. This steady state solution is considered to be a “conservative” or “worst case” estimate. The calculations are based on the maximum hydraulic head within the fine reject emplacement which will only occur during the final stages of deposition. The analytical solution is comparable to the observed site data.

The seepage assessment was further carried out using numerical models both in 2D and 3D. Two SEEP/W sectional models were developed for the fine reject emplacement and seepage rates of 859 m^3/day and 777 m^3/day were predicted. These seepage rates are comparable to the analytical solution and site water balance estimates and were applied to an existing 3D numerical model. The 3D modelling allows for the prediction of impacts to the existing groundwater regime, users and environment.

The fine reject emplacement will result in mounding of groundwater beneath and immediately adjacent to the emplacement footprint. The extent of groundwater level change is predicted to occur at a maximum distance of 500 m to 600 m from the footprint. The maximum mounding in the Bayswater Coal Seam is predicted to be 11.2 m for the CWW model. The height of mounding is predicted to reduce to approximately 7.5 m, three years following closure of the fine reject emplacement.

The CWW Pit seepage is predicted at slightly higher rates than predicted by MER (2010b). This is likely due to the way the backfilled spoil has been simulated in the respective models. However, the proposed modification does not impact the predicted inflow to the mined voids.

The model predicts that the seepage will not flow far from the fine reject emplacement footprint, and will result in a change in storage in both the alluvium and spoil beneath the fine reject. This change in storage is expressed as localised mounding of the water table.

The model predicts that the impact of the proposed modification on flow in the Hunter River and associated alluvium is negligible. As the mounding predicted by the model is localised, there will be no impact on the Carrington Billabong GDE. Furthermore, the closest privately owned bores are located approximately 2.5 km south of Carrington Pit, and given the localised effect of mounding due to seepage, there is unlikely to be any impact to these bores from the proposed modification.

16 WATER QUALITY

The following discussion relates to a qualitative assessment on probable changes to groundwater quality over time as a result of the proposed modification.

With regards to mine seepage, MER (2010b) predicted that "*the quality of groundwater entering the mine pit is expected to reflect an average of water quality for the alluvium and coal measures generally. Based on current monitoring, the quality is expected to be in the range 2000 to 8000µS/cm with a likely average value of about 4000µS/cm determined from coal measures water samples*."

With the addition of a fine reject emplacement, this prediction regarding the quality of mine seepage is still considered to be accurate with regards to the likelihood of groundwater quality reporting to the open cut pit. The fine reject emplacement is predicted to add a maximum of 800 m^3/day to 900 m^3/day to the local groundwater system. The quality of the fine reject seepage is expected to be comparable to that currently observed at the existing facility, which is slightly alkaline water with EC in the range of 1,000 µS/cm to 6,000 µS/cm. Whilst the anion and cation ratios of the fine reject seepage is different from the Permian groundwater, the fine reject seepage is not significantly different in quality to that observed within the Permian strata. Numerical modelling predicts that the seepage from the proposed modification is unlikely to reach the open cut within the active mining period. The extra seepage to the open cut pit from the fine reject emplacement is predicted to be negligible and will be considered insignificant in the mine water balance.

With regards to final void groundwater quality, MER (2010b) predicted that "*the long term void water quality is considered most likely to exhibit a pH range from 7.5 to 9.5, a TDS range from 1,000mg/L increasing to about 3,000-4,000mg/L in the long term with a speciated signature Na>Mg>Ca and HCO_3>Cl>SO_4 if rejects are not emplaced. If they are then SO_4 may become more dominant. This characterisation is similar to the regional groundwater quality observed in the coal measures. It differs from the pre-mining palaeochannel groundwater quality in so far as bicarbonate is more dominant than chloride – the void water is less saline*."

Seepage from the fine reject emplacement will not occur into perpetuity. After it is decommissioned and active deposition and decant stops, rainfall recharge will be the only input to the fine reject emplacement and the outputs will be drainage under gravity and evaporation from the surface and embankments. After decommissioning, recharge to groundwater within the fine reject emplacement footprint is also highly likely to reduce to rates approaching those occurring pre-mining. The seepage from the emplacement is likely to result in a similar water quality prediction as if rejects are emplaced in the final void. Fine reject seepage is more sulphate dominant which would increase the total concentration of sulphate in the final void.

17 WATER LICENSING

Licensing under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources* is required to account for any reduction of flow to the alluvium. The current Carrington operations already have approvals to account for any alluvial water loss and MER (2010b) presents any additional licensing required for the CWW.

The modelling for the proposed modification predicts that there is no additional alluvial loss or river leakage, and as a result, there is no additional licensing required as part of the approval process to offset these losses.

18 MANAGEMENT AND MONITORING

Groundwater management is currently undertaken in accordance with the existing Water Management Plan (WMP) for HVO North. This WMP includes scheduled monitoring of a number of groundwater facilities within and around the HVO North site (Table 16). This monitoring is undertaken as a strategy to assess potential impacts relating to:

- Open cut depressurisation;
- Continuing loss of coal measures aquifer pressures;
- Change in groundwater quality in coal measures; and
- Leakage of groundwater from shallow aquifers.

Groundwater level change is predicted to be limited to localised mounding beneath and adjacent to the fine reject emplacement, as a result there are no specific management measures that are proposed as part of the proposed modification.

It is recommended that the monitoring bores and vibrating wire piezometers (Table 5) installed as part of this assessment be included in the groundwater monitoring plan for the Carrington Pit. The purpose of these bores will be to monitor the water levels beneath the fine reject emplacement to ensure that the water level mounding that will occur is consistent with model predictions. It is recommended that no additional monitoring bores be installed.

It is recommended that installation of electronic water level loggers in all monitoring bores be considered. The electronic water level loggers should be programmed to record water levels at six-hourly intervals, and continue for the life of the proposed modification. It is recommended that these new installations be manually measured monthly for groundwater levels, and every two months for the following water quality parameters:

- pH, EC, TDS;
- major and minor ions; and
- trace elements.

Yearly audits of the performance of the monitoring network should be included as part of the AEMR, and optimisation of the monitoring sites and frequency should be undertaken where required. Furthermore, the HVO North WMP will be reviewed to ensure the schedule and monitoring facilities are sufficient to monitor potential impacts and to achieve the objectives of the WMP.

Table 16: GROUNDWATER MONITORING PROGRAMME FOR CARRINGTON PIT																
Site Descriptor	Loc.[1]	Type	Measure and Frequency									Reporting			Life Expectancy	Representative Site for Determining Release Criteria
			Water Level	EC	pH	Major ions	TDS	NFR	NTU	Volume	Temp	AEMR	DNR Licence	Other		
CGW1	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM	
CGW2	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM	
CGW3	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM	
CGW5	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM	
CGW6	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM	
CGW18	CAR	Piezo.	D	2'M	2'M	6'M	6'M					√			2000 - <LOM^{+10}	√
CGW39	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM^{+10}	
CGW42	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM	
CGW43	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM^{+10}	
CGW44	CAR	Piezo.	M	2'M	2'M							√		Trigger	2000 - <LOM^{+10}	
CGW45	CAR	Piezo.	M	2'M	2'M							√		Trigger	2003 - <LOM^{+10}	
CGW46	CAR	Piezo.	M	2'M	2'M	6'M	6'M					√		Trigger	2003 - <LOM^{+10}	√
CGW47	CAR	Piezo.	M	2'M	2'M							√		Trigger	2003- <LOM^{+10}	
CGW48	CAR	Piezo.	M	2'M	2'M							√		Trigger	2003 - <LOM^{+10}	
CGW49	CAR	Piezo.	M	2'M	2'M							√		Trigger	2003 - <LOM^{+10}	
CGW51A	CAR	Piezo.	M	2'M	2'M							√		Trigger	2005 - <LOM^{+10}	
CGW52	CAR	Piezo.	M	2'M	2'M							√		Trigger	2005 - <LOM^{+10}	
CGW53	CAR	Piezo.	M	2'M	2'M							√		Trigger	2005 - <LOM^{+10}	
CGW54	CAR	Piezo.	M	2'M	2'M							√		Trigger	2005 - <LOM^{+10}	
CGW55	CAR	Piezo.	M	2'M	2'M							√		Trigger	2005 - <LOM^{+10}	
NPz8	CAR	Piezo.	M	2'M	2'M	6'M	6'M					√		Trigger	~2008 - <LOM^{+10}	√
NPz9	CAR	Piezo.	M	2'M	2'M	6'M	6'M					√		Trigger	~2008 - <LOM^{+10}	√
NPz10	CAR	Piezo.	M	2'M	2'M							√		Trigger	~2008 - <LOM^{+10}	
NPz11	CAR	Piezo.	M	2'M	2'M							√		Trigger	~2008 - <LOM^{+10}	
NPz12	CAR	Piezo.	M	2'M	2'M							√		Trigger	~2008 - <LOM^{+10}	
NPz13	CAR	Piezo.	M	2'M	2'M							√		Trigger	~2008 - <LOM^{+10}	
NPz14	CAR	Piezo.	M	2'M	2'M	6'M	6'M					√		Trigger	~2008 - <LOM^{+10}	√
NPz15	CAR	Piezo.	M	2'M	2'M	6'M	6'M					√		Trigger	~2008 - <LOM^{+10}	√
NPz16	CAR	Piezo.	M	2'M	2'M							√		Trigger	~2008 - <LOM^{+10}	
NPz18	CAR	Piezo.	M	2'M	2'M							√		Trigger	~2008 - <LOM^{+10}	

18.1 Data Management and Reporting

It is recommended that data management and reporting include:

- Annual assessment of departures from identified monitoring data trends. If consecutive monitoring data over a period of 6 months exhibit an increasing divergence in an adverse impact sense from the previous data or from the established or predicted trend, then such departures should initiate further actions. These may include a need to conduct more intensive monitoring, or to invoke impact re-assessment and/or mitigation measures.
- Formal review of depressurisation of coal measures and alluvium should be undertaken annually by a suitably qualified hydrogeologist.
- Annual reporting (including all water level and water quality data).
- All groundwater data should be stored in a database customised for HVO North with suitable QA/QC controls.

19 CONCLUSIONS

The fine reject emplacement has been assessed in terms of impact to the groundwater regime, groundwater users and GDEs. The analytical and numerical modelling that has been carried out has been done so to provide a conservative or worst case scenario for the proposed modification.

The numerical modelling predicts that the groundwater level change due to the proposed modification is limited to localised mounding beneath and adjacent to the fine reject emplacement. The proposed modification results in a negligible increase in flow from the Hunter River and associated alluvium and no predicted impact to the Carrington Billabong GDE. The nearest private groundwater user is some 2.5 km from HVO North and hence no impact is predicted in this regard. As a result of the predicted unmeasurable increase in flux from the Hunter River, there is no additional water licensing required as part of the proposed modification.

Water quality is not expected to be impacted by the proposed modification. Numerical modelling predicts that the seepage from the proposed modification is unlikely to reach the open cut within the active mining period. Post closure, the seepage from the fine reject emplacement is likely to result in a similar water quality as if rejects are emplaced in the final void. Fine reject seepage is more sulphate dominant which would increase the total concentration of sulphate in the final void.

As there is no impact predicted from the modification, there are no specific management measures that are proposed. It is recommended that the monitoring bores and vibrating wire piezometers installed as part of this assessment be included in the groundwater monitoring plan. No additional monitoring bores need to be installed.

20 REFERENCES

Australasian Groundwater and Environmental Consultants Pty Ltd, (August, 2012), "*Peer Review of HVO North Carrington West Wing Extension Model*", prepared for EMGA Mitchell McLennan Pty Ltd on behalf of Coal & Allied/RTCA, Ref: Project No. G1591.HVO North.

ANCOLD, (2011), *"Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure"*.

ANZECC, (2000), *"Australian Water Quality Guidelines for Fresh and Marine Waters"*, Australia and New Zealand Environment and Conservation Council and the Agricultural and Resource Management Council of Australia and New Zealand.

ATC Williams, (2012), "*Carrington Tailings Storage Facility Alternative Arrangements Version 2.0.3.2*", drawings prepared for RTCA, November 2012.

Barnett *et al*, (2012), *"Australian groundwater modelling guidelines"*, Waterlines report, National Water Commission, Canberra.

Biosis Research, (2010), *"Final Flora and Fauna Assessment: Carrington West Wing Modification"*, in Carrington West Wing Environmental Assessment (EA), Volume 2, Appendix C – Groundwater Study, March 2010.

Department of Land & Water Conservation (1998), "*The NSW Groundwater Quality Protection Policy, A Component Policy of the NSW State Groundwater Policy"*, December 1998.

Environmental Resources Management Australia Pty Ltd, (2005), *"Carrington Pit Extended Flora & Fauna Assessment"*, prepared for Coal & Allied, October 2003.

ERM Mitchell McCotter, (1999), *"Carrington Mine Environmental Impact Statement"*, prepared for Coal & Allied, May 1999.

Fetter C.W., (2001), *"Applied Hydrogeology"*, 4th Edition. MacMillan College Publishing Company.

Glen R.A. and Beckett J., (1993), "*Hunter Coalfield Regional Geology 1:100 000",* 2nd Edition. Geological Society of New South Wales, Sydney.

Groundsearch Australia Pty Ltd, (2008), *"Hunter Valley Operations Cheshunt Trial Resistivity Report"*, for Coal & Allied Operations Pty Ltd, June 2008.

Mackie C.D., (2009), *"Hydrogeological Characterisation of Coal Measures and Overview of Impacts of Coal Mining on Groundwater Systems in the Upper Hunter Valley of NSW",* thesis for phD in Groundwater Management – Faculty of Science, University of Technology, Sydney, January 2009.

Mackie Environmental Research, (2003), *"Hunter Valley Operations West Pit Extension & Minor Modifications Surface & Groundwater Management Studies"*, prepared for Coal & Allied Operations Pty Ltd, September 2003.

Mackie Environmental Research, (2005), *"Carrington Extended – Water Management Studies"*, prepared for Coal & Allied, in Carrington Pit Extended – Statement of Environmental Effects, Volume 2, Annex D – Groundwater & Surface Water Assessment & Associated Peer Review, September 2005.

Mackie Environmental Research, (2010a), *"Carrington Extended – Review of Mining Related Impacts on the Paleochannel Groundwater System",* report on behalf of Coal & Allied, January 2010.

Mackie Environmental Research, (2010b), *"Carrington West Wing Modification – Groundwater Assessment"*, prepared for Coal & Allied, in Carrington West Wing Environmental Assessment (EA), Volume 2, Appendix C – Groundwater Study, March 2010.

McIlveen G.R., (1984), *"Singleton 1:25 000 Geological Map"*, 9132-IV-N, Geological Survey of New South Wales, Sydney.

Murray Darling Basin Commission, (2000), "*Groundwater Flow Modelling Guideline*", November 2000.

NSW Office of Water, (2012), "*NSW Aquifer Interference Policy"*, NSW Government policy for the licensing and assessment of aquifer interference activities, Department of Primary Industries, September 2012.

Rust PPK Pty Ltd (1997), *"Groundwater and Mine Water Management Study South Lemington Mine"*, 58H038A, for Lemington Coal Mines Pty Ltd.

Sniffin M.J., McIlveen G.R. and Crouch A., (1988), *"Doyles Creek 1:25 000 Geological Map"*, 9032-I-N, Geological Survey of New South Wales, Sydney.

Sniffin M.J. and Summerhayes G.J., (1987), *"Jerrys Plains 1:25 000 Geological Map"*, 9033-II-S, Geological Survey of New South Wales, Sydney.

Summerhayes G., (1983), *"Muswellbrook 1:25 000 Geological Map"*, 9033-II-N, Geological Survey of New South Wales, Sydney.

Umwelt, (2007), *"Carrington Billabong River Red Gum Rehabilitation and Restoration Strategy",* prepared for Coal & Allied, June 2007.

Umwelt (2010). "*Ravensworth Operations Project Environmental Assessment*", compiled on behalf of Xstrata Coal – Ravensworth Operations.

Water Solutions, (2010), *"Carrington West Wing – Surface Water Assessment"*, prepared for Coal & Allied, in Carrington West Wing Environmental Assessment (EA), Volume 2, Appendix D – Surface Water Study, August 2010.

21 GLOSSARY

Alluvium - Sediment (gravel, sand, silt, clay) transported by water (i.e. deposits in a stream channel or floodplain).

Aquiclude - A low-permeability unit that forms either the upper or lower boundary of a ground-water flow system.

Aquifer - Rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer, Confined - An aquifer that is overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer.

Aquifer, Perched - A region in the unsaturated zone where the soil may be locally saturated because it overlies a low-permeability unit.

Aquifer, Semi-confined - An aquifer confined by a low-permeability layer that permits water to slowly flow through it. During pumping of the aquifer, recharge to the aquifer can occur across the confining layer. Also known as a leaky artesian or leaky confined aquifer.

Aquifer, Unconfined - An aquifer in which there are no confining beds between the zone of saturation and the surface. There will be a water table in an unconfined aquifer. Water-table aquifer is a synonym.

Aquitard - A low-permeability unit than can store ground water and also transmit it slowly from one aquifer to another.

Colluvium - Sediment (gravel, sand, silt, clay) transported by gravity (i.e. deposits at the base of a slope).

Cone of Depression - The depression in the water table around a well or excavation defining the area of influence of the well. Also known as cone of influence.

Drawdown - A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by pumping of ground water from wells or excavations.

Falling/Rising Head Test - A test made by the instantaneous addition, or removal, of a known volume of water to or from a well. The subsequent well recovery is measured.

Head - sum of datum level, elevation head and pressure head which in unconfined aquifers is equal to the groundwater elevation.

Hydraulic Conductivity - A measure of the rate at which water moves through a soil/rock mass. It is the volume of water that moves within a unit of time under a unit hydraulic gradient through a unit cross-sectional area that is perpendicular to the direction of flow.

Hydraulic Gradient - The change in total head with a change in distance in a given direction. The direction is that which yields a maximum rate of decrease in head.

Infiltration - The flow of water downward from the land surface into and through the upper soil layers.

Model Calibration - The process by which the independent variables of a digital computer model are varied in order to calibrate a dependent variable such as a head against a known value such as a water-table map.

Packer Test - An aquifer test performed in an open borehole to determine rock permeability; the segment of the borehole to be tested is sealed off from the rest of the borehole by inflating seals, called packers, both above and below the segment.

Piezometer - A non-pumping well, generally of small diameter, that is used to measure the elevation of the water table or potentiometric surface. A piezometer generally has a short well screen through which water can enter.

Porosity - The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.

Potentiometric Surface - A surface that represents the level to which water will rise in tightly cased wells. If the head varies significantly with depth in the aquifer, then there may be more than one potentiometric surface. The water table is a particular potentiometric surface for an unconfined aquifer.

Pumping Test - A test made by pumping a well for a period of time and observing the response/change in hydraulic head in the aquifer in order to determine aquifer hydraulic characteristics.

Slug Test - A test made by the instantaneous addition, or removal, of a known volume of water to or from a well. The subsequent well recovery is measured and analysed to provide a permeability value.

Specific Yield - The ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil. Gravity drainage may take many months to occur.

Storativity - The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer, per unit change in head.

Transmissivity - A measure of the rate at which water moves through an aquifer of unit width under a unit hydraulic gradient.

Unsaturated Zone - The zone between the land surface and the water table. It includes the root zone, intermediate zone, and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched ground water, may exist in the unsaturated zone. Also called zone of aeration and vadose zone.

Water Budget - An evaluation of all the sources of supply and the corresponding discharges with respect to an aquifer or a drainage basin.

AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD

Reviewed by:

CLAIRE STEPHENSON
Hydrogeologist / Groundwater Modeller

DANIEL BARCLAY
Principal Hydrogeologist

NEIL MANEWELL
Senior Hydrogeologist / Groundwater Modeller

ANDREW DURICK
Principal Modeller

LIMITATIONS OF REPORT

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) has prepared this report for the use of Coal and Allied Operations Pty Limited in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 14 May 2012.

The methodology adopted and sources of information used by AGE are outlined in this report. AGE has made no independent verification of this information beyond the agreed scope of works and AGE assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to AGE was false.

This study was undertaken between 7 June 2012 and 6 Junel 2013 and is based on the conditions encountered and the information available at the time of preparation of the report. AGE disclaims responsibility for any changes that may occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. It may not contain sufficient information for the purposes of other parties or other users. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing and other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. Where borehole logs are provided they indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of the site, as constrained by the project budget limitations. The behaviour of groundwater is complex. Our conclusions are based upon the analytical data presented in this report and our experience.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, AGE must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge, information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time. Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.

Appendix A

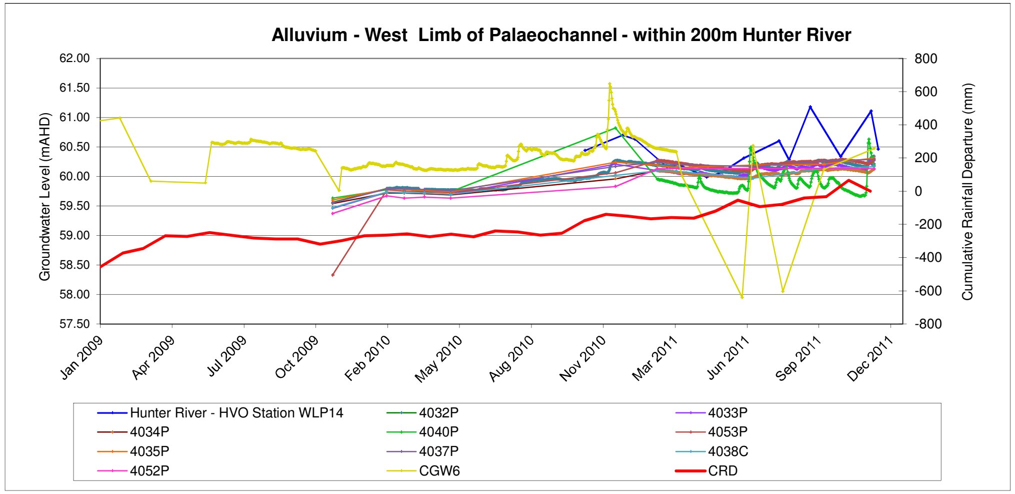
Carrington Pit - Bore Construction Details

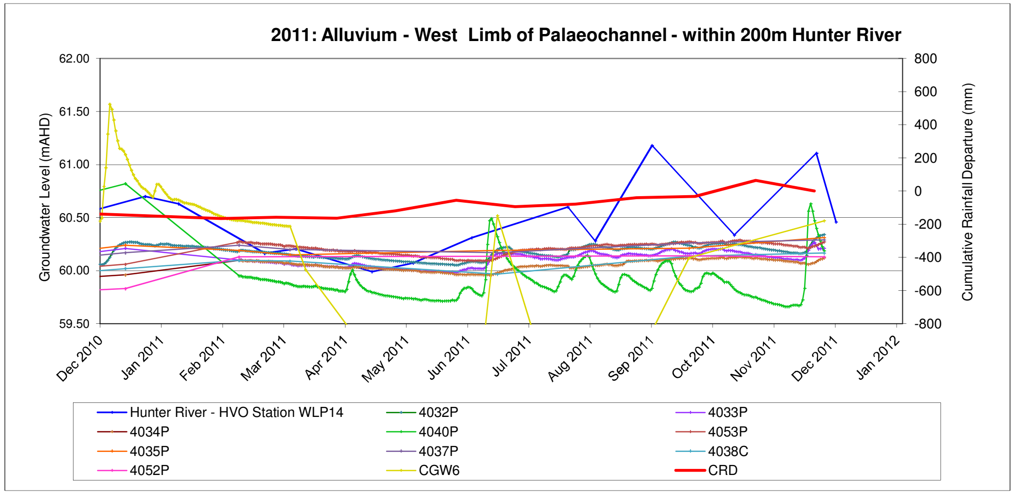
Bore ID	Easting	Northing	Bore RL (mAHD) T.O.P.	Stick-up (m) T.O.P.	Mon. Height (m)	Bore Dia. (mm)	Bore Depth (m) b.T.O.P.	Bore Depth (mAHD)	Screen Depth (m) bT.O.P.	Logger Install depth (m) b.T.O.P	Logger Install depth (mAHD)	Target Stratigraphy	Comments
CARRINGTON													
CFW63	310828	6403724										Base of Spoil	
CFW64	310877	6403617										Base of Spoil	
4032P	308609	6402945	70.29	0.94	1.03	65	14.40	54.95	7.44 - 13.44	12.56	57.73	Palaeochannel Alluvium	
4033P	308877	6402939	69.89	0.95	1.05	65	10.10	58.84	7 - 17	10.00	59.89	Palaeochannel Alluvium	
4034P	308239	6402959	71.46	0.31	1.02	65	15.00	56.15	5.6 - 14.6	14.00	57.46	Palaeochannel Alluvium	
4035P	308386	6402778	70.49	1.02	1.05	65	12.82	56.65	5.7 - 11.7	n/a		Palaeochannel Alluvium	
4037P	308277	6402702	71.77	1.03	1.07	65	15.40	55.34	8.28 - 14.28	n/a		Palaeochannel Alluvium	
4038C	308502	6403116	69.97	0.99	1.06	65	12.98	56.00	6 - 12	n/a		Palaeochannel Alluvium	
4039c-VW1*	308468	6402673	70.70	n/a	n/a	n/a	75.42	-4.72		13.50	57.20	Palaeochannel Alluvium	
4040P	308675	6402723	70.13	0.97	1.04	65	12.91	56.25	5.9 - 11.9	12.00	58.13	Palaeochannel Alluvium	
4052P	307924	6402680	72.58	1.09	0.64	65	15.58	55.91	8.4 - 14.4	n/a		Palaeochannel Alluvium	
4053P	308112	6402680	71.61	1.02	1.04	65	15.84	54.75	8.8 - 14.8	14.00	57.61	Palaeochannel Alluvium	
CFW55R	310439	6402180	70.28	0.50	0.70	65	16.60	53.18		15.50	54.78	Palaeochannel Alluvium	
CFW56	310333	6402255	69.89									Palaeochannel Alluvium	Blocked/Destroyed
CFW57a	310084	6402053	70.75	0.70	0.80	65	16.73	53.32		13.27	57.48	Palaeochannel Alluvium	Faulty VWP
CFW57	310088	6402053	70.88	0.87	0.82	65	7.92	62.09		n/a		Alluvial Floor	Faulty VWP
CGW32	308598	6404872	84.00	-	-	-	-	-	-	-	-	Palaeochannel Alluvium	North of Carrington
CGW45	308042	6403350	72.51	0.33	n/a	25	14.44	57.74		n/a		Palaeochannel Alluvium	Blocked
CGW46	308414	6403276	71.95	0.00	n/a	25	13.64	58.31		n/a		Palaeochannel Alluvium	Blocked
CGW47	308729	6403407	70.83	0.44	n/a	25	16.47	53.92		n/a		Palaeochannel Alluvium	Datalogger marked as CGW47A
CGW48	308410	6402894	70.39	0.48	n/a		15.90	54.01				Palaeochannel Alluvium	Destroyed
CGW49	308777	6403087	69.57	0.49	n/a	80	13.30	55.78		n/a		Palaeochannel Alluvium	
CGW52a	309906	6402255	71.36	0.75	0.72	65	18.55	52.06		17.50	53.86	Palaeochannel Alluvium	
CGW53a	309606	6402333	70.53	0.70		65	14.74	55.09		14.00	56.53	Palaeochannel Alluvium	
CGW54a	310193	6402155	70.00	0.79	0.75	65	17.10	52.11		15.80	54.20	Palaeochannel Alluvium	
CGW55a	309840	6402458	71.04	0.48	0.72	65	18.46	52.10		17.50	53.54	Palaeochannel Alluvium	
CGW6	308757	6402771	70.12	0.82	n/a	80	21.82	47.48		14.89	55.23	Palaeochannel Alluvium	
CFW59	310245	6402370	68.92	0.54	0.74	65	19.68	48.70		14.00	54.92	Palaeochannel Alluvium/ Permian	Form A indicates coal from 53mAHD and total depth of 13.3m - water quality results indicate high Cl/Na/SO4
CGW51a	310150	6402420	70.21	0.17	0.71	65	17.18	52.86		16.50	53.71	Palaeochannel Alluvium/ Permian	Hydrograph results show similar trend to CFW59.
CGW39	308566	6403694	70.84	0.53	n/a	65	13.45	56.86	5 - 14	13.00	57.84	Palaeochannel Alluvium/ Spoil	Water quality results indicate high Cl/Na/SO4 concentrations
4036C	308272	6402688	71.78	1.08		65	35.20	35.50	33.1 - 34.1	n/a		Permian Coal Seam	
4051C	308664	6402721	69.90	0.98	0.98	65	31.51	37.41	31.75 - 32.75	n/a		Permian Coal Seam	20m Below Alluvium
CFW56a	310333	6402255	68.89									Permian Coal Seam	Blocked/Destroyed
CGW45a	308042	6403350	72.65	0.47	n/a	65				n/a		Permian Coal Seam	MER (2011)
4039c-VW3*	308468	6402673	70.70	n/a	n/a	n/a	75.42	-4.72		65.00	5.70	Permian Coal Seam (Bayswater)	
CGW53	309611	6402329	70.48	0.61	0.68	25	43.00	26.87		41.80	28.68	Permian Coal Seam (Broonie 1)	
CGW54	310196	6402159	69.95	0.73	0.78	25	36.58	32.64		31.54	38.41	Permian Coal Seam (Broonie 1)	
CGW52	309901	6402249	71.40	0.70	0.77	25	45.25	25.45		40.00	31.40	Permian Coal Seam (Broonie 2)	
4039c-VW2*	308468	6402673	70.70	n/a	n/a	n/a	75.42	-4.72		52.30	18.40	Permian Coal Seam (Broonie 5)	No data
CGW46a	308414	6403276	71.95	0.00	n/a	65				n/a		Permian Coal Seam/ Alluvium?	MER (2011) documented as Permian - hydrograph indicates potentially in alluvium
CGW47a	308729	6403407	70.83	0.44	n/a	65				15.50	55.33	Permian Coal Seam/ Interburden	MER (2011) - hydrograph indicates potentially within sandstone outcrop

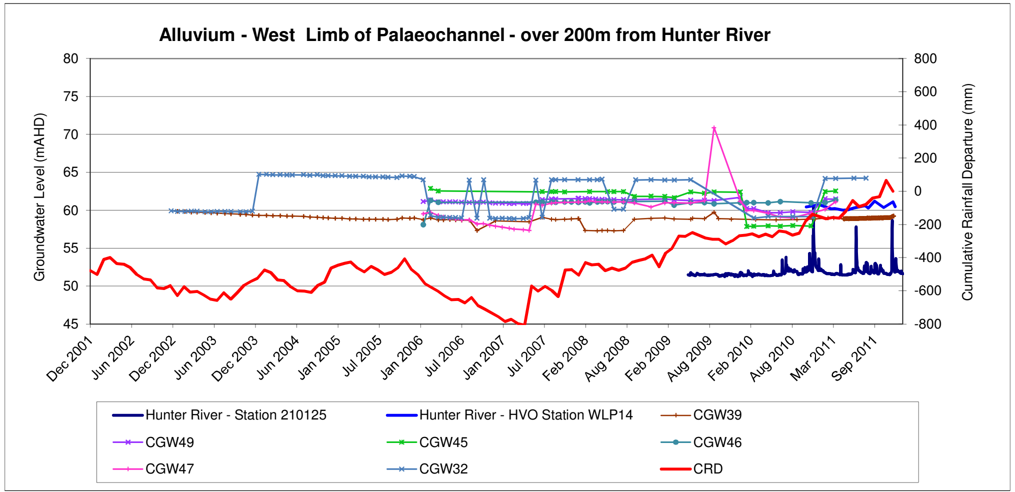
mAHD	Australian Height Datum (metres)
T.O.P.	Top of Pipe; Top of bore pipe/casing
b.T.O.P	Below Top of Pipe; Below Top of bore pipe/casing
*	Indicates bore RL (mAHD) is ground level (mAHD)

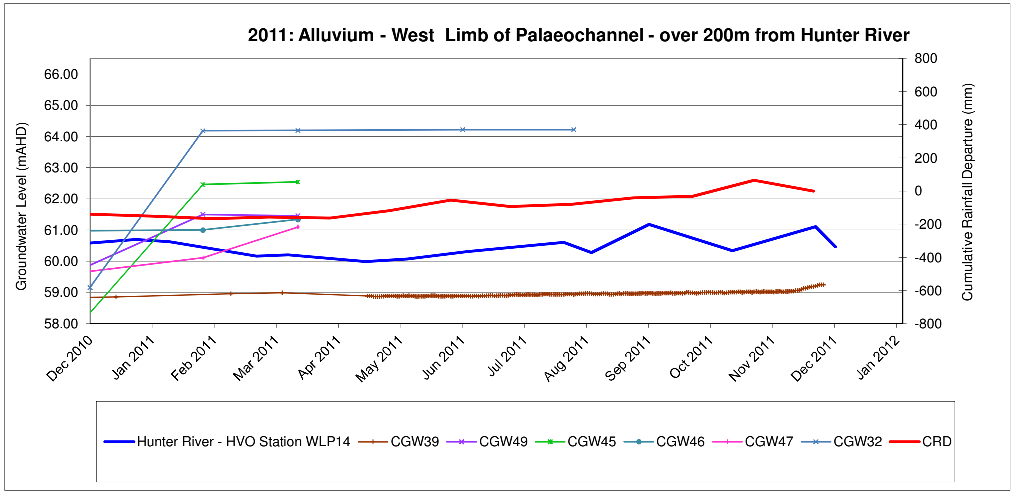
Appendix B

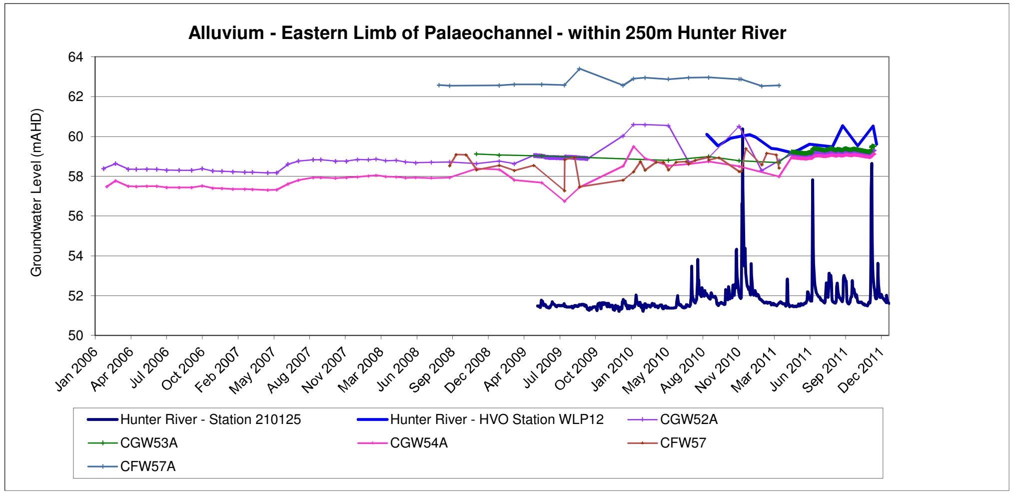
Long Term Hydrographs

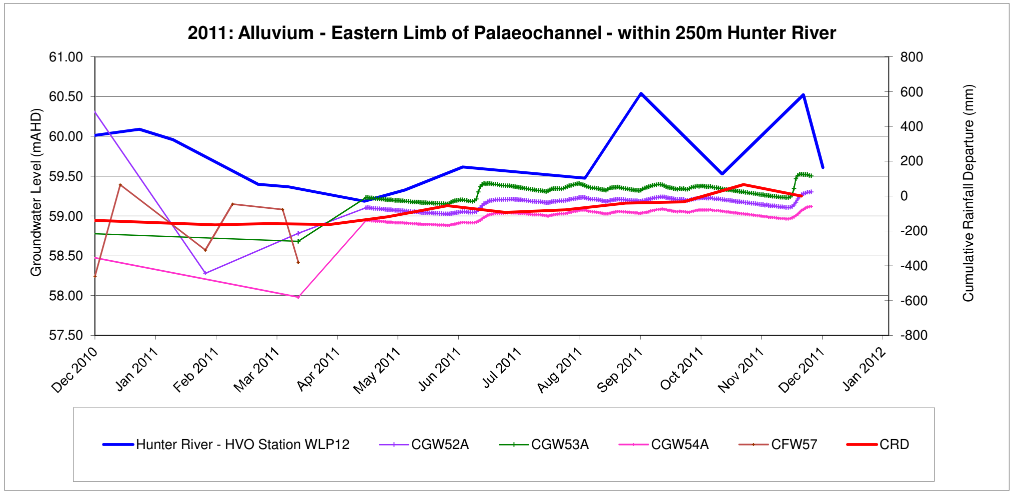

Alluvium - West Limb of Palaeochannel - within 200m Hunter River
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - HVO Station WLP14
4032P
4033P
4034P
4040P
4053P
4035P
4037P
4038C
4052P
CGW6
CRD

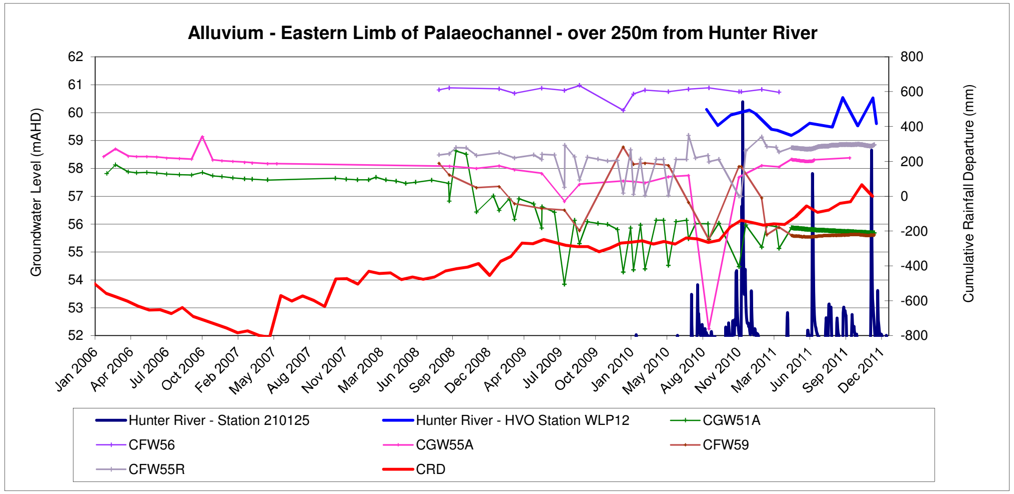

2011: Alluvium - West Limb of Palaeochannel - within 200m Hunter River
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - HVO Station WLP14
4032P
4033P
4034P
4040P
4053P
4035P
4037P
4038C
4052P
CGW6
CRD

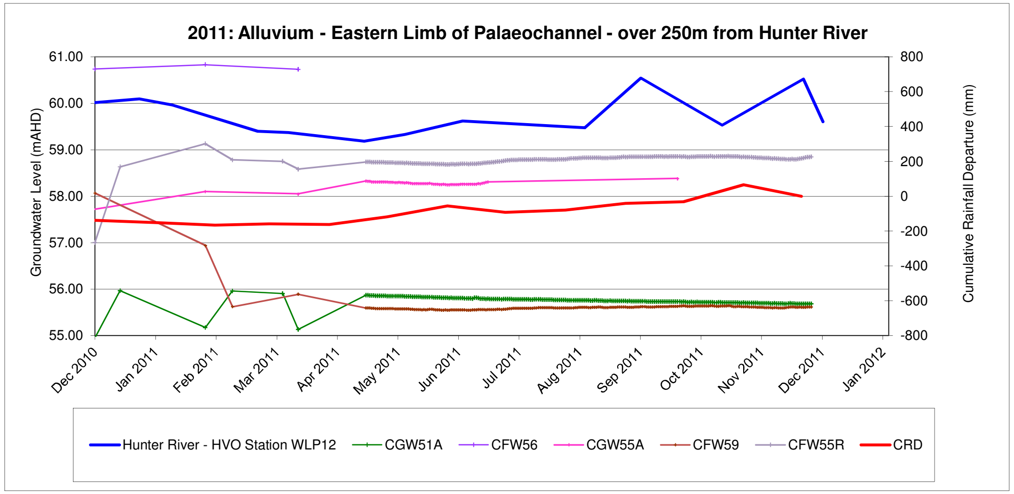

Alluvium - West Limb of Palaeochannel - over 200m from Hunter River
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - Station 210125
Hunter River - HVO Station WLP14
CGW39
CGW49
CGW45
CGW46
CGW47
CGW32
CRD

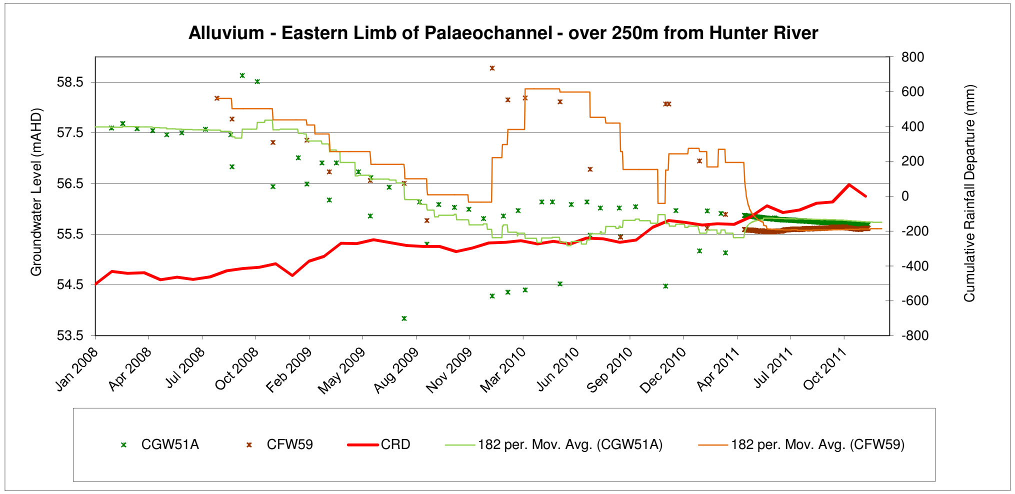

2011: Alluvium - West Limb of Palaeochannel - over 200m from Hunter River
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - HVO Station WLP14
CGW39
CGW49
CGW45
CGW46
CGW47
CGW32
CRD

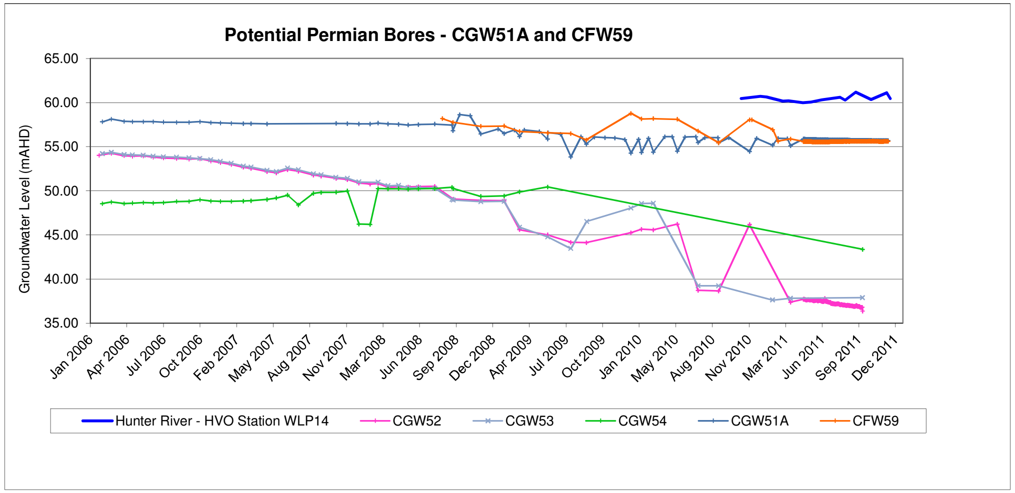

Alluvium - Eastern Limb of Palaeochannel - within 250m Hunter River
Groundwater Level (mAHD)
Hunter River - Station 210125
Hunter River - HVO Station WLP12
CGW52A
CGW53A
CGW54A
CFW57
CFW57A

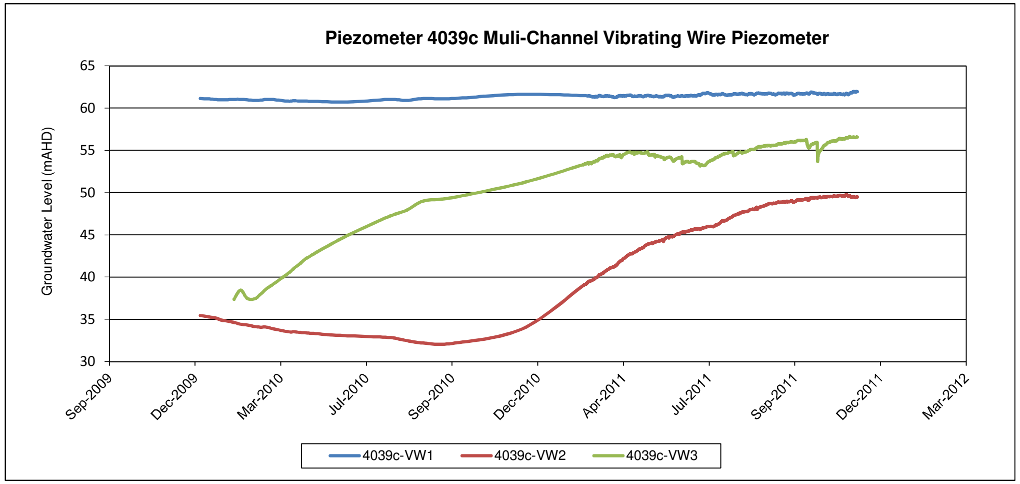

2011: Alluvium - Eastern Limb of Palaeochannel - within 250m Hunter River
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - HVO Station WLP12
CGW52A
CGW53A
CGW54A
CFW57
CRD

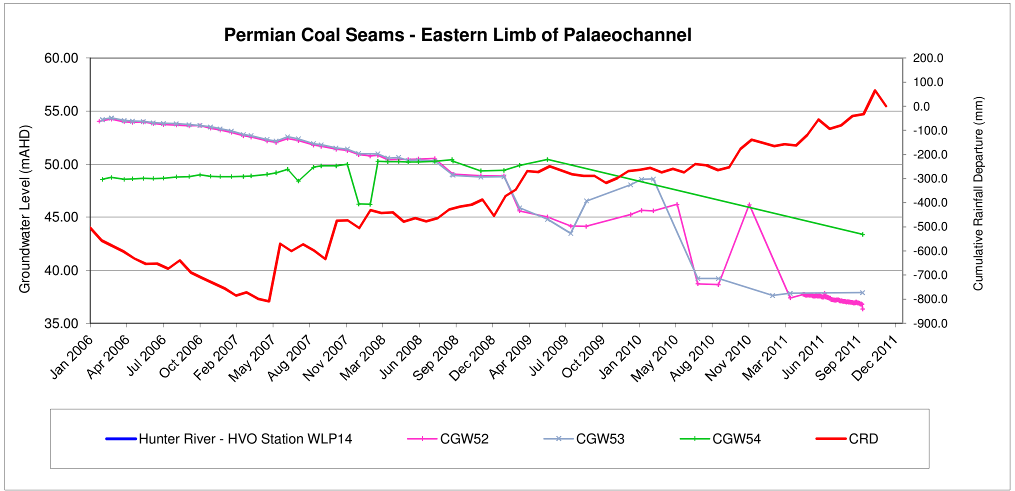

Alluvium - Eastern Limb of Palaeochannel - over 250m from Hunter River
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - Station 210125
Hunter River - HVO Station WLP12
CGW51A
CFW56
CGW55A
CFW59
CFW55R
CRD

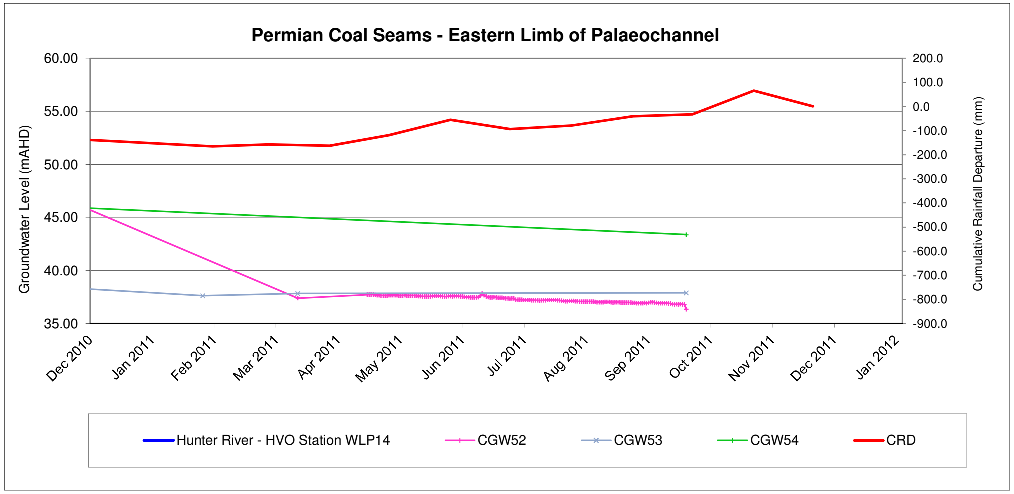

2011: Alluvium - Eastern Limb of Palaeochannel - over 250m from Hunter River
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - HVO Station WLP12
CGW51A
CFW56
CGW55A
CFW59
CFW55R
CRD

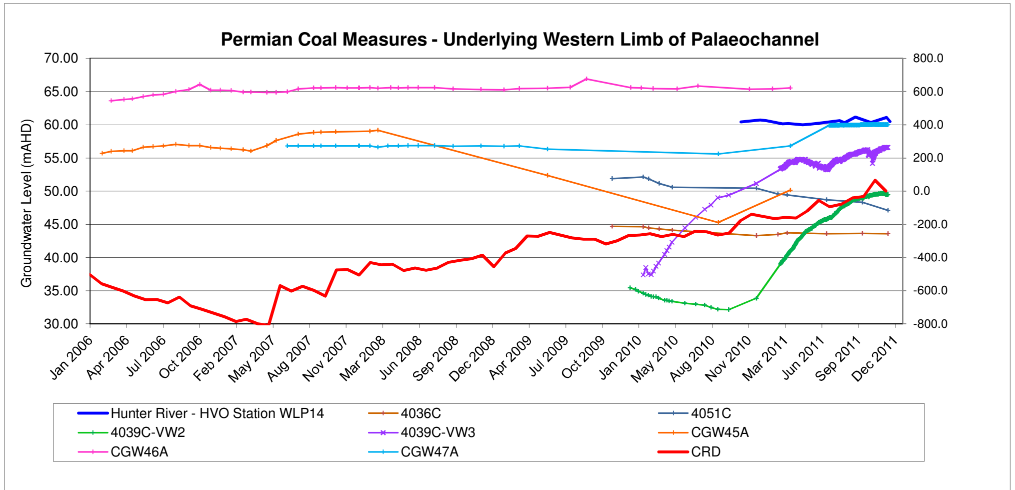

Alluvium - Eastern Limb of Palaeochannel - over 250m from Hunter River
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
CGW51A
CFW59
CRD
182 per. Mov. Avg. (CGW51A)
182 per. Mov. Avg. (CFW59)

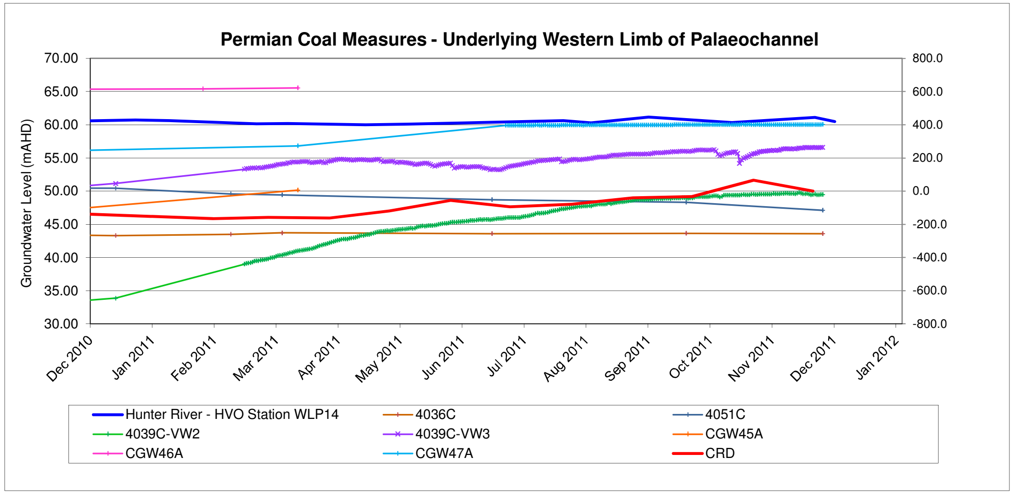

Potential Permian Bores - CGW51A and CFW59
Groundwater Level (mAHD)
Hunter River - HVO Station WLP14
CGW52
CGW53
CGW54
CGW51A
CFW59


Piezometer 4039c Muli-Channel Vibrating Wire Piezometer
Groundwater Level (mAHD)
4039c-VW1
4039c-VW2
4039c-VW3


Permian Coal Seams - Eastern Limb of Palaeochannel
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - HVO Station WLP14
CGW52
CGW53
CGW54
CRD


Permian Coal Seams - Eastern Limb of Palaeochannel
Groundwater Level (mAHD)
Cumulative Rainfall Departure (mm)
Hunter River - HVO Station WLP14
CGW52
CGW53
CGW54
CRD


Permian Coal Measures - Underlying Western Limb of Palaeochannel
Groundwater Level (mAHD)
Hunter River - HVO Station WLP14
4036C
4051C
4039C-VW2
4039C-VW3
CGW45A
CGW46A
CGW47A
CRD


Permian Coal Measures - Underlying Western Limb of Palaeochannel
Groundwater Level (mAHD)
Hunter River - HVO Station WLP14
4036C
4051C
4039C-VW2
4039C-VW3
CGW45A
CGW46A
CGW47A
CRD

Appendix C

Carrington Water Quality

Coal & Allied - Water Quality Analysis

Sample Location	Lithology	Location	Sample Date	Aluminium mg/L	Arsenic mg/L	Barium mg/L	Boron mg/L	Calcium mg/L	Chloride mg/L	Electrical Conductivity µS/cm	Iron (filterable) mg/L	Lithium mg/L	Magnesium mg/L	Manganese mg/L	pH	Phosphorus mg/L	Potassium mg/L	Rubidium mg/L	Selenium mg/L	Silica mg/L	Sodium mg/L	Strontium mg/L	Sulfates mg/L	Total Dissolved Solids mg/L	Zinc mg/L
CFW55R	Palaeochannel	Eastern Limb	16/03/2011	2.08	<0.001	0.14	0.036	32	1210	5190	<0.05	0.071	97	0.112	7.4	0.12	22	0.018	<0.01	31.3	1070	2.08	201	3170	0.01
CFW55R	Palaeochannel	Eastern Limb	29/08/2011	71.30	0.012	0.11	0.294	31	1080	4910	<0.05	0.095	87	3.830	7.4	3.83	17	0.104	0.01	29.9	981	2.64	235	2790	0.36
CFW57	Palaeochannel	Eastern Limb	16/03/2011	20.70	0.003	0.10	0.242	70	909	4700	<0.05	0.015	96	7.080	7.4	0.44	7	0.015	<0.01	27.8	808	2.85	163	2600	0.06
CFW57	Palaeochannel	Eastern Limb	26/10/2011	0.16	<0.001	0.09	0.054	32	911	3680	<0.05	0.004	82	0.038	7.3	0.12	5	0.001	<0.01	29.6	694	1.76	145	2190	<0.005
CFW59	Interburden?	Eastern Limb	16/03/2011	255.00	0.034	0.16	1.090	133	3210	11360	<0.05	0.194	409	19.300	7.3	2.27	34	0.125	<0.01	27.6	1950	10.20	478	7320	0.55
CFW59	Interburden?	Eastern Limb	26/10/2011	17.20	0.003	0.13	0.140	38	3420	10620	<0.05	0.070	385	0.639	7.3	0.31	36	0.023	<0.01	28.1	2060	8.21	360	7680	0.03
CGW54A	Palaeochannel	Eastern Limb	16/03/2011	0.54	0.002	0.13	0.040	-	-	3710	<0.05	0.006	-	0.043	7.6	-	-	0.002	<0.01	-	-	1.39	-	-	0.01
CGW54A	Palaeochannel	Eastern Limb	26/10/2011	0.65	0.001	0.12	0.031	19	758	3490	<0.05	0.005	53	0.030	7.6	0.42	7	0.002	<0.01	27.2	725	1.13	143	2150	<0.005
CGW39	Palaeochannel	Western Limb	16/03/2011	13.70	0.003	0.05	0.265	164	2040	7350	<0.05	0.013	278	0.662	7.4	0.70	10	0.009	<0.01	23.8	1160	4.07	311	5130	0.05
CGW39	Palaeochannel	Western Limb	26/08/2011	1.12	<0.001	0.07	0.280	185	2050	8020	<0.05	0.009	302	0.042	7.4	0.18	9	0.002	0.01	25.8	1250	4.83	380	4920	0.02
CGW6	Palaeochannel	Western Limb	16/03/2011	0.10	<0.001	0.06	0.026	53	210	1318	<0.05	0.001	56	0.016	7.5	0.38	2	<0.001	<0.01	35.0	165	0.56	56	856	0.01
CGW6	Palaeochannel	Western Limb	26/08/2011	0.06	0.001	0.06	0.033	50	213	1249	<0.05	<0.001	55	0.240	7.3	0.33	1	<0.001	<0.01	39.1	139	0.55	53	788	<0.005
4053P	Palaeochannel	Western Limb	28/07/2011	17.50	0.005	0.07	0.190	82	413	1990	<0.05	0.010	95	1.070	7.1	1.11	3	0.016	<0.01	40.8	190	0.95	88	-	0.24
4053P	Palaeochannel	Western Limb	20/10/2011	8.47	0.003	0.06	0.111	79	378	1900	<0.05	0.007	96	0.554	7.1	0.83	3	0.010	<0.01	38.6	196	0.96	94	-	0.09
4037P	Palaeochannel	Western Limb	28/07/2011	4.62	0.003	0.07	0.101	90	423	2310	0.82	0.005	81	0.596	7.2	0.43	3	0.007	<0.01	40.9	210	0.93	72	-	0.16
4037P	Palaeochannel	Western Limb	20/10/2011	1.16	0.001	0.05	0.045	93	364	1755	<0.05	0.002	91	0.127	7.1	0.38	2	0.003	<0.01	42.6	161	0.83	87	-	0.04
4037P	Palaeochannel	Western Limb	15/12/2011	5.82	0.002	0.09	0.058	60	371	1738	<0.05	0.002	73	0.174	7.3	0.82	2	0.006	<0.01	40.1	310	0.70	75	-	0.03
4035P	Palaeochannel	Western Limb	28/07/2011	1.23	0.002	0.08	0.114	87	376	1772	0.07	0.003	82	0.866	6.9	0.72	3	0.003	<0.01	38.5	171	0.79	71	-	0.06
4035P	Palaeochannel	Western Limb	20/10/2011	0.74	<0.001	0.06	0.103	91	341	1750	<0.05	0.002	86	0.649	7.0	0.51	3	0.003	<0.01	37.7	159	0.87	85	-	0.05
4035P	Palaeochannel	Western Limb	2/12/2011	1.10	0.001	0.07	0.075	91	360	1647	<0.05	0.002	90	0.249	7.0	0.44	2	0.002	<0.01	41.1	159	0.81	80	-	0.04
4034P	Palaeochannel	Western Limb	28/07/2011	0.65	0.001	0.09	0.086	56	429	2090	<0.05	0.004	76	0.658	7.2	0.21	4	0.002	<0.01	32.0	281	0.72	82	-	0.09
4034P	Palaeochannel	Western Limb	20/10/2011	0.26	0.001	0.08	0.074	57	413	2040	<0.05	0.003	81	0.482	7.3	0.50	4	0.001	<0.01	32.4	303	0.82	90	-	0.04
4034P	Palaeochannel	Western Limb	2/12/2011	4.49	0.002	0.33	0.064	83	353	1970	<0.05	0.003	85	0.335	7.2	0.45	2	0.008	<0.01	39.8	166	0.72	79	-	0.09
4032P	Palaeochannel	Western Limb	28/07/2011	14.80	0.002	0.10	0.114	64	404	1970	<0.05	0.006	64	0.504	7.1	0.43	3	0.010	<0.01	30.0	321	0.70	74	-	0.13
4032P	Palaeochannel	Western Limb	20/10/2011	7.81	0.002	0.08	0.071	57	352	1970	<0.05	0.003	67	0.203	7.2	0.68	2	0.004	0.01	38.1	309	0.77	80	-	0.04
4032P	Palaeochannel	Western Limb	15/12/2011	6.03	0.003	0.06	0.071	80	389	1920	<0.05	0.006	100	0.205	6.9	0.96	3	0.007	<0.01	39.8	203	0.88	89	-	0.06
DM1	Spoil	North Void	Jan-11		0.007			97	1930	9090			506		6.3		1380						1310		0.06
DM3	Spoil	North Void	Jan-11		0.002			208	1790	8500			489		6.7		1240						1840		0.07
4116P	Spoil	North Void	Jan-11		0.004			130	2880	9890			475		7.0		1470						857		0.05

Appendix D

Analytical Seepage Results

Unit	Dam GWL (mAHD)	Depth to base of dam (mAHD)	Unit GWL (mAHD)	Depth to top of spoil (mAHD)	Depth to base of dam minus depth to unit ΔL (m)	Hydraulic head difference Δh (m)	Vertical Hydraulic Gradient (i_z)
Spoil	119.00	80.00	65.00	79.00	1.00	54.00	54.00
Alluvium	119.00	80.00	85.00	79.00	1.00	34.00	34.00

Leakage from Alluvium to Target Coal Seam	Flow Direction	Vertical Hydraulic Conductivity of clay liner K_Z (m/d)	Vertical Hydraulic Gradient (i_z)	Surface Area (m2)	Vertical Discharge from Dam to Spoil Q_Z (L/s)	Vertical Discharge from Dam to Spoil Q_Z (ML/d)
Spoil	Vertical	0.0000864	54.00	500,000	27.0	2.33
Alluvium	Vertical	0.0000864	34.00	110,000	3.7	0.32

Leakage from Dam through Embankment	Flow Direction	Horizontal Hydraulic Conductivity of Embankment K_{XY} (m/d)	Horizontal Hydraulic Gradient (i_{XY})	Pit Wall Length (m)	Wall Height	Horizontal Discharge from Dam through Embankment Q_{XY} (L/s)	Horizontal Discharge from Dam through Embankment Q_{XY} (ML/d)
Embankment	Horizontal	0.000864	1.00	3,700	40	1.48	0.128

Unit	Total Seepage (ML/d)	Total Seepage (m3/d)
Spoil	2.33	2333
Alluvium	0.32	323
Embankment	0.13	128
TOTAL	**2.78**	**2784**
Rainfall (640mm/yr)	1.33	1332
Evaporation (1640mm/yr)	3.41	3412
TOTAL	**0.70**	**703**

Notes

i_{XY}	Horizontal hydraulic gradient
i_Z	Vertical hydraulic gradient. Head difference between nested bores.
K_{XY}	Horizontal hydraulic conductivity (m/d)
K_Z	Vertical hydraulic conductivity (m/d)

Groundwater Flow

Q=KiA

Q	Discharge (m^3/d)
K	Hydraulic Conductivity (m/d)
i	Hydraulic Gradient
A	Area Intersected (m^2)

estimate only

APPENDIX D

Surface water assessment

HVO NORTH MODIFICATION – FINE REJECT EMPLACEMENT SURFACE WATER ASSESSMENT

Coal & Allied Operations Pty Ltd
June 2013

www.wrmwater.com.au

WRM Water & Environment Pty Ltd
ABN: 96 107 404 544 ACN: 107 404 544

Level 9, 135 Wickham Tce, Spring Hill
PO Box 10703
Brisbane Adelaide St QLD 4000
tel (07) 3225 0200 fax (07) 3225 0299
www.wrmwater.com.au

REPORT TITLE: HVO North Modification – Fine Reject Emplacement, Surface Water Assessment

CLIENT: Coal and Allied Operations Pty Ltd

REPORT NUMBER: 0594-04-B [Rev 1]

Revision Number	Report Date	Report Author	Reviewer
1	5 June 2013	MGB	GR

For and on behalf of
WRM Water & Environment Pty Ltd

Greg Roads
Director

EXECUTIVE SUMMARY

Proposed Modification Overview

Coal & Allied Operations Limited (Coal & Allied) proposes to modify the fine reject emplacement strategy at the existing approved HVO North mining area, which is located north of the Hunter River, approximately 24km north-west of Singleton. The proposed modification comprises two elements, namely:

- fine reject emplacement in the Cumnock Void 3 via pipelines from HVO North CPPs;
- construction and operation of a fine reject emplacement to the north of the existing Carrington Pit; and
- a minor amendment to the HVO North development consent boundary to encompass Cumnock Void 3 is proposed to accommodate the modification.

The Cumnock Void 3 is located outside of the HVO North development consent boundary and within a mining lease held the Cumnock Joint Venture. A joint use agreement between the Cumnock Joint Venture and Coal & Allied is in place in respect of each company's use of the void. Coal & Allied's contribution to fine reject emplacement in Cumnock Void 3 will utilise about 25 per cent of the void's emplacement capacity.

Fine reject will be transported to the Cumnock Void 3 via an overland pipeline adjacent to the existing haul roads from the Howick CPP. No native tree or substantial native vegetation disturbance will be required for its construction.

The fine reject emplacement will occupy an area of approximately 161 ha and will be on land that has been mined and is cleared of remnant native vegetation. The emplacement will have a life of approximately five years and will be completed within the existing development consent period, which is currently to 2025.

This report, prepared by WRM Water & Environment Pty Ltd, presents the methodology and results of the surface water investigations undertaken to assess the potential impacts of the proposed modification on local surface hydrology and the mine water management system.

Assessment of Impacts on Minesite Water Management

The potential impacts of the proposed modification on the HVO North surface water management system have been assessed using the OPSIM water balance model. The outcomes from the surface water impact assessment are summarised as follows:

- Loss of catchment runoff to the Hunter River during the life of the project is considered negligible due to the relative magnitude of flows in the Hunter River. In addition, the construction of the fine reject emplacement is required to prevent contamination of a water source and therefore would not require a water supply works approval, and there is no requirement for a Water Access licence to take and use water;
- It is expected that there would be little impact on runoff water quality to the Hunter River, as the system would continue to be generally operated in accordance with the HRSTS discharge rules and criteria. Also, it is proposed that all areas are to be returned to a rehabilitated catchment after mining;
- The proposed modification does not have any significant impact on expected pit inundation at HVO North;
- The proposed modification does not have any significant impact on accumulation or reduction in overall site inventory volumes;

- Given the volume of water currently stored at HVO North (primarily in Dam 30N), the forecast modelling indicates that extraction of water from the Hunter River would not be required. That is, the proposed modification has no impact on site raw water requirements;
- There is an increase in the risk of discharge from Dam 15N to the Hunter River (via Farrells Creek. The maximum modelled discharge is only around 70ML, at an estimated EC of 700-800µs/cm. Given that the discharge only occurs during a HRSTS discharge window and at a low salinity, the proposed modification should not impact on Farrells Creek or Hunter River water quality;
- The proposed modification has little or no impact on the potential for HRSTS discharges to the Hunter River; and
- The proposed fine reject emplacement footprint marginally encroaches the Q100 flood inundation zone, however it is limited to the Hunter River backwater zone (in the Unnamed Tributary) and would have no impact on flood levels or velocities in the Hunter River.

The water balance modelling indicates that the proposed modification would have little impact on the existing HVO North water management system. Discharges can generally be managed within the HRSTS rules.

There are no substantial changes proposed to the HVO North water management system to accommodate the proposed modification. It is recommended that surface and groundwater monitoring be reviewed regularly, and existing water management tools be updated as appropriate to ensure currency with the operational configuration of the mine water management system.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

Hunter Valley Operations (HVO) mining complex is located approximately 24 kilometres (km) north-west of Singleton, New South Wales (NSW) (Figure 1.1). Coal & Allied owns and operates HVO with management services provided by Rio Tinto Coal Australia (RTCA). The mining and processing activities at HVO are geographically divided by the Hunter River into HVO North and HVO South. While HVO is managed as one operation, HVO North and HVO South each have separate planning approvals.

The complex comprises the active Carrington, North, West and Mitchell Pits and related mining activities and infrastructure such as overburden emplacement areas. There are two coal preparation plants operating at HVO North, the Hunter Valley and Howick Coal Preparation Plants (CPPs) and two train load out areas, the Hunter Valley and Newdell load points.

HVO North currently operates under Development Consent No. DA 450-10-2003 (DA 450-10-2003), which was issued by the then Minister for Infrastructure, Planning and Natural Resources in 2004, under Part 4 of the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act).

Coal & Allied is proposing to modify DA 450-10-2003 under section 75W of the EP&A Act, to allow for:

- the construction and operation of a fine reject emplacement to the north of the existing Carrington Pit;
- fine reject emplacement in Cumnock Void 3, located to the north-east of West Pit; and
- a minor amendment to the HVO North development consent boundary to encompass Cumnock Void 3 is proposed to accommodate the modification.

Figure 1.2 shows the general arrangement of the existing HVO North mining operations, as well as the locations of the proposed fine reject emplacement and Cumnock Void. The ‘project area’ comprises the fine reject emplacement and areas of associated disturbance, including pipelines. Further detail on the proposed modification is provided in Section 3.

1.2 LOCALITY

The majority of HVO North is located within the Singleton Local Government Area (LGA) with the exception of the northern most section, which is located within the Muswellbrook LGA. Dominant features of the HVO North landscape comprise the existing open cut pits, mine-related infrastructure and rehabilitated former mining areas, to the north, east and south.

Mine operations and related infrastructure in the surrounding area include Ravensworth/ Narama Mine, HVO South, Ashton Coal, Warkworth Mine, Wambo Mine and United Colliery.

Bayswater Power Station is situated to the north. Grazing and cropping land dominates areas to the west.

The proposed modification will take place on predominately disturbed land. The closest privately owned residences are over 4 km to the west, south-west and south of the fine reject emplacement and are located within the village of Jerrys Plains and along the Golden Highway.

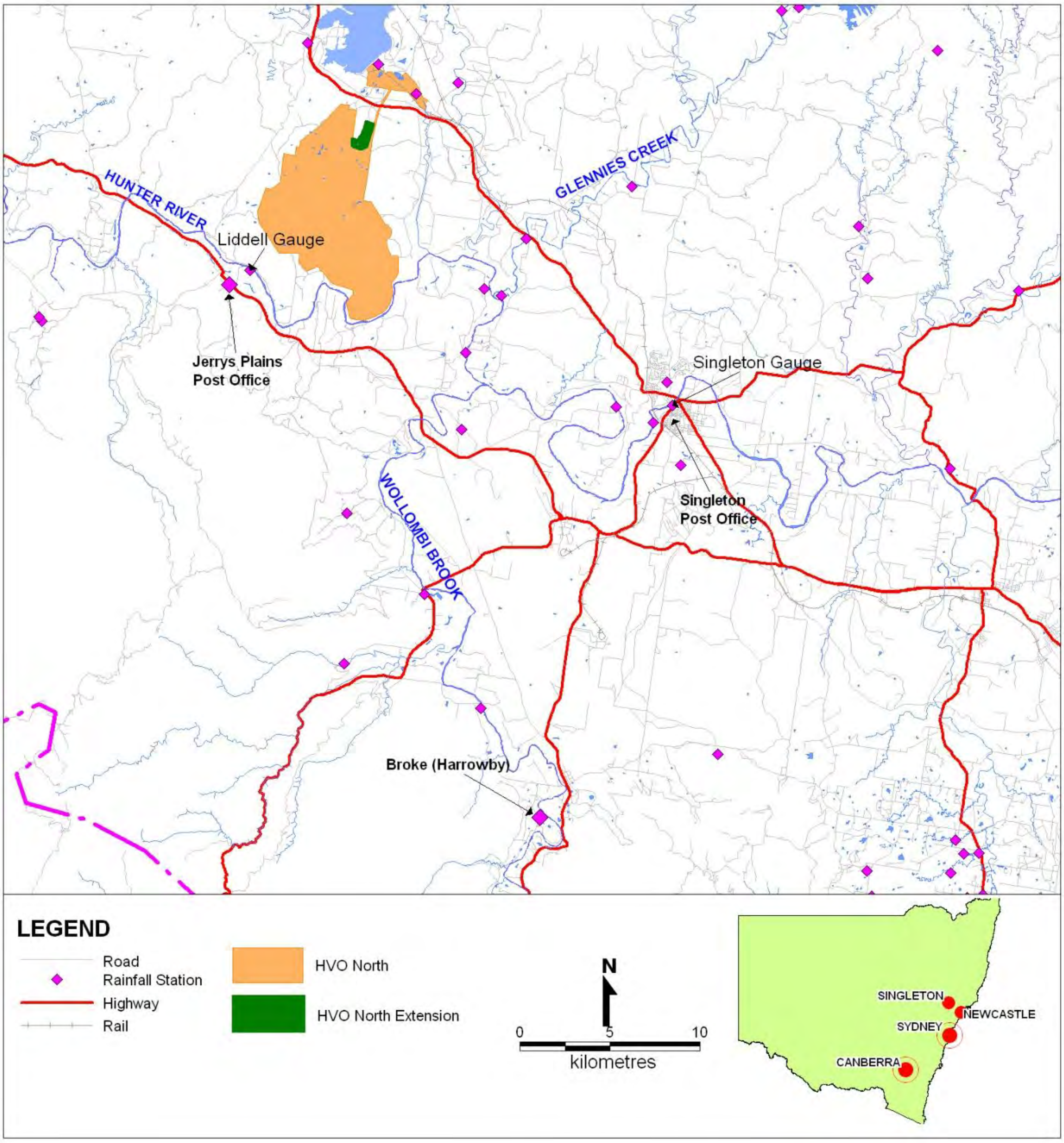


Figure 1.1 HVO North Locality

Figure 1.2 HVO North Modifications

1.3 REPORT PURPOSE AND STRUCTURE

WRM Water and Environmental (WRM) was commissioned by EMGA Mitchell McLennan (EMM) to assess the potential impacts of the proposed modification on surface water and develop measures to manage and monitor these impacts.

This report is structured as follows.

- Section 2 describes the regulatory framework relevant to the proposed modification;
- Section 3 describes the project and the components of the proposed modification works;
- Section 4 describes the existing environment with respect to surface water resources and mine water management;
- Section 5 describes the potential impacts of the proposed modification on surface water resources and identifies the proposed measures to mitigate the impacts;
- Section 6 describes the methodology and results of water balance modelling undertaken to assess the impact of the proposed modification on the minesite water management system;
- Section 7 summarises the findings of the study;
- Section 8 provides a list of references; and
- Appendix A summarises the HVO North water management system (WMS) including an overview of the water balance model.

2 REGULATORY FRAMEWORK

2.1 OVERVIEW

The following legislation, plans, policies and regulations are relevant to this modification:

- *Protection of the Environment Operations Act 1997*;
- *Water Management Act 2000* and applicable water sharing plans and harvestable rights provisions;
- State Water Management Outcomes Plan (SWMOP) and Hunter and Central Rivers Catchment Action Plan (CAP);
- *Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002*;
- National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000); and
- NSW Office of Water (NOW) Water Reporting Requirements for Mining Operations 2009.

The relevance of key legislation is briefly outlined in the following sections.

2.2 PROTECTION OF THE ENVIRONMENT OPERATIONS ACT 1997

The Project is licensed under *Protection of the Environment Operations Act 1997.* The existing licence (EPL 640) makes provision for release of water from the site at the outlet pipe from three locations, with concentration and volume limits shown in Table 2.1.

Table 2.1 HVO EPL 640 Discharge Conditions

Item	Unit	Limit
pH	pH units	Lower: 6.5 Upper: 9.5
Total suspended solids	mg/L	120
Volume	ML/d	Varies depending on discharge location

2.3 WATER MANAGEMENT ACT 2000

2.3.1 Water Sharing Plans

The *Water Management Act 2000* covers surface waters associated with the modification area and the Hunter River itself through the following Water Sharing Plans:

1. Hunter Unregulated and Alluvial Water Sources Sharing Plan 2009. Surface water in Farrells Creek, Parnells Creek, the Unnamed Tributary and its tributaries is regulated under this plan. Where water volumes extracted from these catchments exceeds the Harvestable Right provisions, a water entitlement (an unregulated river access license) is required. The plan limits annual extraction to a limit which provides for no new growth in water entitlements.
2. Hunter Regulated River Water Sharing Plan 2003. All water extractions from the Hunter River will be managed under appropriate water access licenses (WALs). HVO holds approximately 2685 high security units of Hunter River water shares. Water will continue to be extracted from existing licenses, and there will therefore be no cumulative impact on Water Supplies in the Hunter River catchments caused by the proposed modification.

2.3.2 Excluded Works

Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream are excluded works and accordingly are not required to be the subject of water supply works approval and there is no requirement for a Water Access Licence to take water and use water from them.

2.4 STATE WATER MANAGEMENT OUTCOMES PLAN (SWMOP) AND HUNTER AND CENTRAL RIVERS CATCHMENT ACTION PLAN (CAP)

The SWMOP (established under the *Water Management Act 2000*) and CAP (established under the *Catchment Management Authorities Act 2003*) set out the broad targets and strategic directions for the state and for the catchment. Natural resource features to be protected and enhanced are identified, along with actions to achieve key outcomes. The proposed modification is consistent with the SWMOP and CAP objectives because:

- Surface disturbance is restricted to the area of the modification site. Impacts will be mitigated within the site water management system. Erosion and sediment controls will be designed and operated in accordance with the Blue Book requirements (DECCW, 2008);
- Any extraction of water will be in accordance with licensing provisions; and
- Discharges from the site will only occur if water complies with the site EPL and where applicable, the HRSTS.

2.5 PROTECTION OF THE ENVIRONMENTAL OPERATIONS (HUNTER RIVER SALINITY TRADING SCHEME) REGULATION 2002

The Hunter River Salinity Trading Scheme (HRSTS) was introduced by the NSW Government to reduce salinity levels in the Hunter River, and operates under the *Protection of the Environment Operations* (Hunter River Salinity Trading Scheme) *Regulation 2002*.

Releases of mine water to the Hunter River can be made in compliance with the conditions of an EPL and in accordance with credits purchased under the HRSTS. The HRSTS limits the quantity of salt that may be discharged through a cap and trade system that also restricts discharge to periods of high flow.

Under the HRSTS, credit holders are permitted to discharge saline water to the Hunter River on a managed basis. The aim is to maintain river salinity levels below 600 µS/cm at Denman and 900 µS/cm at Singleton. This is achieved through:

- Discharge scheduling that allows discharge only at times when the river flow and salinity level are such that salt can be discharged without breaching the salinity targets; and
- Sharing the allowable discharge according to licensed holdings of tradeable salinity credits.

The discharge schedule prohibits discharges during low flow periods. Discharges are regulated in proportion to credit holdings during high flow periods and unlimited discharges are permitted during flood flow periods, subject to tributary protection limits and the overarching requirement to achieve the upper limit salinity levels at Denman and Singleton.

A total of 1,000 credits are available for allocation through the scheme. Consequently, a holding of one credit entitles the owner to discharge 0.1 per cent of the total allowable discharge for the period.

If discharge of further excess water to the Hunter River system is required, under the scheme, credits may be obtained on a day to day basis though trade between licensed users, or, for long term use, through public auction.

Under the HRSTS, the Hunter River is separated into three sectors upstream of Singleton: Upper, Middle and Lower. HVO North lies in the Middle Sector. The HRSTS flow and river salinity thresholds for the Middle Sector are presented in Table 2.2.

Table 2.2 HRSTS Flow & River Salinity Thresholds, Middle Sector

Hunter R Flow Rate (ML/d)	Block Classification	River Target Salinity (EC)	Discharge Procedure
<1,800	Low	n/a	No discharges allowed
1,800 – 6,000	High	900 µS/cm	Limited discharges allowed, controlled by salt credits and Total Allowable Discharge (TAD)
>6,000	Flood	900 µS/cm	Unlimited discharges

The water in the river is divided into numbered blocks. The scheme operators monitor the flow and salinity in each block, and calculate the TAD of salt to meet the salinity target. Credit holders are notified via a dedicated website of the TAD and the start and end times for each release.

Note that HVO is currently a Member of the HRSTS.

3 PROJECT DESCRIPTION

3.1 OVERVIEW

Reject material is produced as a by-product of the coal washing process. Run-of-mine (ROM) coal often contains part of the rock strata above and below the coal seam. The rock is removed from the product through the washing process in the Coal Preparation Plant (CPP). As a result, two forms of reject are produced: coarse reject and fine reject. Coarse reject, together with waste rock, is hauled to active emplacement areas. The fine reject are pumped as slurry from the CPP to emplacement facilities via pipeline.

Mine planning has identified that fine reject capacity at HVO North will be constrained. Additional storage is required to enable ongoing mining operations at HVO North. The proposed fine reject emplacements will provide an additional six years of capacity and are, therefore, critical to the viability of HVO North.

3.2 PROPOSED MODIFICATION

The proposed modification comprises two elements, namely:

- the construction and operation of a fine reject emplacement to the north of the existing Carrington Pit; and
- fine reject emplacement in Cumnock Void 3, located to the north-east of West Pit; and
- a minor amendment to the HVO North development consent boundary to encompass Cumnock Void 3 is proposed to accommodate the modification.

Figure 3.1 and Figure 3.2 shows the proposed arrangement of each element of the modification.

3.2.1 Cumnock Void 3 Fine Reject Emplacement

The Cumnock Void 3 emplacement is located outside of the HVO North development consent boundary and within a mining lease held by the Cumnock Joint Venture. Fine reject emplacement within the void was assessed in the Ravensworth Operations Project Environmental Assessment by Umwelt 2010 and approved under DA 09_0176. A draft joint use agreement between the Cumnock Joint Venture and Coal & Allied is being developed in respect of each company's use of the void. Coal & Allied's contribution to fine reject emplacement in Cumnock Void 3 will utilise about 25 per cent of the void's emplacement capacity.

Fine reject will be transported to the Cumnock Void 3 emplacement via an overland pipeline adjacent to the existing haul roads from the Howick CPP (HCPP). The entire pipeline route is yet to be confirmed, but will be located on land previously disturbed by mining and related activities. No native tree or substantial native vegetation disturbance will be required for its construction. If a pipeline is required from the Hunter Valley CPP (HVCPP) it will be connected to the pipeline from the HCPP.

As reject emplacement in Cumnock Void 3 has already been assessed and approved, this assessment only considers the potential impacts to the HVO WMS.

Figure 3.1 Fine Reject Modification - Cumnock Void 3 Fine Reject Emplacement

3.2.2 Fine Reject Emplacement

The fine reject emplacement will occupy an area of approximately 161ha and will be on land that has been mined and is cleared of remnant native vegetation. The emplacement will have a life of approximately five years and will be completed within the existing development consent period, which is currently to 2025.

Fine reject will be transported to the fine reject emplacement via an overland pipeline adjacent to existing haul roads direct from the HVO North CPPs. No substantial vegetation disturbance will be required for its construction.

Figure 3.2 Fine Reject Modification – Fine Reject Emplacement

3.3 PROJECT STAGING

Given that the Cumnock Void 3 emplacement commences around a year earlier than the fine reject emplacement, the surface water impact assessment for the proposed modification has been undertaken for three modelling stages:

- Stage 1 - Existing fine reject emplacement strategy (Years 2012-13);
- Stage 2 - Cumnock Void 3 emplacement commences (Year 2014);
- Stage 3 - Cumnock Void 3 and fine reject emplacement both active (Years 2015+).

These stages form the basis of the water balance modelling work, described in further details in Section 5.

3.4 CARRINGTON WEST WING PROPOSAL

The Carrington West Wing (CWW) modification was approved by the NSW Department of Planning and Infrastructure (DP&I) on 19 March 2013. The project comprises a 137ha extension allowing for the recovery of approximately 17 million tonnes of in-situ coal.

There is no direct interaction between the CWW project and the fine reject modification proposal. However, the assessment of the potential impacts on the HVO North water management system has included the approved CWW proposal.

4 EXISTING ENVIRONMENT

4.1 REGIONAL DRAINAGE NETWORK

The regional drainage network in the area of interest is shown in Figure 1.1. The Hunter River has a catchment area of approximately 13,400km^2 to HVO. The catchment extends some 110km to the north and 140km to the west and includes the major tributaries of the Pages River, Dart Brook and the Goulburn River.

The Hunter River in the vicinity of HVO North has a base width of between 80m and 150m and is about 10m deep. The bed of the river consists of mobile bars of sand and gravel separated by pools of water. The banks of the river are moderately steep particularly on the outside bends and are vegetated with a range of native and non native (willow) species. There is some evidence of active slumping of the high banks. The river floodplain varies in width from 700m to about 1.7km in the vicinity of HVO North. Much of the floodplain has been intensively cropped with significant areas under irrigation. Figure 4.1 shows a photograph of the Hunter River adjacent to the project area taken in June 2009 (see Figure 1.2 for approximate location of photo).

The Hunter River is a regulated river supplying water from Glenbawn Dam to a range of industrial and agricultural users as well as town water supplies. Glenbawn Dam is located on the upper headwaters of the Hunter River. Two major tributaries, Glennies Creek and Wollombi Brook, drain into the Hunter River some 10km downstream of the mine. The total catchment area of the Hunter River to Singleton, located 20km downstream, is 16,400km^2.

The existing HVO North operation is located partly on the Hunter River floodplain and partly on the adjoining hill slopes. Levees are currently used to prevent Hunter River floodwater from entering areas of the mine. The existing licensed levees on HVO North are shown in Figure 1.2.

4.2 LOCAL DRAINAGE NETWORK

4.2.1 Unnamed Tributary

A local catchment of 13.75km^2 drains the south-western side of HVO North via an Unnamed Tributary to the Hunter River, as shown in Figure 1.2. At its downstream end, the Unnamed Tributary is a fourth-order stream, based on the Strahler system of stream order classification. However, the stream is ephemeral, effectively functioning as a lower order stream. The upstream reach of the Unnamed Tributary has been constructed across previously mined areas and has been substantially realigned from pre-mining conditions. The realigned Unnamed Tributary consists of a small channel that is about 10m wide and 1m to 2m deep and is well grassed. A licence under the *Water Act 1912* was previously obtained for these works.

Adjacent to the existing Carrington Pit, the Unnamed Tributary drains along an ill defined paleo-channel to the Hunter River. In this reach, the Unnamed Tributary has a bed slope of approximately 0.27% and is wide and denuded of vegetation. In the downstream reach, the Unnamed Tributary falls along a relatively defined channel to the Hunter River at a slope of 4%.

The Unnamed Tributary is ephemeral, subject to gully erosion and lacks any significant riparian vegetation. It is of low aquatic significance, providing only poor to marginal habitat for aquatic species (Biosis, 2010). Further discussion of riparian and ecological values of the watercourses on site and downstream of the project area is provided in the Biosis (2010) Carrington West Wing Ecology Assessment. Figure 4.2 shows a photograph of the Unnamed Tributary adjacent to the existing Carrington Pit (see Figure 1.2 for approximate location of photo).

4.2.2 Farrells Creek

Farrells Creek is a minor tributary of the Hunter River that drains the catchment north-east of Carrington Pit. It has an average bed slope of approximately 0.66%, prior to draining into the Hunter River downstream of the site.

The HVO North WMS has the ability to discharge into Farrells Creek via Dam 11N.

4.2.3 Parnells Creek

Parnells Creek is a minor tributary of the Hunter River that drains the catchment to the west of West Pit. It has an average bed slope of approximately 0.72%, prior to draining into the Hunter River upstream of the site.

The HVO North WMS has the ability to discharge into Parnells Creek via Dam 9W.

4.3 HUNTER RIVER FLOODING AND LEVEES

As shown in Figure 1.2, a levee currently extends along the Hunter River, adjacent to the mine area to the south-east of the Unnamed Tributary and proposed fine reject emplacement location. The purpose of this levee is to protect the mine workings from Hunter River flooding.

A flood impact assessment has previously been undertaken for the CWW proposal, including an assessment of predicted flooding levels around the Unnamed Tributary for existing conditions.

Key outcomes from this assessment include:

- The 2 year Average Recurrence Interval (ARI) Hunter River design flood is generally confined to the main channel. The Hunter River flood flows exceed the capacity of the channel and inundate the floodplain in the vicinity of the proposed fine reject emplacement for the 5 year ARI design event.
- The Hunter River dominates flood levels in the vicinity of the proposed fine reject emplacement for floods greater than and equal to the 10 year ARI event. Local catchment flows from the Unnamed Tributary dominate for the more frequent floods.

Figure 4.1 Hunter River Channel adjacent to the Carrington Pit

Figure 4.2 Unnamed Tributary

4.4 RAINFALL AND EVAPORATION

Table 4.1 shows summary details of Bureau of Meteorology rainfall recording stations in the vicinity of HVO North. The locations of the various stations are shown in Figure 1.1.

Table 4.1 Rainfall Stations

Station No.	Station Name	Elevation (m)	Lat. (°S)	Long. (°E)	Distance from Site (km)	Opened	Closed
061086	Jerrys Plains Post Office	90	32.497	150.909	7	1884	-
061070	Singleton Post Office	41	32.567	151.167	20	1881	1969
061100	Broke (Harrowby)	76	32.767	151.087	30	1887	-

Table 4.2 shows mean monthly rainfalls for the three rainfall stations shown in Table 4.1. The mean annual rainfall in the area of interest ranges from 644mm to 698mm, with maximum monthly rainfalls occurring during the summer months.

Table 4.2 also shows mean monthly evaporation (based on a Class A evaporation pan) recorded at Jerrys Plains Post Office (Station No. 61086), located some 7km to the west of HVO North. Mean annual evaporation is 1,641mm, which is more than double mean annual rainfall.

Figure 4.3 shows the annual distribution of mean monthly rainfall and mean monthly evaporation in the local area. Mean evaporation is similar to mean rainfall in the winter months, but substantially exceeds rainfall for the remainder of the year.

Table 4.2 Mean Monthly Rainfall and Evaporation

Month	Mean Monthly Rainfall (mm)			Mean Monthly Evaporation (mm)
	Singleton Post Office (061070) [1881 - 1969]	Jerrys Plains Post Office (061086) [1884 -]	Broke (Harrowby) (061100) [1887 -]	Jerrys Plains Post Office (061086) [8 years data]
January	75.3	77.0	71.2	220
February	72.1	72.4	75.3	170
March	71.3	58.3	65.5	155
April	55.8	44.5	50.0	120
May	46.4	40.9	43.0	90
June	57.1	48.1	53.3	60
July	51.4	43.5	40.4	71
August	41.5	36.5	35.6	81
September	44.7	42.0	39.4	111
October	50.8	52.2	50.6	164
November	58.4	61.1	60.1	195
December	73.6	67.9	68.9	205
Total	**698**	**644**	**653**	**1,641**

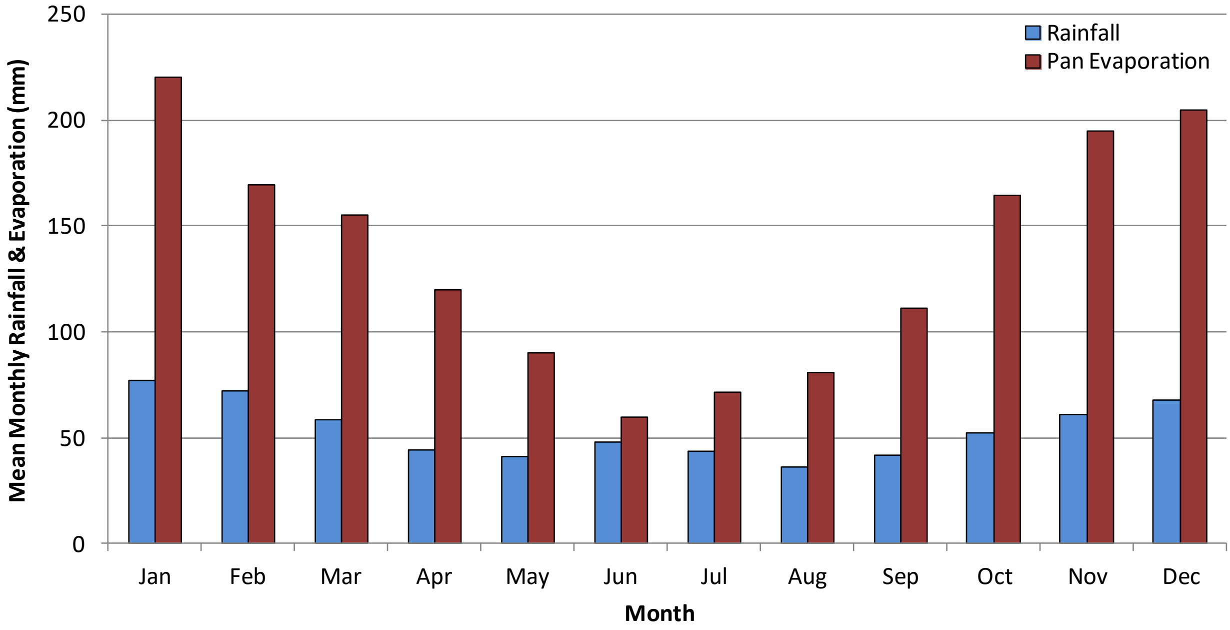


Figure 4.3 Distribution of Monthly Rainfall and Evaporation (Jerrys Plains Post Office)

4.5 STREAMFLOW

Table 4.3 shows the estimated annual runoff volumes for the Hunter River catchment to the Liddell gauge (Station No. 210083). The Liddell gauge is located approximately 7.0km upstream of HVO North and has a catchment area of 13,400km^2. Data has been collected at Liddell since 1969. The volumetric runoff coefficient (rainfall to runoff relationship) of the Hunter River flows to Liddell is approximately 4 percent. Figure 4.4 shows the flow-duration relationship for the Hunter River at the Liddell gauge which indicates that flow is non-zero almost 100 percent of the time, which is characteristic of regulated river systems.

Figure 4.5 shows a plot of annual runoff versus rainfall for the Hunter River at Liddell. Very little runoff is generated by the catchment when annual rainfall is less than about 400mm. Once annual rainfall exceeds this value, the volume of surface runoff increases substantially.

Table 4.3 Annual Rainfall and Runoff Volumes for Hunter River to Liddell Gauging Station

Year	Annual Rainfall [a] (mm)	Annual Runoff Volume (GL)	Annual Runoff Volume (mm)	Volumetric Runoff Coefficient
1971	752	1479	110	0.147
1972	672	325	24	0.036
1973	724	419	31	0.043
1974	624	732	55	0.088
1975	556	166	12	0.022
1976	799	1105	82	0.103
1977	563	1037	77	0.138
1978	873	1028	77	0.088
1979	538	243	18	0.034
1980	331	88	7	0.020
1981	743	164	12	0.016
1982	501	146	11	0.022
1983	589	103	8	0.013
1984	821	602	45	0.055
1985	559	375	28	0.050
1986	542	94	7	0.013
1987	819	118	9	0.011
1988	838	284	21	0.025
1989	757	1056	79	0.104
1990	784	1100	82	0.105
1991	578	96	7	0.012
1992	711	594	44	0.062
1993	647	158	12	0.018
1994	469	52	4	0.008
1995	605	108	8	0.013
1996	569	228	17	0.030
1997	532	145	11	0.020
1998	838	1188	89	0.106
1999	663	194	14	0.022
2000	808	817	61	0.076
2001	757	392	29	0.039
2002	557	104	8	0.014
2003	674	107	8	0.012
2004	730	75	6	0.008
2005	641	87	6	0.010
2006	371	43	3	0.009
2007	888	674	50	0.057
2008	736	289	22	0.029
2009	707	92	7	0.010
2010	827	526	39	0.047
2011	821	533	40	0.048
Mean	**671**	**419**	**31**	**0.043**

[a] Based on rainfall for the Jerrys Plains Post Office Station which has been adopted as representative of rainfall over the catchment.

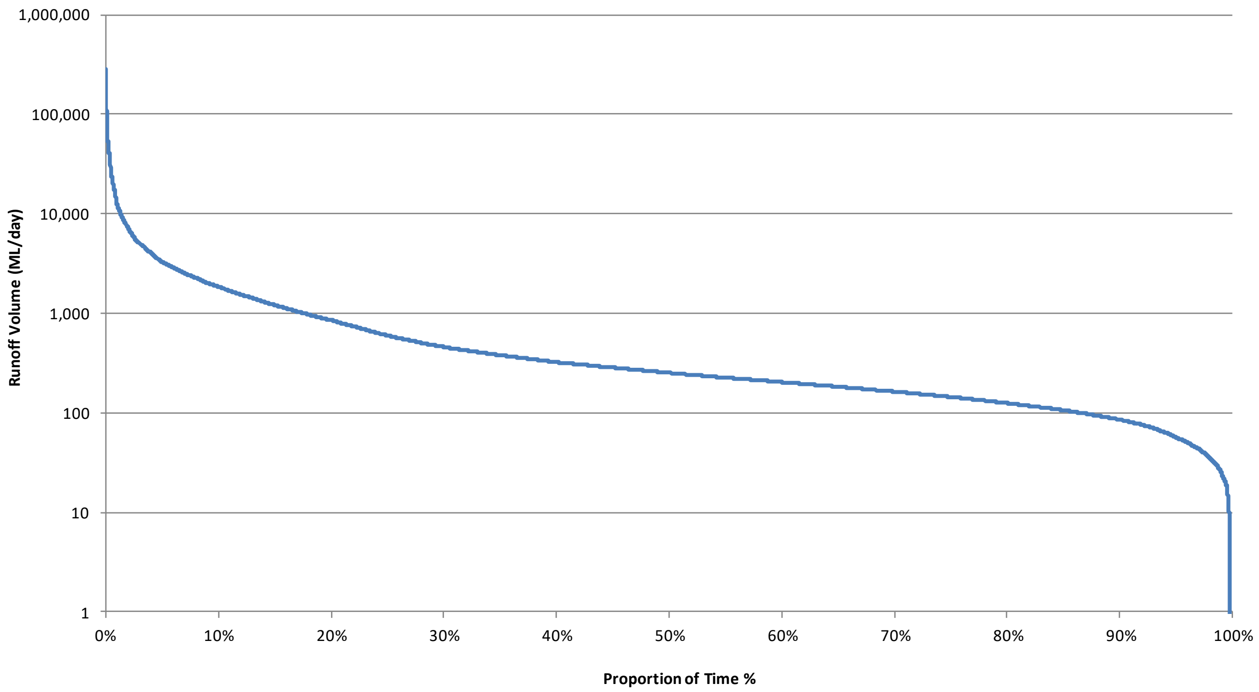


Figure 4.4 Derived Flow-Duration Relationship for the Hunter River at Liddell (1949-2009)

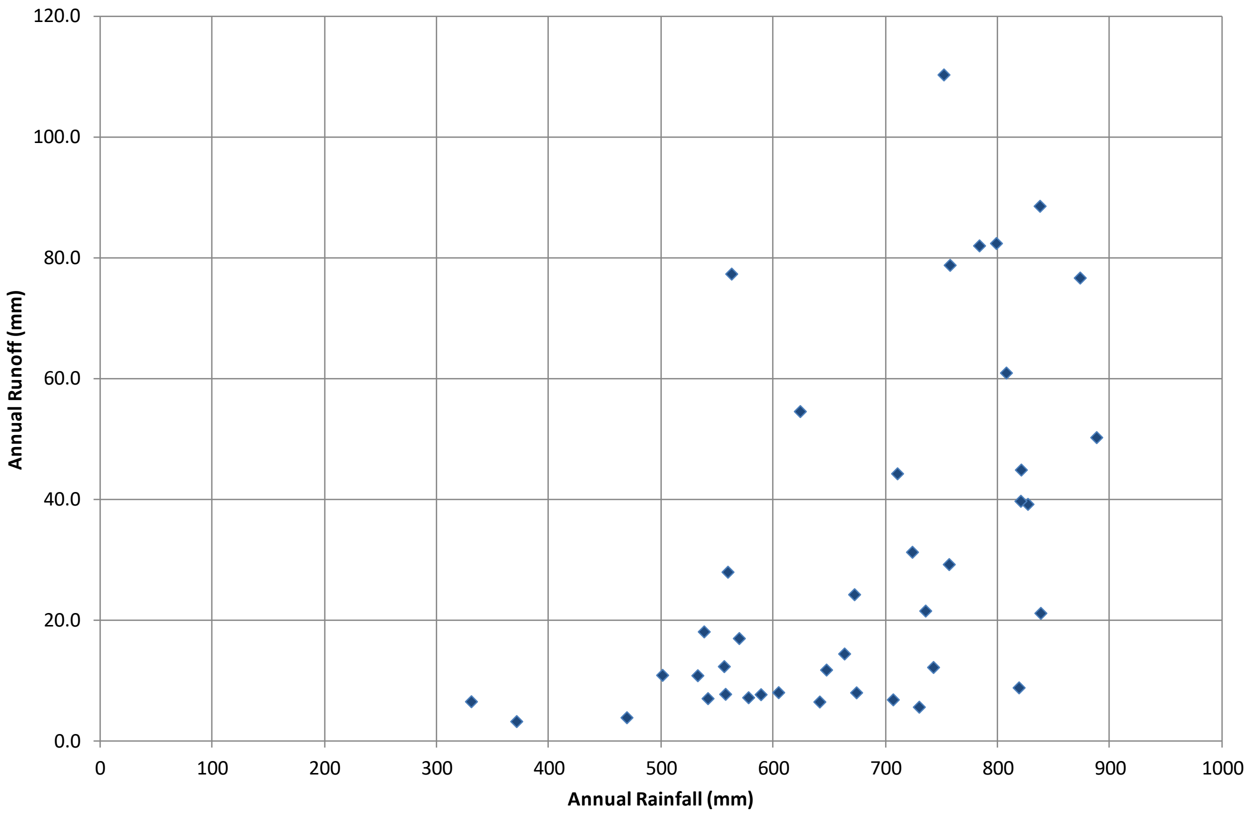


Figure 4.5 Annual Runoff versus Rainfall for the Hunter River at Liddell Gauging Station

4.6 SURFACE WATER QUALITY

Surface water quality is monitored at HVO in on-site dams and surrounding natural watercourses (including Wollombi Brook and the Hunter River) at 25 locations. The monitoring is managed under Rio Tinto Coal Australia's Health, Safety, Environment and Quality (HSEQ) Management System which is certified to the international standard ISO:14001 (2004), and is reported to the Department of Planning annually through the Annual Environmental Management Report (AEMR).

The location of surface water monitoring points is shown in Figure 4.6.

4.6.1 Hunter River

Table 4.4 shows a summary of pH results at key monitoring points recorded in 2011 along the Hunter River. Electrical conductivity (EC) results are shown in Table 4.5 and total suspended solids (TSS) are shown in Table 4.6.

The two water quality sampling locations, W1 and W4, are generally located on the Hunter River upstream and downstream of the project area, respectively. A comparison of results between W1 and W4 indicates that there was no significant change in water quality between these stations in 2011.

Table 4.4 Hunter River - pH Summary 2011

		pH	
Monitoring Point	Location	Result Range 2011	Annual Average 2011
W109	Hunter River U/S	8.0-8.5	8.3
W1	Hunter River U/S	8.0-8.6	8.3
W3	Hunter River D/S	7.9-8.9	8.3
W4	Hunter River D/S	8.0-8.8	8.4

Table 4.5 Hunter River - Electrical Conductivity Summary 2011

		EC (µS/cm)	
Location	Location	Result Range 2011	Annual Average 2011
W109	Hunter River U/S	610-920	740
W1	Hunter River U/S	610-920	730
W3	Hunter River D/S	440-970	700
W4	Hunter River D/S	610-940	740

Figure 4.6 HVO Surface Water Monitoring Network

Table 4.6 Hunter River - TSS Summary 2011

		TSS (mg/L)	
Location	**Location**	**Result Range 2011**	**Annual Average 2011**
W109	Hunter River U/S	10-36	26
W1	Hunter River U/S	7-35	28
W3	Hunter River D/S	9-46	37
W4	Hunter River D/S	10-42	32

4.6.2 Parnells Creek and Farrells Creek

Water quality sampling is undertaken for the two minor waterways at HVO North, Parnells Creek (W3) and Farrells Creek (W11). As summary of pH, EC and TSS results for 2011 and provided in Table 4.7, Table 4.8 and Table 4.9, respectively.

These results show that the water quality in Parnells Creek and Farrells Creek is generally consistent with the Hunter River flow for 2011, with the exception of somewhat elevated TSS for Farrells Creek.

Table 4.7 Parnells & Farrells Ck - pH Summary 2011

		pH	
Monitoring Point	**Location**	**Result Range 2011**	**Annual Average 2011**
W3	Parnells Creek	7.9-8.9	8.3
W11	Farrells Creek	7.6-8.0	7.8

Table 4.8 Parnells & Farrells Ck - Electrical Conductivity Summary 2011

		EC (μS/cm)	
Location	**Location**	**Result Range 2011**	**Annual Average 2011**
W3	Parnells Creek	440-970	700
W11	Farrells Creek	200-670	540

Table 4.9 Parnells & Farrells Ck - TSS Summary 2011

		TSS (mg/L)	
Location	**Location**	**Result Range 2011**	**Annual Average 2011**
W3	Parnells Creek	9-46	30
W11	Farrells Creek	18-93	44

4.7 ENVIRONMENTAL VALUES IN RECEIVING WATERS

The Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) have prepared a guideline for water quality management for use throughout Australia and New Zealand based on the philosophy of ecologically sustainable development (ESD). The guideline is called the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) and is often referred to as the 'ANZECC guidelines'.

The NSW Department of Environment, Climate Change and Water (DECCW) has prepared a booklet using the ANZECC guidelines and Water Quality Objectives in NSW (2006) to assist technical practitioners with applying the ANZECC guidelines in NSW (referred to herein as the NSW guideline).

The NSW guideline defines the 'Environmental values' of receiving waters as those values or uses of water that the community believes are important for a healthy ecosystem. The environmental values of the receiving waters of the Hunter River are regarded as:

- Aquatic ecosystem;
- Irrigation water supply;
- Livestock water supply;
- Primary and secondary contact recreation; and
- Visual amenity.

The ANZECC guidelines specify three levels of protection, from stringent to flexible, corresponding to whether the condition of the particular ecosystem is:

- of high conservation value;
- slightly to moderately disturbed; or
- highly disturbed.

According to the DECCW booklet, the policy in NSW is that the level of protection applied to most waterways is the one suggested for "slightly to moderately disturbed ecosystems". As there is no justification to determine otherwise, the receiving waterways adjacent to the project area are regarded as slightly to moderately disturbed.

4.8 EXISTING MINE WATER MANAGEMENT SYSTEM

4.8.1 Objectives of the HVO North WMS

The existing HVO North mine water management system is operated in accordance with the current HVO Water Management Plan, last updated in September 2009. The key objectives of the Water Management Plan are as follows:

- Diversion of clean surface water runoff away from areas disturbed by mining activities;
- Collection of surface water runoff from areas disturbed by mining activities to control suspended sediment prior to runoff from site or re-use via the mine water management system;
- Transfer of open cut pit water to storage dams for re-use in the mine water management system;
- Maximise the re-use and recycling of stored water on site, especially for use as the process supply to the CPPs and other related activities;
- Use stored water for dust suppression on haul roads, trafficable areas and stockpiles;
- Minimise extraction of water from the Hunter River during dry and drought periods; and
- Minimise offsite discharge under the Hunter River Salinity Trading Scheme (HRSTS) during wet periods.

4.8.2 Operational Guidelines & WMS Schematic

Operational guidelines for the HVO North WMS model, based on a review of available site operating protocol are presented in Appendix A.

A schematic of the current HVO North mine WMS is provided in Figure A1 and Figure A2, in Appendix A.

The fine reject modification assessment will utilise the existing water management system configuration, with minor changes relating to the proposed disposal options.

4.8.3 Existing Fine Reject Disposal Operations

There are two coal preparation plants operating at HVO North, the HVCPP and the HCPP. Coarse reject from HVO North can be hauled between any pit, CPP and emplacement within HVO, as required, on existing private haul roads. Fine reject disposal operations currently operate as follows:

- HVCPP –pump to Dam 29N (North Pit Void Tailings Dam); and
- HCPP – pump to Dam 20W (Bob's Dump Tailings Dam).

As discussed in Section 3.2, it is proposed to alter the existing fine reject disposal configuration in accordance with the proposed modification.

4.9 HUNTER RIVER SALINITY TRADING SCHEME (HRSTS)

HVO participates in the HRSTS (as described in Section 2.5) and is allowed to discharge from Dam 11N (to Farrells Creek), and Dam 9W (to Parnells Creek) (see Figure 4.6) during periods of 'high' or 'flood' flows in accordance within the scheme rules. Discharge to the Hunter River is also permitted at HVO South from Dam 15S (Lake James), under the HRSTS.

HVO is located in the middle sector of the Hunter River. In 2011 HVO held an allocation of 145 credits and operated discharge points under Environmental Protection Licence (EPL) 640 at Dam 9W (Parnells Dam), Dam 11N and Dam 15S (Lake James – HVO South). If the discharge criteria were met, water was permitted to be released from the dams at rates of up to 130ML/day, 100ML/day and 120ML/day respectively, regardless of where it was generated.

Since 1st July 2012, HVO increased the HRSTS credit allocation to 151 following the 2012 HRSTS credit auction.

Table 4.10 shows a summary of the discharges from Dam 9W (EPA Point 4, Parnells Dam), Dam 11N (EPA Point 3) and K Dam (EPA Point 8, Lake James) under the HRSTS for 2011.

Table 4.10 HRSTS Discharges 2011

Discharge Year	Location	Number of Discharge Blocks	Credits Held	Allowable Discharge (tonnes)		Total Salt Load Discharged (tonnes)
				Total	At location	At location
2011	Dam 9W	9	145	30,945	4,890	932
	Dam 11N	3	145	21,744	3,153	215
	Dam 15S	14	145	48,804	7,932	2,240

5 POTENTIAL IMPACTS AND MITIGATION MEASURES

5.1 OVERVIEW

The potential changes to surface water and water management during the life of the project are summarised below:

- Additional surface water runoff from the fine reject emplacement;
- Change in surface water runoff volume to receiving waters;
- Change in runoff water quality;
- Impacts on HRSTS discharges and Hunter River water quality; and
- Impacts on Hunter River flooding.

Note that as the use of Cumnock Void 3 for fine reject disposal already has planning approval, potential impacts are only related to impacts on the site water balance associated with the fine reject disposal operations which are primarily associated with the return of decant water from Cumnock Void 3 back to the HVO water management system. Cumnock Joint Venture will be the manager of the joint tailings facility , and the decant return arrangement is currently subject to agreement between Coal & Allied and Cumnock Joint Venture.

For the purposes of assessment it was assumed that the volume of decant water from CumnockVoid 3 to HVO would be equal to the moisture in the emplaced HVO reject material minus losses, notionally 25% of the total emplaced fine reject material. The Cumnock Joint Venture would retain responsibility for the remaining 75%.

5.2 ADDITIONAL SURFACE WATER RUNOFF

Additional surface water would be generated by the collection of runoff into the proposed fine reject emplacement and Cumnock Void 3. Fine reject emplacement water can have elevated levels of salinity and may also contain elevated levels of suspended sediment.

The management of water in the proposed modification area would essentially be the same as for the existing operations. Surface water accumulated in the emplacement and Cumnock Void 3 (Coal & Allied allocation only) would be transferred via pit dewatering pumps to Dam 9N and Dam 9W respectively, where it would be re-used and recycled in the HVO North mine water management system.

An assessment of the impact of the additional water on the mine site water balance is given in Section 6.

5.3 CHANGE IN SURFACE WATER RUNOFF VOLUME TO RECEIVING WATERS

The expected removal of catchment due to the construction and management of the fine reject emplacement and associated average annual runoff volume draining to receiving waters associated with the project is presented in Table 5.1. The loss of catchment is confined to the catchment for the Unnamed Tributary. There are no licensed or unlicensed water users on the Unnamed Tributary.

The volume of surface water runoff from the various catchment areas on the minesite was estimated using the OPSIM model (described in Section 5) and long term rainfall data. For comparison, the average annual flow in the Hunter River at the closest gauging station has also been included.

Table 5.1 shows that the relative reduction in the Hunter River flows due to the proposed modification is small compared to the total flows in the Hunter River. It is proposed that the catchment removed due to mining would be largely reinstated to existing conditions through capping and rehabilitation of the tailing emplacement at the end of the life of the mine.

Note that the construction of the fine reject emplacement is required to prevent contamination of a water source and therefore would not require a water supply works approval, and there is no requirement for a Water Access licence to take and use water (as outlined in Section 2.3).

Table 5.1 Catchment Diversion & Loss of Runoff

Catchment Loss (ha)	Average Annual Catchment Runoff Reduction (ML/annum)	Average Annual Hunter River Volume (ML/annum)
90	57	419,000

There is no change in surface water runoff volume to receiving waters in relation to fine reject placement in the Cumnock Void 3.

5.4 CHANGE IN RUNOFF WATER QUALITY

Land disturbance associated with the construction of the proposed fine reject emplacement has the potential to adversely affect the quality of surface runoff through increased sediment loads. The following measures will be implemented to minimise these potential impacts:

- Runoff from undisturbed catchments will be diverted away from disturbed areas using surface drains;
- Surface runoff from disturbed areas will be treated through sedimentation basins prior to discharge from the site. Sediment dams will be maintained or constructed as required and will be designed in accordance with relevant design standards (DECCW, 2008);
- Sedimentation basins will be used to treat surface runoff from rehabilitated areas until the quality of runoff is suitable for release; and
- Saline water from mining-related activities will be collected within the mine water management system. Discharges will be released in accordance with the HRSTS rules.

The proposed management measures will ensure no measurable adverse impacts on riparian and ecological values of watercourses on the site and downstream of the proposed modification. There is no expected change in surface water runoff quality in relation to fine reject emplacement in the Cumnock Void 3.

5.5 HUNTER RIVER WATER QUALITY AND HRSTS

Changes in the site water management system at HVO North due to the proposed fine reject modification may impact the frequency of discharges to the Hunter River under the HRSTS, as well as the availability of HRSTS credits for other areas of the mine. The HVO North OPSIM model has been used to assess this potential impact.

Figure 5.1 shows the modelled annual discharge volumes for each stage of the proposed modification. The annual discharge volumes have been ranked from highest to lowest and plotted against the percentage exceedance for each stage. The results indicates that there is a 50% chance that at least 550ML/a to 600ML/a will be discharged via the HRSTS.

As described in detail in Section 6.3, the proposed modification has little impact on potential HRSTS discharges.

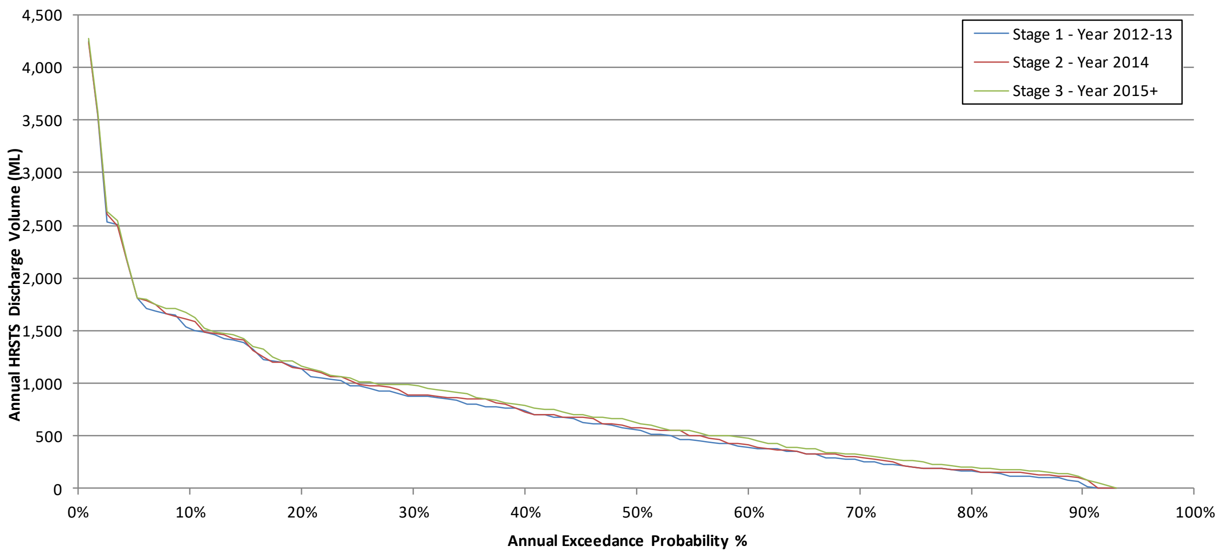


Figure 5.1 HRSTS Discharge Assessment

5.6 HUNTER RIVER FLOODING

Figure 5.2 shows the extent of the previously modelled 100 year Average Recurrence Interval (ARI) flood inundation for the Unnamed Tributary, overlain with the proposed fine reject emplacement footprint.

The figure shows that the proposed fine reject emplacement footprint only marginally encroaches into the 100 year ARI flood inundation extent. The flooding in this area is associated with backwater from the Hunter River (in the Unnamed Tributary), and the marginal encroachment of the proposed fine reject emplacement would have no impact on flood levels or velocities in the Hunter River.

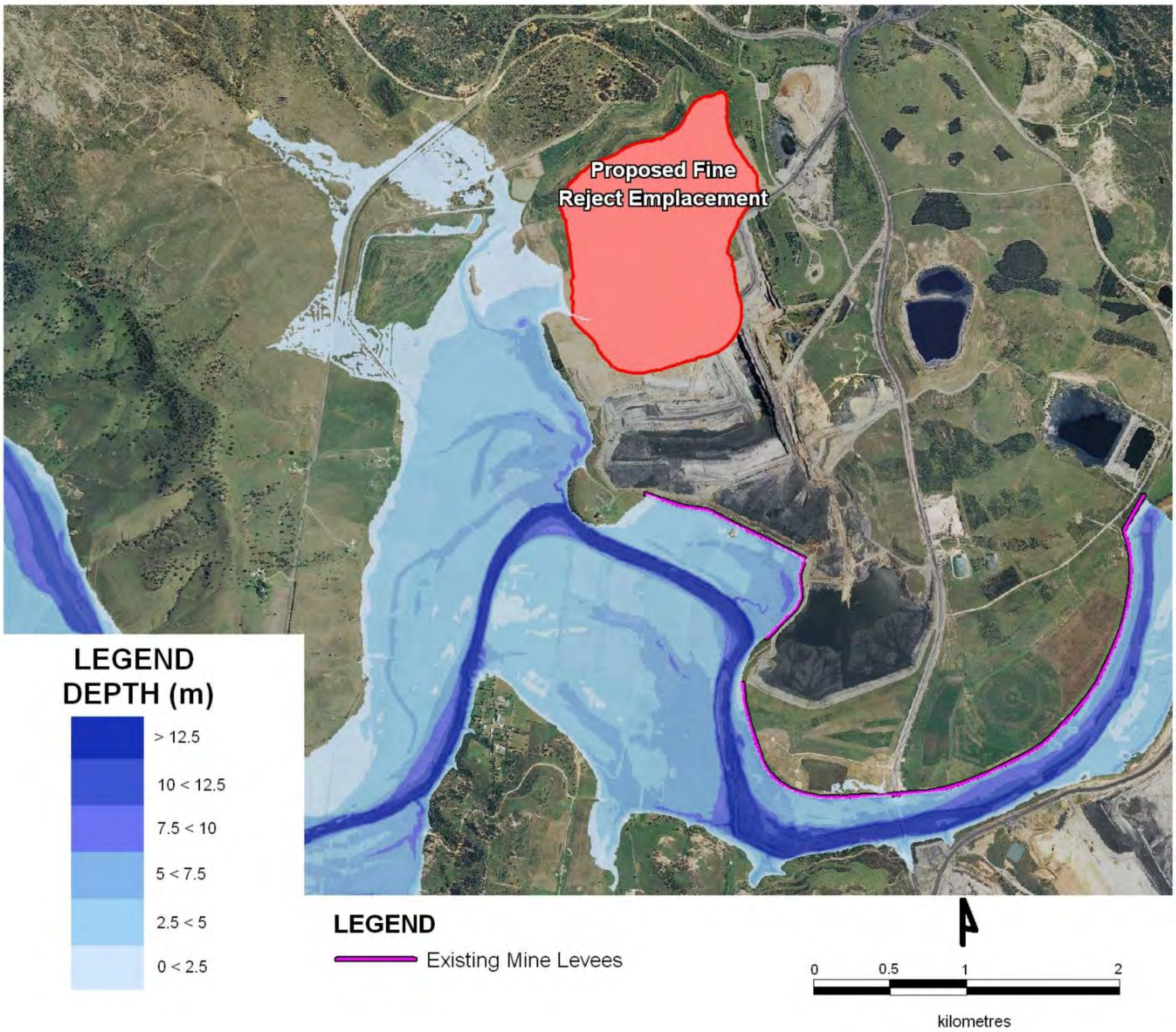


Figure 5.2 Existing Conditions Q100 Flood Depths – (with fine reject emplacement overlay)

6 WATER MANAGEMENT SYSTEM ASSESSMENT

6.1 OVERVIEW

An assessment of the potential impacts of the proposed modification on the HVO North mine water management system has been undertaken using the HVO North OPSIM Model. Assessment of the potential impacts on the performance of the existing water management system has been undertaken against the following key performance indicators:

- Pit Inventory;
- North Void Inventory;
- Site raw water requirements;
- HRSTS discharges;
- Uncontrolled discharges; and
- Overall site water balance.

A schematic layout of the HVO North OPSIM model is presented in Figure A.1 and Figure A.2. Operational guidelines and controls applied to the model are described in Appendix A.

Details of the assessment methodology and assessment outcomes are discussed in the following sections.

The assessment has incorporated the approved CWW proposal. It has been assumed that the CWW project commences in 2013, and will be completed in 2018.

Adopted catchment areas for the CWW project are as follows:

- Year 3 (2015):
  - Mining pit: 26.4ha
  - Spoil: 67.1ha
  - *Total: 93.5ha*
- Year 6 (2018):
  - Mining pit: 15.6ha
  - Spoil: 126.2ha
  - *Total: 141.8ha*

Modelling outcomes for both cases are provided in Section 6.3.

6.2 METHODOLOGY

6.2.1 Water Balance Model (OPSIM)

HVO has developed a representative water balance model utilising the OPSIM Operational Simulation Program. The OPSIM operational simulation model was initially set up in 2007, and has since been regularly updated and calibrated when new data has been made available.

The HVO OPSIM model has been designed to simulate the operation of all major components of the water management system, including:

- Climatic variability – rainfall and evaporation;
- Catchment runoff and collection;
- Pit dewatering;
- Pump and gravity transfers;
- Water storage filling, spilling, evaporation and leakage;
- Industrial water extraction, usage and return;
- Regional groundwater inflows; and
- Controlled discharges (HRSTS).

A schematic of the HVO North model is presented in Figure A1 and Figure A2. The model comprises a collection of functional nodes, each representing a specific operational feature of the mine's water management system.

The current surface water impact assessment has utilised the most recent OPSIM model, which was updated and calibrated as part of the current investigations. Details of the model calibration are provided in Appendix A.

It should be noted that the proposed modification does not significantly alter the configuration of the water management system, including how the extended operations of the proposed modification would affect water supply and demand.

6.2.2 Modelling Stages

As discussed in Section 3, the Cumnock Void 3 emplacement commences around a year earlier than the fine reject emplacement. As such, the surface water impact assessment for the proposed modification has been undertaken for three modelling stages:

- Stage 1 - Existing fine reject emplacement strategy (Years 2012-13);
- Stage 2 - Cumnock Void 3 emplacement commences (Year 2014);
- Stage 3 - Cumnock Void 3 and fine reject emplacement both active (Years 2015+).

A comparison of overall site catchment areas associated with the proposed works for each modelling stage is provided in Table 6.1.

Table 6.1 HVO North Catchment Areas

Catchment Type	Catchment Area (ha)				
	Stage 1	Stage 2		Stage 3	
	Total	Total	Proposed Project Area Only	Total	Proposed Project Area Only
Natural/Undisturbed	143	143	-	143	-
Open Cut Pits	44	44	-	44	-
Cleared/Prestrip	16	16	-	16	-
Roads/Industrial/Hardstand	139	139	-	139	-
Spoil – Unrehab	197	197	-	197	-
Spoil – Rehab	1,807	1,807	-	1,807	-
Spoil – Rehab	111	111	-	181	70
Total	2,457	2,457	-	2,527	70

Table 6.1 shows the following:

- For Stage 2, there is no change in HVO North disturbed catchment, due to the Cumnock Void 3 being located off-lease.
- For Stage 3, there is an increase in HVO North disturbed catchment area of 3% compared with the existing case, primarily associated with the fine reject emplacement.

Assessment of the impact of the proposed modification for is discussed in Section 6.3.

6.2.3 Interpretation of Assessment Results

Depending on the type of impact being assessed, the model has been run either as a forecast simulation or static assessment. A description of the two assessment types is as follows:

- Forecast assessment
  - A single 10-year model (Years 2012-2021) incorporating the varying fine reject emplacement configuration and production throughput over time.
  - This model is run using 114 years of rainfall data, to produce 105 sets of individual results.
  - The results are then presented as percentiles versus time.
  - This type of assessment is most suited to tracking inventory changes over the life of a project.
- Static assessment
  - A number of models are set up representing a particular stage and fine reject emplacement configuration.
  - Unless stated otherwise, the existing CHPP throughput at HVO North (16.7Mtpa feed) has been used for all stages, to allow the impact of the proposed modification to be assessed in isolation.
  - For this assessment, 3 modelling stages were developed, consistent with those discussed in Section 6.2.2.
  - Each model stage is run using 114 years of rainfall data, producing a continuous dataset for each stage.
  - The results are then presented as Annual Exceedance Probabilities (AEPs).
  - This type of assessment is most suited to tracking impacts which can be annualised, such as discharges, raw water supply etc.

6.3 ASSESSMENT OUTCOMES

6.3.1 Pit Inventory

An assessment of pit inventory characteristics at HVO North has been undertaken for each model stage to determine the likelihood of inundating the pit, which could impact production. This impact has been assessed using a static simulation. Note that only total Carrington and CWW Pit inventory have been assessed due to their location relative to the fine reject emplacement.

Figure 6.1 shows the Carrington and CWW Pit inventory versus annual exceedance probability, and shows that there is a small increase in the risk of pit inundation in Stage 2 and Stage 3. This is due to the increase in pit disturbance area as a result of CWW, and not the modification. Pit inundation is primarily controlled by the pump capacity in Carrington Pit, and the availability of storage within the water management system.

For a 10% Annual Exceedance Probability (AEP), the modelled pit inundation for any stage is around 65-75ML.

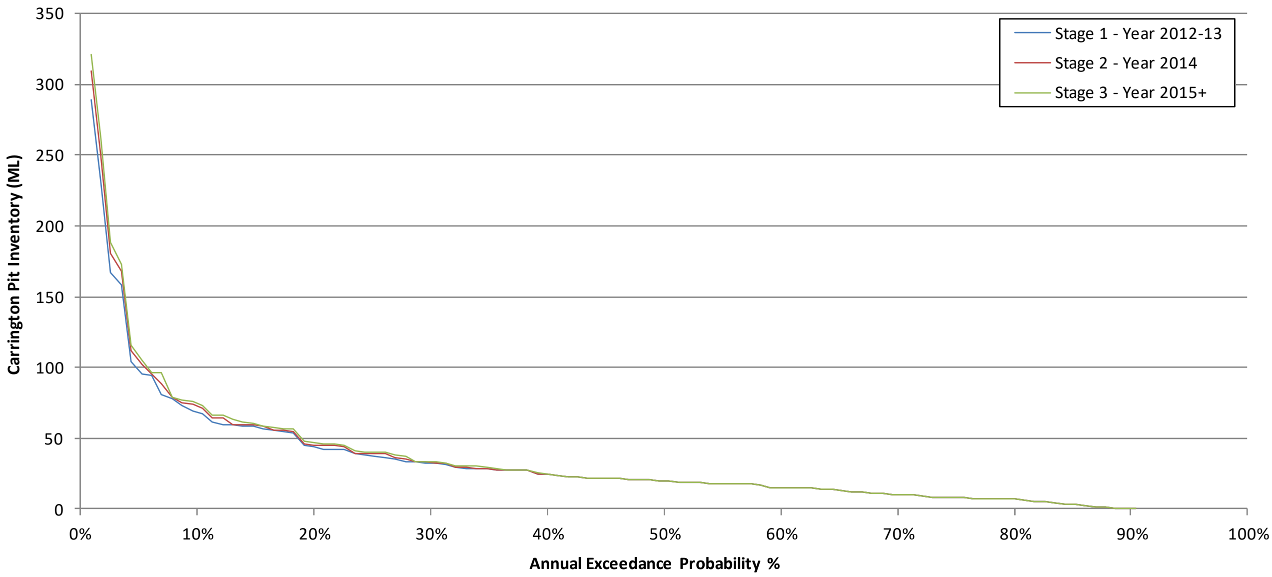


Figure 6.1 Carrington Pit Inventory – Annual Exceedance Probability (AEP)

6.3.2 North Void Inventory

A forecast assessment of water accumulation in the North Void (Dam 30N) at HVO North has been undertaken for the period covering the proposed modification (Years 2012-2021) to provide an indication of potentially available mine water reserves at HVO North. North Void (Dam 30N) is the primary mine water storage at HVO North.

This assessment has been based on a starting volume in the North Void of 19,300ML (estimated inventory at January 2012) and a full supply volume of 24,400ML. After reaching this volume, the North Void spills to the Hunter River. Additionally, modelling has conservatively assumed that water is extracted from the North Void only as required, and is not exported to other areas of the HVO minesite.

Figure 6.2 shows the forecast North Void inventory over a 10–year period, starting in 2012, indicating the following:

- There is a 1% chance that the North Void would increase to 22,450ML over the life of the project.
- There is a 10% chance that the North Void would decrease in volume by around 1,050ML over the life of the project.
- There is a 50% chance that the North Void would decrease in volume by around 4,000ML over the life of the project.
- The proposed modification does not have any significant impact on accumulation or reduction in North Void volumes.

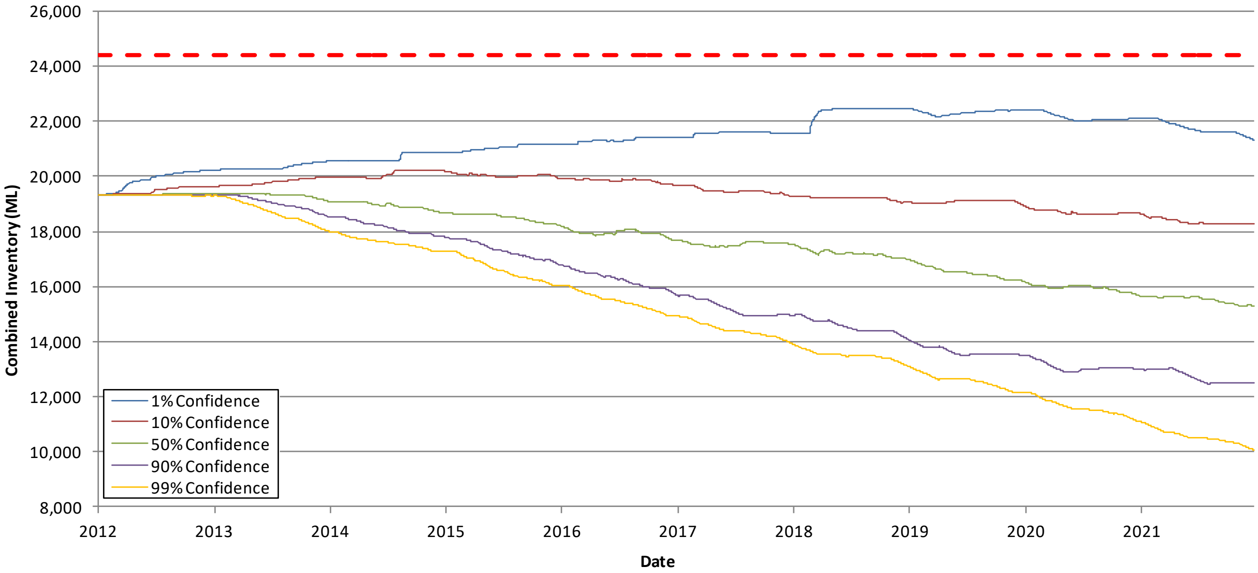


Figure 6.2 North Void Forecast Assessment

6.3.3 <u>Site Raw Water Requirements</u>

For the purposes of current investigations, the term "site raw water requirements" represents the amount of imported raw water via the current Hunter River Extraction licence that is required to sustain the nominated design production rate and associated operational demands at HVO North. Any shortfall in mine water is made up from imported raw water – that is, during dry periods imported raw water is used to ensure that all operational demands are met.

This impact has been assessed using a forecast simulation. The results show that off-site supplies will not be required, because there is around 20GL currently available in site storages. That is, the proposed modification has no impact on site raw water requirements.

6.3.4 HRSTS Discharges

Expected HRSTS discharge characteristics at HVO North have been assessed for each stage of the proposed modification, on the basis of controlled discharges occurring from Dam 11N and Dam 9W, using the methodology detailed in Appendix A. This impact has been assessed using a static simulation.

Figure 6.3 shows the annual HRSTS discharge versus Annual Exceedance Probability, summarised as follows:

- The proposed modification does not have any significant impact on modelled HRSTS discharge volumes.
- There is a 50% chance that the annual HRSTS discharge volume would be around 560-640ML or greater.
- There is a 10% chance that the annual HRSTS discharge volume would be around 1,560-1,650ML or greater.

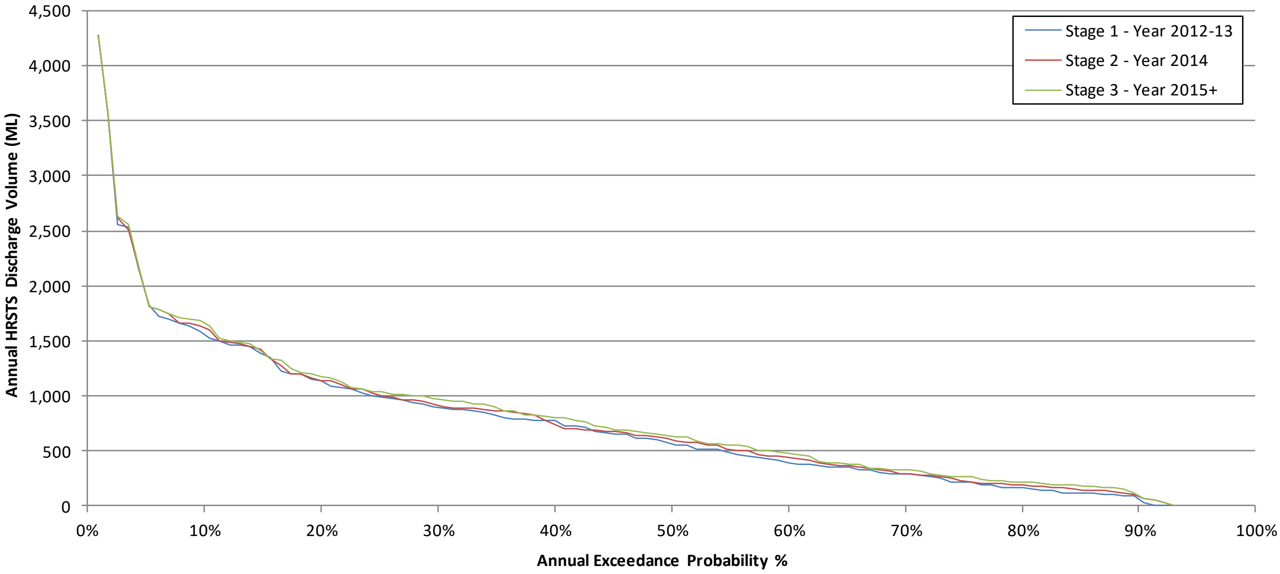


Figure 6.3 HRSTS Discharge Assessment

The HRSTS modelling results indicate, on average, 4.4 HRSTS discharge events per year (from each discharge location). Based on the calculated discharge opportunities and the current HVO credit allocation of 151 credits, modelled controlled discharges from HVO North would be in compliance with the HRSTS.

6.3.5 Storage Discharges

Expected discharge characteristics at HVO North have been assessed on the basis of simulated spillway overflows from key site storages to receiving waters. This impact has been assessed using a forecast simulation.

The assessment has only included storages which have the ability to discharge via a spillway into the receiving waters, as follows:

- Dam 11N
- Dam 15N
- Dam 16N
- Dam 17N
- Dam 18N

The forecast modelling results indicate the following:

- There is zero expected spillway discharges from Dam 11N, Dam 16N, Dam 17N and Dam 18N into receiving waters, over the life of the modification.
- Under the existing configuration (without the fine reject modification and CWW project), there is around a 12% risk of a spillway discharge from Dam 15N in any one year.
- Under the proposed configuration (with the fine reject modification and CWW project), there is around a 25% chance that a spillway discharge from Dam 15N would occur.
- Therefore the proposed modification results in a higher risk of uncontrolled discharge from site storages to receiving waters.

Although the results indicate a risk of discharge from Dam 15N to the Hunter River (via Farrells Creek), the maximum modelled discharge volume is only 50ML, at an estimated EC of around 700-800μs/cm. Dam 15N collects runoff from a mostly clean catchment.

In addition, the spillway discharge only occurs during very high rainfall events, which coincide with a Hunter River HRSTS discharge window. Therefore, it is expected that this minor discharge would have no impact on either Farrells Creek or Hunter River water quality.

Despite this, Dam 15N is not a licensed discharge point and hence, any potential for release from this location would be managed to minimise the risk.

In summary, the proposed modification increases the risk of discharge from site storages (Dam 15N) to receiving waters, however it should have no impact on either Farrells Creek or Hunter River water quality.

6.3.6 Overall Site Water Balance

A representative long-term water balance for each modelling stage for HVO North (not including HVO South) is presented in Table 6.2. The data presented in the table has been derived from long-term averages estimated from the static simulation.

Table 6.2 Summary Average Annual Water Balance

Item	Base Case (Year 2012)		Cumnock Void 3 Only (Year 2014)		Cumnock Void 3 & fine reject emplacement (Year 2015+)	
	Inflow (kL/d)	Outflow (kL/d)	Inflow (kL/d)	Outflow (kL/d)	Inflow (kL/d)	Outflow (kL/d)
Climatic & Regional						
Rainfall Runoff	7,328		7,205		7,079	
Evaporation		2,384		1,751		1,208
Groundwater Inflow	2,185		2,185		2,185	
Imported						
Raw Coal Moisture	3,420		3,420		3,420	
Hunter River Extraction	547		375		329	
Inflows from HVO South	1,659		1,592		1,618	
Losses						
Product Moisture Loss		3,180		3,180		3,180
Coarse Reject Loss		2,020		2,020		2,020
Fine Reject Moisture Retention		1,479		1,479		1,479
Vehicle Washdown Loss		31		31		31
HVCPP Misc. Ind Use Loss		125		125		125
Water Cart Loss		2,754		3,128		3,609
Site Release/Spills						
HRSTS Discharges		1,990		2,047		2,120
Spills to Receiving Waters (in addition to HRSTS Discharges)		502		504		504
Diverted Water		100		100		100
Change in Storage	93	488	31	488	9	487
Total	**15,232**	**15,053**	**14,809**	**14,852**	**14,639**	**14,863**

The long-term water balance rates provided above are the average of the 114 year operational simulation. It should be recognised that the following items are subject to climatic variability:

- Rainfall runoff.
- Evaporation.
- Imported water requirement.
- Site releases/spills.

Whilst it provides an indication of the long-term average rates for each of the items, application of the nominated rates for other purposes should only be undertaken with due consideration of the suitability of the nominated rate and any potential implications.

6.4 MANAGEMENT AND MITIGATION

There are no substantial changes proposed to the HVO North water management system due to the proposed modification. Recommended management measures include the following:

- Continuation of surface and groundwater quality monitoring; and
- Regular updates of the HVO water balance model to ensure currency with the current operational configuration of the mine water management system.

7 SUMMARY OF FINDINGS

7.1 CHANGE IN SURFACE WATER RUNOFF VOLUME

The relative reduction in the Hunter River flows due to the proposed modification is small compared to the total flows in the Hunter River. It is proposed that the catchment removed due to the construction of the emplacement would be largely reinstated upon the emplacement reaching capacity and the site rehabilitated once dry.

7.2 CHANGE IN RUNOFF WATER QUALITY

The proposed management measures will ensure no measurable adverse impacts on riparian and ecological values of watercourses on the site and downstream of the proposed modification. It is expected that there would be little impact on runoff water quality to the Hunter River due to either the proposed emplacement or fine reject pipeline (to Cumnock Void 3) associated with the proposed modification.

It is proposed that all areas are to be returned to a rehabilitated catchment after mining. Any releases to receiving water will be made in accordance with the HRSTS rules.

7.3 HUNTER RIVER FLOODING

Review of the flood modelling undertaken as part of the CWW project, shows that the proposed fine reject emplacement footprint only marginally encroaches into the 100 year ARI flood inundation extent. The flooding in this area is associated with backwater from the Hunter River (in the Unnamed Tributary), and this marginal encroachment of the proposed emplacement would have no impact on flood levels or velocities in the Hunter River.

7.4 WATER MANAGEMENT SYSTEM IMPACT

The impact of the additional pit water on the mine site water management system is summarised as follows:

- The proposed modification does not have any significant impact on expected pit inundation at HVO North.
- The proposed modification does not have any significant impact on accumulation or reduction in overall site inventory volumes.
- Given the volume of water currently stored at HVO North (primarily in Dam 30N), the forecast modelling indicates that extraction of water from the Hunter River would not be required. That is, the proposed modification has no impact on site raw water requirements.
- There is an increase in the risk of discharge from Dam 15N to the Hunter River (via Farrells Creek). The maximum modelled discharge is only around 70ML, at an estimated EC of 700-800μs/cm. Given that the discharge only occurs during a HRSTS discharge window and at a low salinity, the proposed modification should have no impact on Farrells Creek or Hunter River water quality.

The water balance modelling indicates that the proposed modification would have little impact on the existing HVO North water management system. Discharges can generally be managed within the HRSTS rules.

There are no substantial changes proposed to the HVO North water management system to accommodate the proposed modification. It is recommended that surface and groundwater monitoring be reviewed regularly, and existing water management tools be updated as appropriate to ensure currency with the operational configuration of the mine water management system.

8 REFERENCES

Biosis (2010)	*Carrington West Wing Ecology Assessment*
Coal and Allied (2011)	*Annual Environmental Management Report 2011 – Hunter Valley Operations.*
Chow (1959)	'*Open Channel Hydraulics'*, written by V.T. Chow, McGraw-Hill Book Company, NY, 1959.
DECCW (2008)	*Managing Urban Stormwater – Soils and Construction – Volume 2E Mine and Quarries,* Department of Environment, Climate Change and Water NSW, June 2008.
Mackie Environmental Research, (2010)	*Carrington West Wing Groundwater Assessment.*

APPENDIX A

HVO NORTH – MINE WATER MANAGEMENT SYSTEM

A.1 OVERVIEW

The existing Hunter Valley Operations North (HVO North) mine water management system (WMS) is operated in accordance with the current HVO Water Management Plan, last updated in September 2009. The key objectives of the Water Management Plan are as follows:

- Diversion of clean surface water runoff away from areas disturbed by mining activities;
- Collection of surface water runoff from areas disturbed by mining activities to control suspended sediment prior to runoff from site or re-use via the mine water management system;
- Transfer of open cut pit water to storage dams for re-use in the mine water management system;
- Maximise the re-use and recycling of stored water on site, especially for use as the process supply to the CPP's and other related activities;
- Use stored water for dust suppression on haul roads, trafficable areas and stockpiles;
- Minimise extraction of water from the Hunter River during dry and drought periods; and
- Minimise offsite discharge under the Hunter River Salinity Trading Scheme (HRSTS) during wet periods.

A schematic of the HVO North mine water management system is provided in Figure A.1 and Figure A.2.

The following sections provide detailed information relating to the HVO North mine water management system and water balance model, including changes due to the proposed modification.

A.2 COAL PRODUCTION

There are currently two plants at HVO North, Hunter Valley Coal Preparation Plant (HVCPP) and Howick Coal Preparation Plant (HCPP). Generally, the majority of coal processing at HVO North occurs at HVCPP.

Current and forecast annual coal production data at HVO North for the life of the project is provided in Table A1.

.

Table A.1 HVO –Coal Production Data (Wet tonnes)

Case	Plant	ROM Feed (Mt)	Coarse Reject (Mt)	Fine Reject (Mt)	Product (Mt)
2012-14 (Base Case)	HVCPP	15.0	3.6	2.1	11.1
	HCPP	1.7	0.5	0.3	1.1
	Total	16.7	4.1	2.4	12.3
2015	HVCPP	21.2	5.8	3.4	15.0
	HCPP	1.2	0.4	0.2	0.7
	Total	22.4	6.2	3.6	15.7
2016	HVCPP	20.4	5.6	3.2	14.4
	HCPP	1.7	0.6	0.4	1.0
	Total	22.1	6.2	3.6	15.4
2017-2021	HVCPP	20.2	5.4	3.1	14.4
	HCPP	1.4	0.4	0.3	0.9
	Total	21.6	5.8	3.3	15.3

Review of Table A.1 shows around a 29%-34% increase in total ROM tonnage during the life of the proposed modification compared with current tonnages. This is within the currently approved production throughput limit for HVO North.

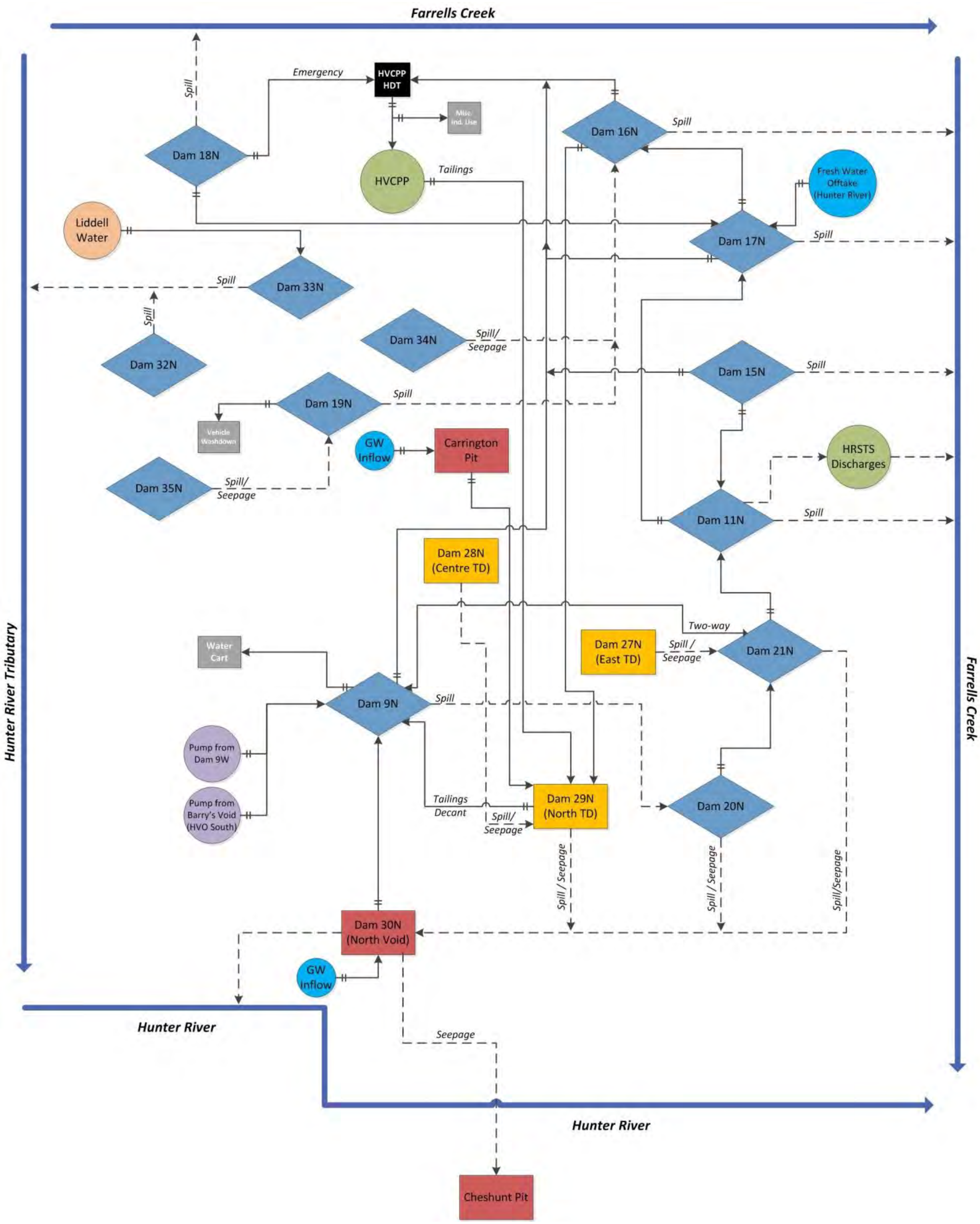


Figure A.1 Minesite Water Management System Schematic – HVO North

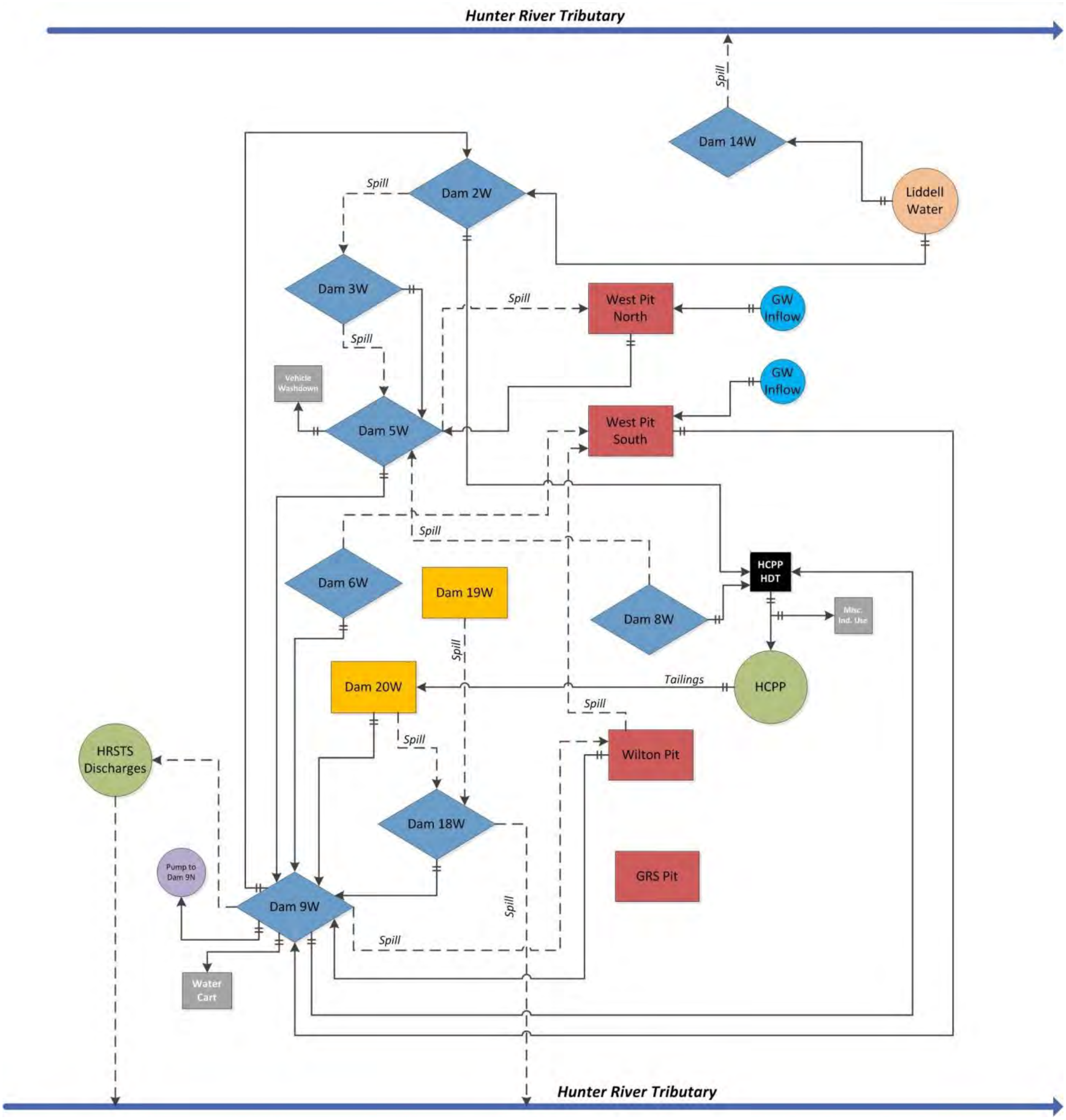


Figure A.2 Minesite Water Management System Schematic – HVO West

A.3 SITE WATER DEMANDS

Site water demands at HVO North are summarised as follows:

- Make-up water for the CPP's;
- Dust suppression; and
- Industrial use, including workshop and washdown facilities and fire fighting.

A.3.1 CPP Makeup Water

Water is required at the HVCPP/HCPP for coal processing, washdown and other associated uses. The volume of water required for CPP makeup is generally related to the annual coal production tonnages. Based on the forecast production information presented in Table A.1, the current and forecast combined HVCPP and HCPP makeup water volumes required are provided in Table A.2.

A review of Table A.2 shows an increased overall process water makeup of 2,240kL/d to 2,775 (or 40%-48%) compared with existing process makeup estimates.

Key CPP operational parameters relating to plant yield, moisture contents (MC) and fine/coarse reject fractions were provided by Coal & Allied, and are summarised as follows:

- Raw coal MC (HVCPP & HCPP): 7.5%
- Product coal MC (HVCPP): 9.5%
- Product coal MC (HCPP): 8.7%
- Coarse reject MC (HVCPP & HCPP): 18.0%
- Fine reject MC (HVCPP & HCPP): 60.0%
- Fine reject fraction (dry): 22.0%
- Coarse reject fraction (dry): 78.0%

Based on current observed operations, return from both Cumnock Void 3 and the proposed fine reject emplacement has been assumed to be 62%. That is, 38% of the moisture in the reject in Cumnock Void 3 and the emplacement is lost through moisture retention in the fine reject matrix.

Table A.2 Design Plant Operational Parameters – Combined HVCPP & HCPP

Case	Design Raw Feed	Water Balance (kL/day)				
		Raw Coal	Product	Coarse Reject	Fine Reject	Process Makeup
	(Mtpa)	(a)	(b)	(c)	(d)	(e) = (b + c + d - a)
2012-14 (Base Case)	16.7	3,422	3,182	2,021	3,896	5,676
2015	22.4	4,607	4,091	3,064	5,906	8,453
2016	22.1	4,550	4,010	3,063	5,904	8,428
2017-21	21.6	4,435	3,991	2,857	5,506	7,918

A.3.2 Haul Road Dust Suppression Water

Water is required for suppression of dust on haul roads and coal stockpiles. For 2011, haul road dust suppression usage for HVO North, South and West was recorded as 1,504ML/annum.

It has been assumed that that this annual haul road dust suppression demand is sustained through the life of the proposed modification.

A.3.3 Industrial Use & Fire Fighting

Water is required for vehicle washdown and other miscellaneous industrial uses.

It is estimated that vehicle washdown usage at HVO North is as follows:
- Dam 19N - 778kL/d
- Dam 5W - 50kL/d

Miscellaneous industrial usage is sourced from the HVCPP and HCPP hose-down tanks, at an estimated rate of 450kL/d and 50kL/d, respectively. This demand is expected to continue through the life of the proposed modification.

A.4 SITE WATER SUPPLY

Water is supplied to HVO North through a number of sources, including:
- Hunter River water extraction;
- Surface water runoff from disturbed and undisturbed areas; and
- Groundwater inflow.

A.4.1 Hunter River Water Extractions

HVO maintains a Water Licence permitting the extraction of up to 2,675ML/annum of fresh water from the Hunter River (via Dam 17N). This is usually only required when site demands cannot be met by the mine water stored on site.

This arrangement will remain in place during the life of the proposed modification.

A.4.2 Surface Water Runoff Volume

The volume of surface runoff water entering the mine water management system is dependent on rainfall and the catchment areas of the open pits, active overburden emplacement areas, industrial areas and rehabilitation areas, which can vary considerably over the life of the proposed modification.

The surface water impact assessment for the proposed modification has been undertaken for three modelling stages:
- Stage 1 - Existing fine reject emplacement strategy (Years 2012-13);
- Stage 2 - Cumnock Void 3 emplacement commences (Year 2014); and
- Stage 3 - Cumnock Void 3 and fine reject emplacement both active (Years 2015+).

A comparison of overall site catchment areas associated with the proposed works for each modelling stage is provided in Table A.3.

Table A.3 HVO North Catchment Areas

Catchment Type	Catchment Area (ha)		
	2012-13	2014	2015+
Natural/Undisturbed	143	143	143
Open Cut Pits	44	44	44
Cleared/Prestrip	16	16	16
Roads/Industrial/Hardstand	139	139	139
Spoil – Unrehab	197	197	197
Spoil – Rehab	1,807	1,807	1,807
Tailings Dam	111	111	181
Total	2,457	2,457	2,527

A.4.3 Groundwater Inflows

In addition to surface water runoff, water also enters the mine water management system due to groundwater inflow to the open cut pits from the coal seam aquifers. Current estimates of groundwater inflow to HVO North is summarised in Table A.4.

Table A.4 Predicted Groundwater Inflow Volumes

Storage	Est. Groundwater Inflow (kL/day)
Dam 30N (North Void)	800
Carrington Pit	775

Significant changes to the groundwater inflow to HVO North over the life of the proposed modification are not expected.

A.5 HUNTER RIVER SALINITY TRADING SCHEME

The OPSIM model has been configured to include the simulation of controlled discharges of stored mine water inventories into the Hunter River in accordance with the requirements of the Hunter River Salinity Trading Scheme (HRSTS). The OPSIM model simulates the ability for controlled discharges from the following locations:

- Dam 11N, at a maximum rate of 100ML/day if the discharge criteria are met.
- Dam 9W (Parnells Dam), at a maximum rate of 130ML/day if the discharge criteria are met.
- Dam 15S (Lake James – HVO South) at a maximum rate of 120ML/day if the discharge criteria are met.

Note that the estimated HRSTS discharge opportunities were based on the 2012 HVO credit allocation of 151 credits.

Discharge opportunities under the HRSTS were estimated by JP Environmental and the streamflow file was developed using streamflow data generated for the Hunter River, in the HRSTS Middle Sector. The streamflow records generated by New South Wales (NSW) Office of Water (NOW) were used for the period 1892 to 1992, whilst recorded data for the station were used from 1993 to 2007. A flow versus electrical conductivity relationship was established and used to estimate total allowable discharge (TAD's) for the HRSTS Middle Sector for high flows. Flood flows were allocated the maximum daily discharge rate allowed by the site discharge location.

As streamflow data was generated using local rainfall data from 1892, the timing of the TAD's are consistent with the rainfall runoff generated by OPSIM. Hence the HRSTS can be simulated by subtracting calculated allowable site TAD's (based on HVO credit holdings) from the relevant discharge storages. A conservative approach to estimating the discharge envelope was used in recognition that many of the EC values at the station are influenced by the operation of the HRSTS since 1993.

A.6 MAIN MINE WATER STORAGES

Surface water at HVO North is managed through a series of dams used for water storage or sedimentation. Many of the dams are interconnected by a pump/pipe network which facilitates the movement of water around the site. A summary of the main water storages, their capacities, surface areas and current estimated water volumes is provided in Table A.5.

Table A.5 HVO North - Summary Storage Details

Storage Name	Full Supply Volume (ML)	Full Supply Surface Area (ha)	Estimated Volume (Dec-2011)
Dam 9N	77	2.0	69
Dam 11N	86	2.0	54
Dam 15N	80	2.5	3
Dam 16N	52	1.5	39
Dam 17N	36	1.2	17
Dam 18N	27	1.1	20
Dam 19N	10	0.5	-
Dam 20N	1,330	79	2
Dam 21N	909	8.4	412
Dam 27N	120	1.2	45
Dam 28N	200	2.2	40
Dam 29N	275	8.1	20
Dam 30N	24,422	-	19,330
Dam 32N	78	3.4	-
Dam 33N	24	1.0	-
Dam 34N	6	0.4	-
Dam 35N	5	0.3	-
Dam 2W	15	0.7	-
Dam 3W	25	2.2	-
Dam 5W	27	2.3	-
Dam 6W	418	9.0	63
Dam 8W	16	0.7	-
Dam 9W	1,306	25.7	358
Dam 11W	15	1.0	-
Dam 14W	20	1.6	-
Dam 18W	105	7.7	-
Dam 19W	100	2.0	-
Dam 20W	211	4.2	22

A.7 OPERATIONAL GUIDELINES

Representative operational guidelines for OPSIM modelling have been developed for the HVO North water management system based on review of available site operating protocol and discussions with HVO operational personnel. Refer to Table A.6 for the HVO North OPSIM model operational guidelines.

Table A.6 HVO North OPSIM – Model Operational Guidelines

Item	Operational Description	Model Operating Rules
1	External Supply to Mine	
1.1	HVCPP River Pumps	❑ Raw water supply to HVO North operations. ❑ Licensed HVO Allocation – 2,665ML/year. ❑ Licensed Lemington Allocation – 1,500ML/year. ❑ Pumped from Hunter River pump station at 90L/s. ❑ Supply to Dam 17N as required.
2	Supply to Demands	
2.1	HVCPP – Raw Water	❑ HV CPP raw water demand is supplied from HVCPP River Pumps via Dam 17N.
2.2	HVCPP – Mine Water	❑ HV CPP mine water demand of is supplied from the following locations, in order of preference: ➢ Dam 15N ➢ Dam 9N ➢ Dam 16N ➢ Dam 17N ➢ Dam 18N (emergency supply)
2.3	HCPP – Mine Water	❑ HV CPP mine water demand of is supplied from the following locations, in order of preference: ➢ Dam 9W ➢ Dam 8W ➢ Dam 2W
2.4	Miscellaneous Industrial Use (i.e. washdown, etc)	❑ Nominal demand of 500kL/day adopted, supplied from the following location: ➢ HVCPP Hose Down Tank (450kL/day) ➢ HCPP Hose Down Tank (50kL/day) ❑ 25% loss assumed.
2.5	Vehicle Washdown	❑ Nominal demand of 828kL/day adopted, supplied from the following location: ➢ Dam 19N (778kL/day) ➢ Dam 5W (50kL/day) ❑ 25% loss assumed.
2.6	Haul Road Water	❑ Total demand of 2,450kL/day nominally supplied from the following location: ➢ Dam 9N (1,650kL/day) ➢ Dam 9W (800kL/day) ❑ 100% loss assumed.

Table A6 – HVO North OPSIM - Operational Guidelines (con't)

Item	Operational Description	Operating Rules
3	Transfer of Mine Waters	
3.1	Carrington Pit	❑ Continuous pumping from pit dewatering pumps at a nominal maximum rate of 100L/s per unit, or 200L/s total (i.e. 2 units). ❑ Pit dewatering directed to Dam 29N.
3.2	Carrington West Wing Pit	❑ Continuous pumping from pit dewatering pumps at a nominal maximum rate of 100L/s per unit, or 200L/s total (i.e. 2 units). ❑ Pit dewatering directed to Dam 9N.
3.3	West Pit - North	❑ Continuous pumping from pit dewatering pumps at a nominal maximum rate of 70L/s. ❑ Pit dewatering directed to Dam 5W.
3.4	West Pit - South	❑ Continuous pumping from pit dewatering pumps at a nominal maximum rate of 70L/s. ❑ Pit dewatering directed to Dam 9W.
3.5	Wilton Pit	❑ Continuous pumping from pit dewatering pumps at a nominal maximum rate of 70L/s. ❑ Pit dewatering directed to Dam 9W.
3.6	GRS Pit	❑ Currently no active dewatering.
4	Operation of Key Storages	
4.1	Dam 9N	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Decant water from Dam 29N (North Pit Void Tailings Dam). ➢ Pumped transfer from Dam 21N. ➢ Pumped transfers from Dam 9W ➢ Pumped transfer from Barry Void (HVO South) ➢ Pumped dewatering from North Void. ❑ Supplies to the following locations: ➢ Pumped transfer to Dam HVCPP ➢ Pumped transfer to Dam 21N. ➢ Haul Road Water. ❑ Storage overflows to Dam 20N.
4.2	Dam 11N	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Pumped transfer from Dam 21N. ➢ Pumped transfer from Dam 15N (emergency). ❑ Supplies to the following locations: ➢ Pumped transfer to Dam 17N. ❑ Licensed HRSTS discharge point, with a maximum daily discharge of 100ML/day. ❑ Storage overflows to Farrells Creek

Table A6 – HVO North OPSIM - Operational Guidelines (con't)

Item	Operational Description	Operating Rules
4.3	Dam 15N	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Overflows from Dam 16N. ❑ Supplies to the following locations: ➢ Dam 15N (priority makeup) ➢ Dam 11N (emergency only) ❑ Storage to be operated in a drawn down condition to provide adequate storm runoff buffer. ❑ Storage overflows to Farrells Creek.
4.4	Dam 16N	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Runoff from HVCPP and coal pads. ➢ Pumped transfers from Dam 16N. ➢ Overflow from Dam 19N & Dam 34N. ❑ Supplies to the following locations: ➢ HV CPP hose down tank. ➢ Pumped transfers to Dam 29N (if required). ➢ Storage overflows to Dam 15N & Farrell's Creek ❑ Storage to be drawn down with a minimum 300mm freeboard maintained.
4.5	Dam 17N	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Pumped transfers from Dam 11N. ➢ Pumped transfers from Dam 18N. ➢ Pumped transfers from Hunter River Fresh Water Offtake. ❑ Supplies to the following locations: ➢ North CHPP, hose down tank. ➢ Pumped transfers to Dam 16N. ❑ Storage intended to be operated with a minimum 500mm freeboard maintained. ❑ Storage overflows to Farrells Creek (not permitted to overflow).
4.6	Dam 18N	❑ Mine water collection and transfer storage: ❑ Supplies to the following locations: ➢ HV CPP hose down tank (emergency supply). ➢ Pumped transfers to Dam 17N. ❑ Storage intended to be operated with a minimum 500mm freeboard maintained. ❑ Storage overflows to Farrells Creek
4.7	Dam 19N	❑ Mine water collection and transfer storage: ❑ Supplies to the following locations: ➢ Vehicle washdown ❑ Storage overflows to Dam16N.

Table A6 – HVO North OPSIM - Operational Guidelines (con't)

Item	Operational Description	Operating Rules
4.8	Dam 20N	❑ Sedimentation dam for rehabilitated catchments. ❑ Receives inflows from the following locations: ➢ Catchment runoff. ➢ Overflows from Dam 9N. ❑ Supplies to the following location: ➢ Pumped transfer to Dam 21N. ❑ Water seeps into Dam 30 N (North Void). ❑ Storage overflows to Dam 30 N (North Void).
4.9	Dam 21N	❑ Mine water collection and transfer storage. ❑ Receives inflows from the following locations: ➢ Pumped transfers from Dam 9N. ➢ Pumped transfers from Dam 20N. ❑ Supplies to the following locations: ➢ Pumped transfer to Dam 9N. ❑ Water seeps into Dam 30 N (North Void). ❑ Storage overflows to Dam 30 N (North Void).
4.10	Dam 27N (East In-Pit Tailings Dam) - Inactive	❑ Inactive tailings storage facility. ❑ Supplies to the following locations: ➢ Seepage to Dam 21N. ❑ Storage overflows to 21N.
4.11	Dam 28N (Centre Tailings Dam) - Inactive	❑ Inactive tailings storage facility. ❑ Supplies to the following locations: ➢ Seepage to Dam 30N. ❑ Storage overflows to Dam 29N.
4.12	Dam 29N (North Pit Void Tailings Dam) - Active	❑ Fine tailings storage. ❑ 'Prescribed Dam' that must be operated in accordance with NSW Dam Safety Committee requirements. ❑ Receives inflows from the following locations: ➢ HVCPP fine reject placement. ❑ Supplies to the following locations: ➢ Decant water pumped to Dam 9N. ➢ Seepage to North Void. ❑ Storage overflows to Dam 30 N (North Void). ❑ Storage can seep to the Hunter River via subsurface drainage (emergency only).
4.13	Dam 30N (North Void)	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Infiltration from North Pit spoil. ➢ Seepage and overflows from Dam 29N (North Pit Void Tailings Dam). ➢ Seepage and overflows from Dam 20N. ➢ Seepage and overflows from Dam 21N. ❑ Supplies to the following locations: ➢ Pumped transfer to Dam 9N (if required) ❑ The Production Bore located at the North Void can pump at around 70L/s, however it is not currently used.

Table A6 – HVO North OPSIM - Operational Guidelines (con't)

Item	Operational Description	Operating Rules
4.14	Dam 33N	❑ Receives catchment inflows: ❑ Storage overflows to Hunter River.
4.14	Dam 33N	❑ Mine water collection and transfer storage: ❑ Storage overflows to Hunter River.
4.15	Dam 34N	❑ Mine water collection and transfer storage. ❑ Receives inflows the following locations: ➢ Overflows from Dam 33N. ❑ Storage overflows to Dam 16N.
4.16	Dam 35N	❑ Sedimentation dam. ❑ Storage overflows to Dam 19N.
4.17	Dam 2W	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Pumped transfers from Dam 13W (Liddell Colliery). ➢ Pumped transfers from Dam 9W. ❑ Supplies to the following locations: ➢ HCPP hose down tank. ❑ Storage overflows to Dam 3W.
4.18	Dam 3W	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Overflows from Dam 2W. ❑ Supplies to the following locations: ➢ Pumped transfer to Dam 5W. ❑ Storage overflows to Dam 5W.
4.19	Dam 5W	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Pumped transfer from Dam 3W. ➢ Pit dewatering from West Pit North. ➢ Storage overflows from Dam 3W. ➢ Storage overflows from Dam 8W. ❑ Supplies to the following locations: ➢ Vehicle washdown demand. ➢ Pumped transfer to Dam 9W. ❑ Storage overflows to West Pit North.
4.20	Dam 6W	❑ Mine water collection and transfer storage: ❑ Supplies to the following locations: ➢ Pumped transfers to Dam 9W. ❑ Storage overflows to West Pit South.
4.21	Dam 8W	❑ Mine water collection and transfer storage: ❑ Supplies to the following locations: ➢ HCPP Hose Down Tank. ❑ Storage overflows to Dam 5W.

Table A6 – HVO North OPSIM - Operational Guidelines (con't)

Item	Operational Description	Operating Rules
4.22	Dam 9W	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Pumped transfer from Dam 5W. ➢ Pumped transfer from Dam 6W. ➢ Pumped transfer from Dam 18W. ➢ Pumped transfer from Dam 20W. ➢ Pit dewatering from Wilton Pit. ❑ Supplies to the following locations: ➢ HCPP Hose Down Tank. ➢ Pumped transfer to Dam 2W. ➢ Pumped transfer to Dam 9N. ❑ Licensed HRSTS discharge point, with a maximum daily discharge of 100ML/day. ❑ Storage overflows to Wilton Pit.
4.24	Dam 14W	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Pumped transfer from Dam 13W (Liddell Colliery). ❑ Storage overflows to Hunter River.
4.25	Dam 18W	❑ Mine water collection and transfer storage: ❑ Receives inflows from the following locations: ➢ Storage overflows from Dam 19W. ➢ Storage overflows from Dam 20W. ❑ Supplies to the following locations: ➢ Pumped transfers to Dam 9W. ❑ Storage overflows to Hunter River.
4.26	Dam 19W	❑ Inactive tailings storage facility. ❑ Storage overflows to Dam 18W.
4.27	Dam 20W	❑ Fine reject storage. ❑ 'Prescribed Dam' that must be operated in accordance with NSW Dam Safety Committee requirements. ❑ Receives inflows from the following locations: ➢ HCPP fine reject placement. ❑ Supplies to the following locations: ➢ Decant water pumped to Dam 9W. ❑ Storage overflows to Dam 18W.
	<u>General</u>	❑ All storages and pits receive local catchment runoff and lose water through evaporation and seepage.

A.8 MODEL VERIFICATION

A.8.1 Overview

Verification of the HVO North water balance model has been undertaken against observed inventory history over 2011. The model was configured to reflect the site operations between January 2011 and December 2011, with appropriate transfer rates and system configurations.

The key model performance confirmed during model verification was change in overall HVO (North and South) site inventory over the year.

A.8.2 Mine Water Inventory Verification

An overall HVO mine water inventory assessment has been undertaken over the period January 2011 to December 2011, using the available monitoring information provided by Coal & Allied. The storages included in the overall HVO mine water inventory assessment are as follows:

- Dam 16/23/24/28S
- Dam 17S (No. 1 Dam)
- Dam 19S (Swan Pond)
- Dam 20S
- Dam 27S (South Park)
- Dam 32S (SE Box Cut)
- Dam 36S (Goat Island)
- Dam 9N
- Dam 11N
- Dam 15N
- Dam 16N
- Dam 17N
- Dam 18N
- Dam 20N
- Dam 21N
- Dam 27N (East TD)
- Dam 28N (Centre TD)
- Dam 29N (North TD)
- Dam 30N (North Void)
- Dam 6W
- Dam 9W
- Dam 20W
- Cheshunt Pit
- Riverview Pit
- 30S (Auger Pit Nth)
- 30S (Auger Pit Sth)
- Barry Void
- Carrington Pit
- GRS Pit
- West Pit – North
- West Pit - South

The associated observed and modelled mine water inventory contained in the identified mine water storages are presented in Figure A.3 and Figure A.4 along with the site rainfall for the verification period.

Note that verification results have been provided both with and without Dam 30N inventory.

Review of Figure A.3 and Figure A.4 show the following:

- For both cases (with and without Dam 30N), the simulated combined mine water inventory for the monitored storages appears to satisfactorily reproduce the observed overall mine water inventory fluctuations between January 2011 and December 2011.
- The verification results are considered to be within reasonable bounds given the potential variability in mine water movements about the site and the constraints imposed on OPSIM modelling by the operational guidelines.

A.8.3 Commentary

It should be noted that the mine water inventory verification is based on the following key assumptions:

- The observed inflows from Liddell and HRSTS discharges during the period were included in the verification results.
- All of the pumping transfer systems identified in the operational guidelines (Table A.6) were operational during the verification period.

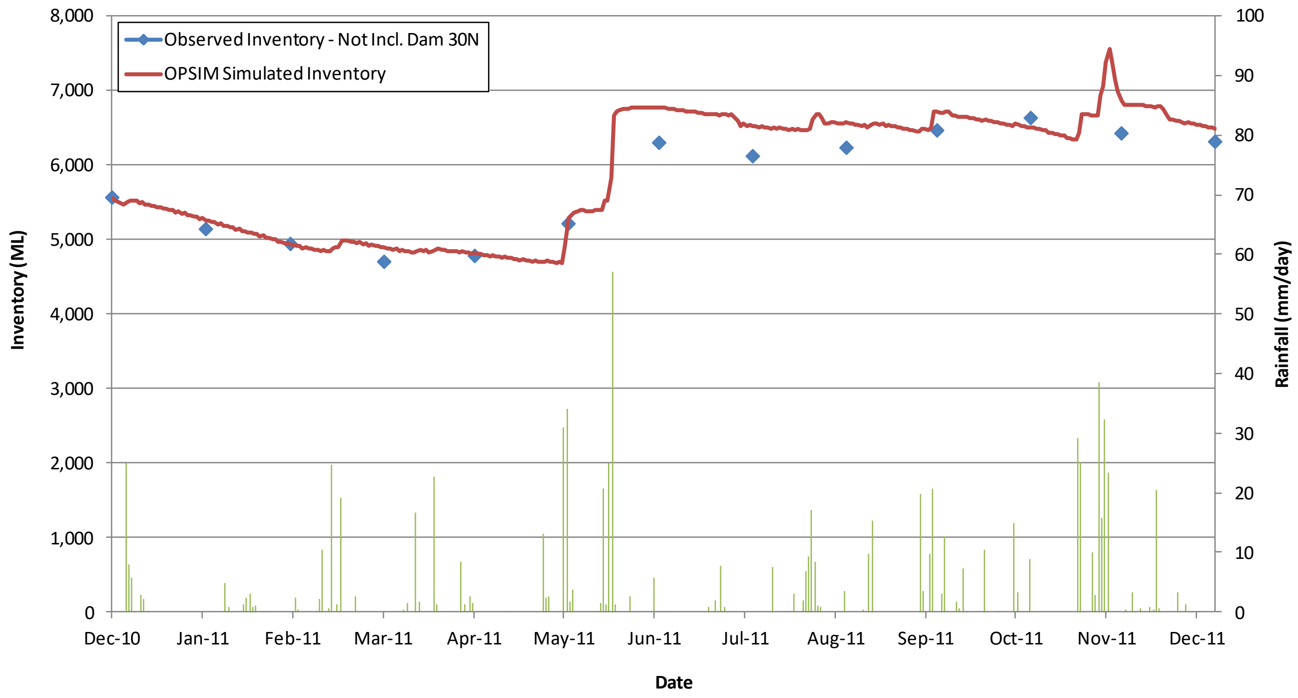


Figure A.3 Model Verification – Site Inventory 2011 (not including Dam 30N)

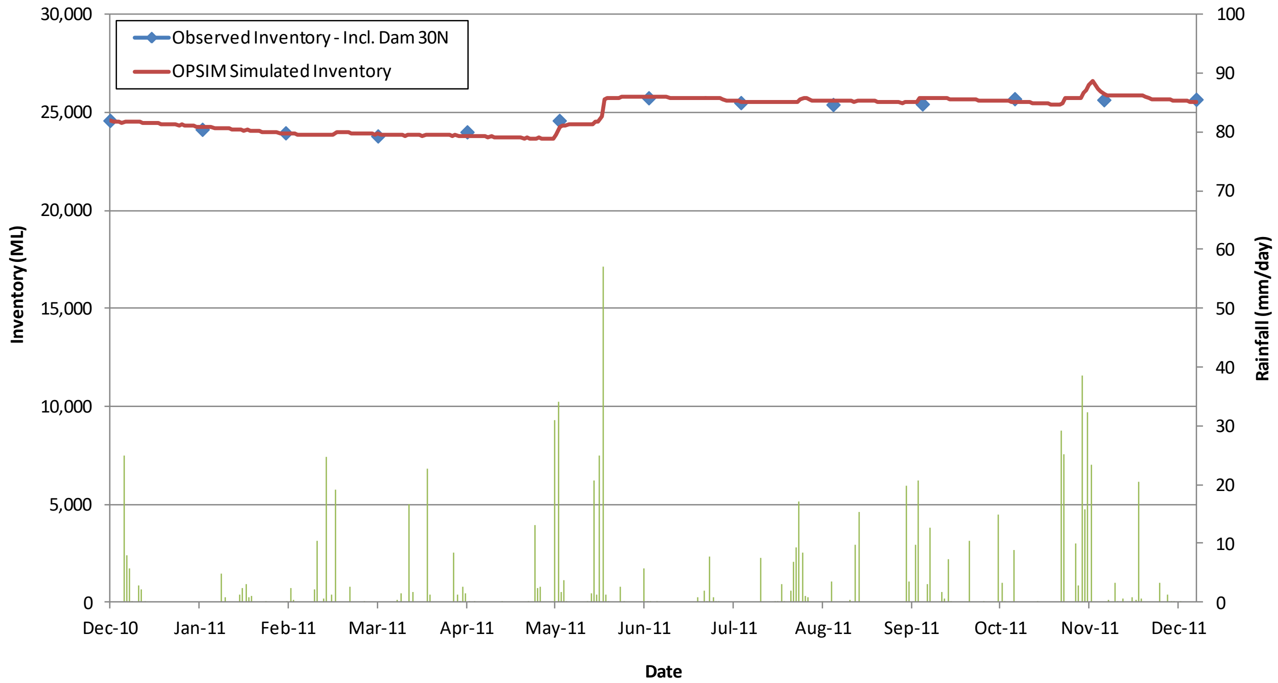


Figure A.4 Model Verification – Site Inventory 2011 (including Dam 30N)

A.9 LIMITATIONS OF THE WATER BALANCE MODEL CALIBRATION

The results of the OPSIM modelling need to be interpreted with caution. Key limitations of the OPSIM model and known discrepancies between the model and water management practice are outlined below:

- The AWBM parameters adopted for the model appear reasonable based on past experience and the available calibration data for HVO North;
- TDS concentrations applied to study area catchments are based on past experience and the limited water quality data available to date. More water quality information is required to accurately calibrate the water balance model to observed site data; and
- TDS is not necessarily the critical contaminant that will control the operation of the water management system and will need to evolve and be operated to recognise the results of future water quality and quantity monitoring programs.

APPENDIX E

Ecology assessment

HVO North - Fine reject emplacement
Ecology assessment

Section 75W Modification to DA 450-10-2003

Prepared for Coal and Allied Operations Pty Limited | June 2013

Planning + Environment + Acoustics

HVO North - Fine reject emplacement

Ecology Assessment

Section 75W Modification to DA 450-10-2003

Prepared for Coal & Allied Operations Pty Limited | 3 June 2013

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

emgamm.com

HVO North - Fine reject emplacement

Final

Report J12046RP1_Ecology | Prepared for Coal & Allied Operations Pty Limited | 3 June 2013

Prepared by	**Katie Whiting**	Approved by	**Luke Stewart**
Position	Senior Ecologist	Position	Director
Signature		Signature	
Date	3 June 2013	Date	3 June 2013

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

Document Control

Version	Date	Prepared by	Reviewed by
v1	16 January 2013	Renae Baker	Luke Stewart
v2	26 March 2013	Renae Baker Andrew Wiltshire	Luke Stewart
v3	5 April 2013	Andrew Wiltshire	Peter Stewart
v4	3 June 2013	Katie Whiting	Luke Stewart

EMM
EMGA Mitchell McLennan

T +61 (0)2 9493 9500 | F +61 (0)2 9493 9599

Ground Floor | Suite 01 | 20 Chandos Street | St Leonards | New South Wales | 2065 | Australia

emgamm.com

Table of Contents

Tables

Figures

Photographs

Appendices

1 Introduction

1.1 Background

The Hunter Valley Operations (HVO) mining complex is located approximately 24 kilometres (km) north-west of Singleton, New South Wales (NSW) (Figure 1.1). The site comprises the active Carrington, North, West and Mitchell Pits and related mining activities and infrastructure such as overburden emplacement areas. Within the HVO North complex, there are two coal preparation plants (CPP) operating; the Hunter Valley CPP and Howick CPP. Run-of-mine (ROM) coal from active pits is trucked via internal haul roads to either of the CPPs for processing.

Coarse reject from HVO North can be hauled between any pit, CPP and emplacement within HVO, as required, on existing private haul roads. Similarly, fine reject is approved to be pumped from any CPP to any applicable storage facility within HVO, as required. There are a number of fine reject storage emplacements located across HVO. These are in different stages of development including rehabilitated, closed, drying and active. Active emplacements located within HVO North are located in North Pit (North Pit Void Tailings Dam) and West Pit (Bob's Dump Tailings Dam). These emplacements are nearing capacity. Additional fine reject capacity has recently become available with the construction of Dam 6W in April 2012, however, this will only provide a limited amount of capacity for the Hunter Valley and Howick CPPs. Mine planning has identified that fine reject capacity at HVO North will be reached in approximately quarter one of 2015. Accordingly, additional storage capacity is required by this time to enable ongoing mining operations at HVO North.

1.2 Proposed modification

The proposed modification comprises two main elements, namely:

- the construction and operation of a fine reject emplacement to the north of the existing Carrington Pit; and
- fine reject emplacement in the Cumnock void 3, located to the northeast of West Pit, via pipelines from HVO North CPPs.

A minor amendment to the HVO North development boundary to encompass Cumnock void 3 is also proposed.

The project area comprises the fine reject emplacement, Cumnock void 3, fine reject pipelines and areas of associated disturbance (see Figure 1.2).

It will occupy an area of approximately 161 ha, including a 13 ha construction disturbance buffer, and will be on land that has been mined and is cleared of remnant native vegetation. The emplacement will have a life of approximately five years and would be completed within the existing development consent period which is currently 2025.

The Cumnock void 3 is located outside of the HVO North development consent boundary and within a mining lease held by the Cumnock Joint Venture. The emplacement of fine reject within Cumnock void 3 will utilise about 25 per cent of the void's emplacement capacity. Fine reject emplacement within the void was assessed in the *Ravensworth Operations Project Environmental Assessment* prepared by Umwelt 2010 and approved under Project Approval DA 09_0176. Emplacement of fine reject within the void from

HVO North requires no substantial construction works. Therefore, this element of the proposed modification has not been considered further in this study.

Fine reject will be transported to the emplacement via an overland pipeline adjacent to existing haul roads on previously disturbed land direct from the Hunter Valley CPPs.

Pipelines will only be constructed in areas:

- previously disturbed by mining and related activities;
- adjacent to existing infrastructure such as haul roads and existing pipelines; and
- that will disturb no more than remnant isolated trees.

Exact alignments will be determined during the detailed design process. However, alignments will be guided by the aforementioned principles.

A site survey of the preferred alignment will be completed before any activities start at each location. This information will be used to complete a Coal & Allied Ground Disturbance Permit (GDP) application. The GDP will ensure that the sites meet the above criteria and appropriate environmental management is assigned to each site.

It is noted that ecological opportunities and constraints were considered in the design process for the proposed modification. An outcome of this process was the reduction of the northern extent of the fine reject emplacement to avoid the remnant vegetation located beyond the approved 20 year mine plan disturbance area.

1.3 The Site and surrounds

The majority of HVO North is located within the Singleton Local Government Area (LGA) with the exception of the northern most section containing part of the rail loading facilities, which is located within the Muswellbrook LGA.

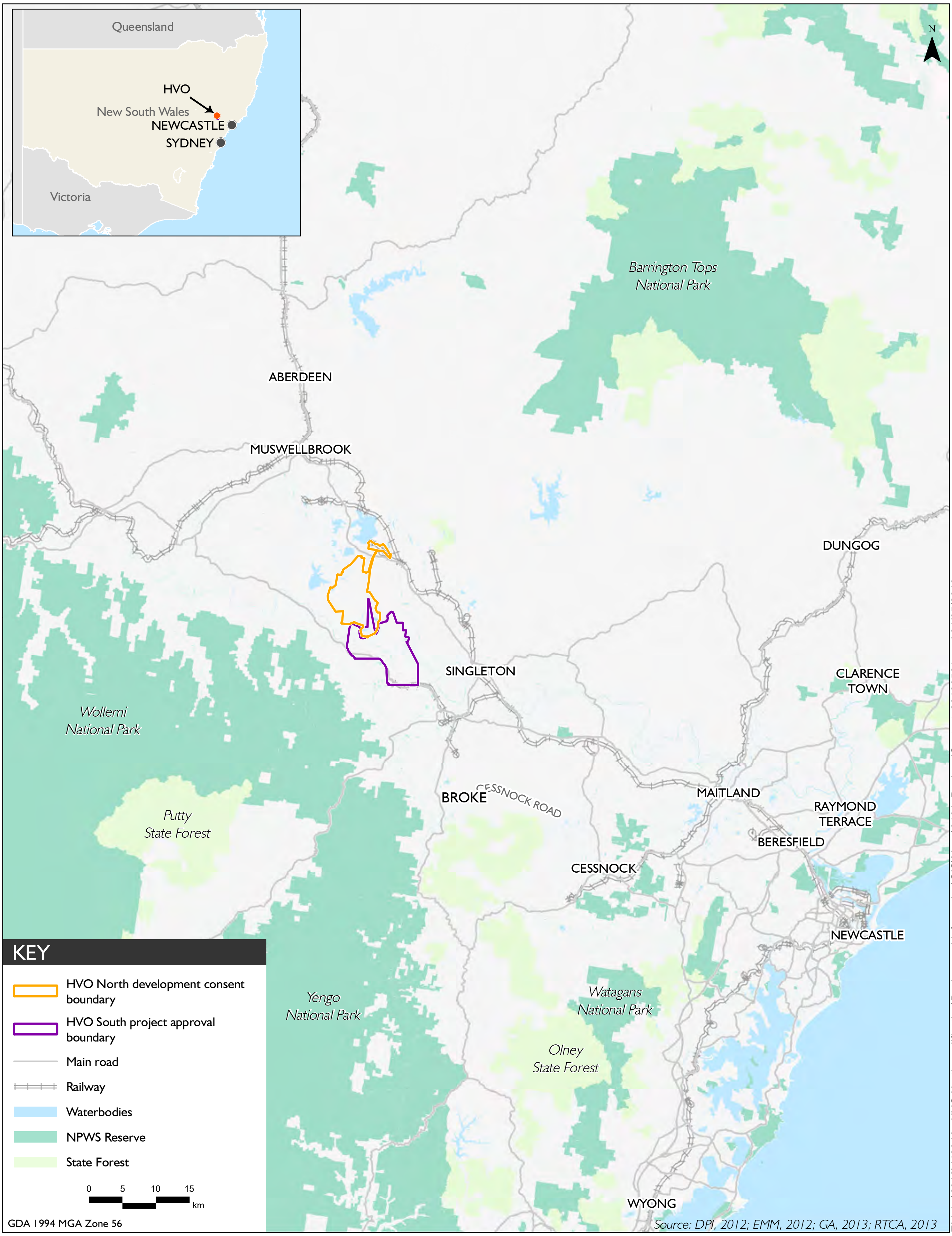
Dominant features of the HVO North landscape comprise the existing open cut pits, mine-related infrastructure and rehabilitated former mining areas, to the north, east and south. Topography is generally undulating and ranges from RL 130 to RL 200 to the north and from RL 50 to RL 120 to the south of West Pit respectively.

Mine operations and related infrastructure in the surrounding area include Ravensworth Operations, HVO South, Ashton Coal, Warkworth Mine, Wambo Mine and United Colliery. Bayswater Power Station is situated to the north. Grazing and cropping land dominates areas to the west. A large ridgeline, approximately RL 220, is located between HVO North and the village of Jerrys Plains found to the south-west.

Of particular relevance to the proposed modification is Ravensworth Operations, located immediately adjacent to the north-east of the HVO North development consent boundary. Ravensworth Operations comprises the existing Ravensworth West Mine, including Cumnock No.1 Colliery, and Narama Mine.

The majority of the proposed modification will take place on land that has been previously disturbed at HVO North for mining activities. The rehabilitated areas within the fine reject emplacement footprint consists of areas planted with native overstorey species and pasture areas. The vegetation within this area cannot be assigned a formal vegetation type in the Biometric database, as it is not a naturally occurring community and does not conform to any known vegetation type, or ecological community. A more detailed description of the existing ecological environment is provided in Section 3.2.1.

The closest privately owned residences are over 4 km to the west, south-west and south of the fine reject emplacement and are located within the village of Jerrys Plains and along the Golden Highway.

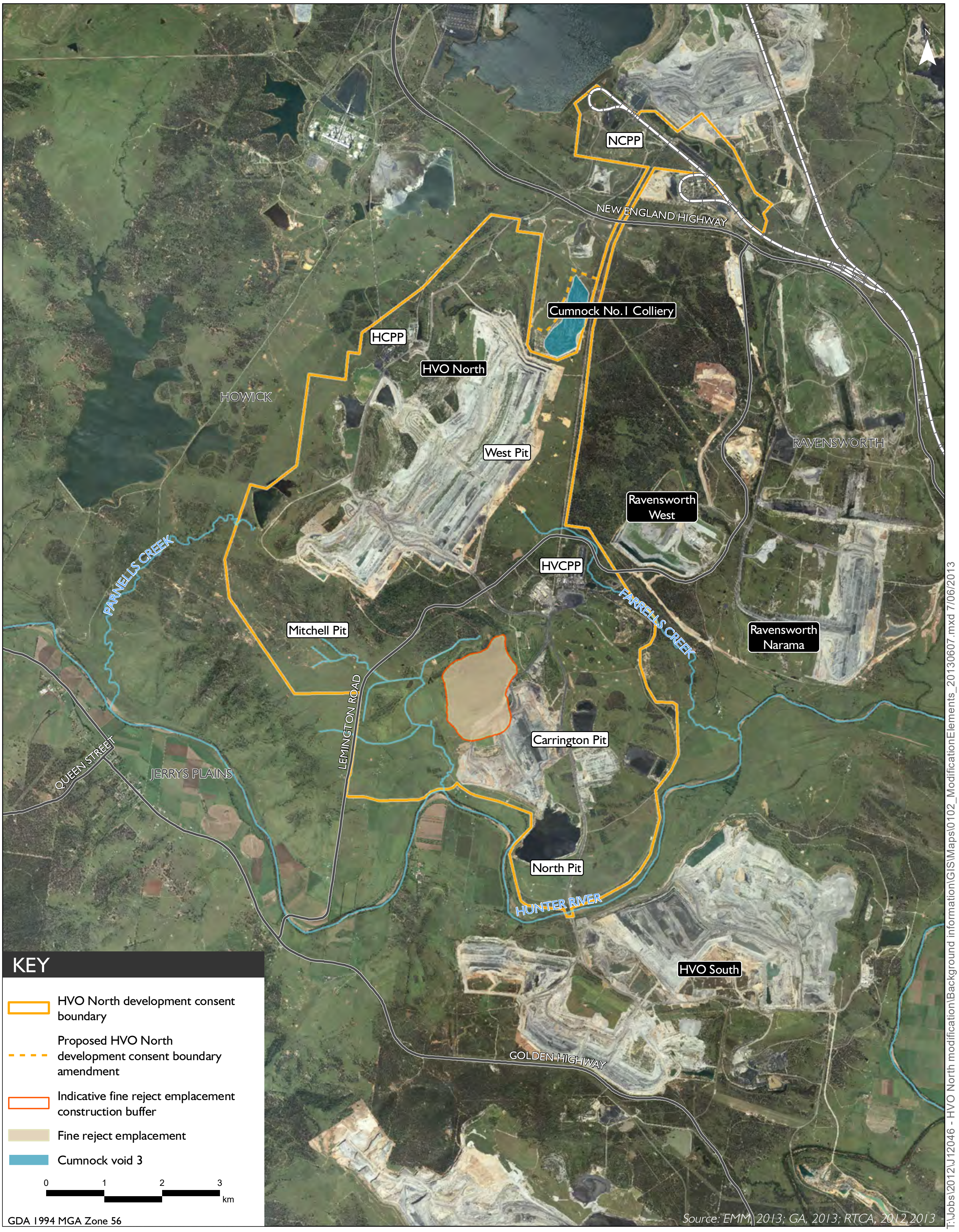


T:\Jobs\2012\J12046 - HVO North modification\Background information\GIS\Maps\0101_RegionalContext_20130531.mxd 31/05/2013

Regional context

HVO North - Fine reject emplacement modification

Figure 1.1



Modification elements

HVO North - Fine reject emplacement modification

Figure 1.2

2 Methods

This chapter describes the methods used to assess the ecological values of the project area and adjacent areas, to accurately assess potential impacts to native flora and fauna species and ecological communities.

2.1 Desktop assessment

Prior to field investigations, a desktop assessment was undertaken to identify the potential ecological values of the project area and its immediate surrounds. This included a review of previous ecological assessments undertaken within HVO North, and database reviews to identify threatened species known from, or with potential to occur within the project area. The following were reviewed as part of the desktop assessment:

- Niche Environment and Heritage (2011) Vegetation Mapping of HVO North;
- Peake (2006) The Vegetation of the Central Hunter Valley;
- EMM (2010) Carrington West Wing Modification Environmental Assessment;
- ERM (2003) West Pit Extension and Minor Modification Environmental Impact Statement (EIS);
- NSW National Parks and Wildlife Service (NPWS) Wildlife Atlas records of threatened species and ecological communities within 10 km of the project area;
- Department of Sustainability Environment Water Populations and Communities (DSEWPC) protected matters database records within 10 km of the project area; and
- Hunter Bird Observers Club (HBOC) Checklist of Birds of the Hunter Region 2011 (HBOC 2011).

2.2 Field investigations

2.2.1 Conditions

Field investigations of the project area were undertaken by two ecologists on 7 and 8 August 2012. Targeted surveys for the Green and Golden Bell Frog (*Litoria aurea*) were undertaken on 9 and 10 January 2013. Weather at the time of the 2012 investigations was cool and mild with no rain. Weather during the January 2013 surveys was warm and dry. Weather data for the investigations are provided in Table 2.1 and Table 2.2. Weather data was not available for Jerrys Plains for January 2013, thus data from the next nearest weather station, Singleton, is provided.

Table 2.1 Weather data for Jerrys Plains for first half of August 2012

Date	Day	Temps		Rain	9:00 AM					3:00 PM				
		Min	Max		Temp	RH	Cld	Dir	Spd	Temp	RH	Cld	Dir	Spd
		°C	°C	mm	°C	%	8th	km/h		°C	%	8th	km/h	
1	We	-1.5	16	0	5	84	4	W	11	14.7	48	6	W	11
2	Th	0.2	17.2	1.2	5.8	88	0	WSW	7	16	46	4	Calm	
3	Fr	2.2	19	0	7.9	66	6	W	11	18.5	33	1	W	15
4	Sa	1.1	20.8	0	9.5	62	0	W	15	20.5	30	0	NW	9
5	Su	0.7	21.7	0	9	73	0	W	19	20	33	3	W	6
6	Mo	7.5	19.7	0	14	57	0	W	19	19.2	30	0	W	28
7	**Tu**	**-0.9**	**18**	**0**	**4.8**	**76**	**0**		**4**	**17**	**43**	**0**	**W**	**9**
8	**We**	**2.2**	**20.5**	**0**	**9.5**	**62**	**0**	**W**	**7**	**20**	**33**	**0**	**W**	**7**
9	Th	5.6	19.7	0	12.2	52	4	WNW	15	18.9	33	2	W	19
10	Fr	1.9	17.4	0	7.6	60	1	W	28	16.2	35	4	S	19
11	Sa	3.7	18.5	0	12.2	72	4	Calm		16.8	43	6	S	46
12	Su	10.5	16.8	0	14	49	2	SE	28	15.3	51	6	S	15
13	Mo	7.6		0	13.4	60	2		4	18.5	43	1	E	7
Statistics for the first 13 days of August 2012														
Mean		3.1	18.8		9.6	66	1		12	17.8	38	2		14
Lowest		-1.5	16	0	4.8	49	0	Calm		14.7	30	0	Calm	

Note: ***Bold*** *denotes the two days field investigations were undertaken, blank denotes no data collected*

Source: ***Bureau of Meteorology Jerrys Plains weather station (www.bom.gov.au accessed 14/8/12)***

Table 2.2 Weather data for Singleton for first half of January 2013

		Temps		Rain	9:00 AM					3:00 PM				
Date	**Day**	**Min**	**Max**		**Temp**	**RH**	**Cld**	**Dir**	**Spd**	**Temp**	**RH**	**Cld**	**Dir**	**Spd**
		°C	**°C**	**mm**	**°C**	**%**	**8th**	**km/h**		**°C**	**%**	**8th**	**km/h**	
1	Tu	17.7	39.2	0	31.2	34	0	N	24	39.2	40	3	N	30
2	We	16.7	28.6	0	24.5	64	5	SE	9	27.7	52	2	SE	24
3	Th	19.1	28.5	0	21.1	65	7	SE	17	28.5	49	6	SE	26
4	Fr	15.4	34.9	0	23.2	70	1	ESE	7	33.7	31	1	ENE	6
5	Sa	16.2	37.6	0	24.9	66	0	ENE	7	35.9	29	1	ENE	9
6	Su	19.1	34.1	0	26.6	64	3	E	15	33.3	40	1	ESE	13
7	Mo	18.5	33	0	25.4	64	1	SE	11	32.5	43	1	ESE	13
8	Tu	16.4	40.2	0	31.2	38	0	NW	30	39.1	40	3	NW	33
9	**We**	**28.2**	**35.6**	**0**	**33.1**	**47**	**5**	**WSW**	**15**	**26.5**	**67**	**4**	**E**	**33**
10	**Th**	**19.4**	**28.2**	**0**	**23.7**	**67**	**7**	**E**	**13**	**27**	**63**	**7**	**ESE**	**17**
11	Fr	15.8	-	0	24.2	74	0	N	4	39.1	50	3	NW	15
12	Sa	-	44	-	-	-	-	-	-	-	-	-	-	-
13	Su	20.5	31.2	4	22.5	88	8	NE	2	-	-	-	-	-
Statistics for the first 13 days of January 2013														
Mean		18.4	33.9	-	25.2	64	3	-	12	32.2	47	3	20	-
Lowest		15.4	25	0	19.6	34	0	NE	2	24.2	29	1	ENE 6	

Note: ***Bold*** *denotes the two days field investigations were undertaken, blank denotes no data collected*

Source: ***Bureau of Meteorology Singleton weather station (www.bom.gov.au accessed 15/1/13)***

2.2.2 Survey

i Field investigations

The following survey methods were used to investigate the ecology of the project area:

- random meanders to:
  - document fauna habitats and habitat features within the project area;
  - assess the general condition of vegetation and habitats within the project area;
  - document the flora species present within the project area and locate any significant species;
  - record the bird species present within the project area;
- morning point census survey for birds using a ten minute survey period at six points along one transect through the project area (for a total of two person hours);
- investigation of the species present within, and habitat provided by, waterbodies that had been identified from aerial photograph interpretation; and

- targeted surveys in January 2013 for the Green and Golden Bell Frog within the project area and around Lake Liddell (where the species has been previously recorded).

All fauna and flora species encountered during the field investigations were recorded. Due to the lack of roosting habitat for nocturnal species, such as possums, gliders or forest owls, nocturnal surveys were not undertaken.

A brief investigation of adjacent remnant vegetation to the north of the project area was also undertaken. This enabled the identification and assessment of potential indirect impacts and comparison of habitats present. Notes were made on the vegetation types and the fauna habitats and fauna species present. As no potential microbat roosting habitat was identified within the project area, an Anabat detector was left overnight within this adjacent remnant vegetation area. It was considered that if microbats were recorded in this area, these species could be foraging within the project area.

ii Targeted surveys

Green and Golden Bell Frog surveys in January 2013 were conducted over two nights by two ecologists. The following tasks were undertaken:

- afternoon survey for basking frogs (total of two person hours);
- all dams and soaks within the project area were surveyed for suitability to breeding of frogs (total of four person hours);
- dams containing water were surveyed for five person hours over two nights (total of 10 person hours); and
- four reference sites at Lake Liddell were surveyed for Green and Golden Bell Frogs (total of three person hours).

Survey methods included:

- netting for tadpoles in areas where there were snags or aquatic vegetation (0.5 hours per night);
- call playback and listening periods for the Green and Golden Bell Frog at two points around each dam;
- recording of all frog calls; and
- spotlighting and visual searches for frogs in aquatic vegetation, on the edge of the dam and surrounding areas.

3 Results

3.1 Desktop assessment

Previous ecological assessments and vegetation mapping projects undertaken within HVO North identified the following ecological communities in the proximity to the project area:

- Central Hunter Grey Box-Ironbark Woodland (listed as Central Hunter Grey Box-Ironbark Woodland endangered ecological community (EEC) under the NSW *Threatened Species Conservation Act 1995* (TSC Act));
- Central Hunter Grey Box-Ironbark Grassland (Niche 2011);
- Central Hunter Bulloak Forest Regeneration (considered to form part of the Central Hunter Grey Box-Ironbark EEC by Niche (2011));
- Central Hunter Swamp Oak Forest (listed as Swamp Oak Floodplain Forest EEC under the TSC Act); and
- Narrabeen Footslopes Slaty Box Woodland (Peake 2006) (listed as Hunter Valley Footslopes Slaty Gum Woodland vulnerable ecological community under the TSC Act).

A search of the NPWS Wildlife Atlas revealed that 23 threatened fauna species and two endangered populations listed under the TSC Act have been previously recorded within 10 km of the project area (NSW Office of Environment and Heritage (OEH) 2012). These species are listed in Table A.1 of Appendix A along with an assessment of their likelihood of occurrence within the project area.

A search for matters of National Environmental Significance (NES) or other matters protected by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) revealed an additional seven fauna species, seven flora species and two critically endangered ecological communities potentially occurring within the project area (DSEWPC 2012). These species are listed in Table A.2 of Appendix A, along with a consideration of their potential occurrence within the project area.

3.2 Field investigations

3.2.1 Existing environment

The project area consists of rehabilitated areas (areas that have been planted with native overstorey species) and pasture areas (areas that have not been planted out). The planted species consisted of a variety of acacias and eucalypts (approximately 5-6 years of age), existing over a weedy understorey and ground cover. The ground cover within the rehabilitated areas contained very few native forbs or native grasses and was dominated by dense growth of Rhode's Grass (*Chloris gayana*).

The vegetation of the project area cannot be assigned to a formal vegetation type in the Biometric database, as it is not a naturally occurring community and does not conform to any known vegetation type, or ecological community. Photograph 3.1 shows the general condition and vegetation of the project area.

Photograph 3.1 Typical vegetation of the project area

Flora species recorded and dominant species observed within the adjacent remnant vegetation area are listed in Table B.1 Annex B. However, the list for the remnant vegetation should not be considered comprehensive, given the brief investigation undertaken in this area. All ground cover species and *Acacia* species within the project area were able to be identified, however due to lack of reproductive material and the unknown providence of the eucalypt plantings, only a portion of these species could be identified.

Fauna habitats recorded within the project area included *Acacia* and eucalypts (approximately 5-6 years of age), dense grass cover (predominantly exotic grasses), one dam and ephemeral soaks that would be wet during heavy rain periods. The *Acacia,* eucalypts and areas of dense grass cover would provide resources for small woodland birds, reptiles, amphibians and common macropods such as the Eastern Grey Kangaroo (*Macropus giganteus*). Four microbat species were recorded in the adjacent remnant vegetation area and these species could also forage within the project area. There is no roosting habitat for bats or hollow-dependent fauna species within the project area.

Two frog species were heard calling during the August 2012 field investigations within the dam located in the north-east of the project area (see Figure 3.1); Common Eastern Froglet (*Crinia signifera)* and Eastern Sign-bearing Froglet (*Crinia parinsignifera*). This dam was fringed by Common Rush (*Juncus usitatus*), but there were no other sedges, rushes or *Typha* present. A photograph of the dam is provided as Photograph 3.2.

Photograph 3.2 Dam in the north-east of the project area

At the time of the August 2012 field investigations the soaks identified within the project area were completely dry. One soak had fringing vegetation of *Typha* and *Eleocharis*, but these species were in poor health indicating the soak had not held water for some time. Common Eastern Froglets were heard calling at this soak, but were absent from the two other soaks within the area. The beds of all soaks were completely dry (see Photograph 3.3).

Photograph 3.3 Soak recorded in the project area

Two larger sediment dams were recorded north-west of the project area that collect surface water runoff from the adjacent rehabilitated areas (see Figure 3.1). These waterbodies contained suitable habitat for amphibians, with clean shallow waters with fringing *Typha*, rushes and sedges present (see Photograph 3.4).

Photograph 3.4 Large sediment dam to the west of the project area

i January 2013 targeted frog surveys

In order to ensure no impact to the Green and Golden Bell Frog, surveys of the project area were undertaken in the species breeding season (January 2013). These surveys supplement the extensive survey effort completed for the Green and Golden Bell Frog at HVO and adjoining Ravensworth Operations during a variety of seasonal conditions.

The two large sediment dams north-west of the project area were the only areas containing water at the time of the surveys. The smaller dam in the north-east of the project area had dried and all soaks within the project area were also dry. Up to 80 individual Broad-palmed Frogs (*Litoria latopalmata*) were observed at the two sediment dams, with smaller numbers of the Eastern Dwarf Sedge Frog (*Litoria fallax*), Striped Marsh Frog (*Limnodynastes peroni*) and Spotted Grass Frog (*Limnodynastes tasmaniensis*) observed during the surveys. No Green and Golden Bell Frogs were observed or heard.

The Broad-palmed Frog and Eastern Dwarf Sedge Frog were recorded in small inlets and wetlands at several locations around Lake Liddell, and near Bayswater Power Station. No Green and Golden Bell Frogs were observed or heard.

3.2.2 Remnant vegetation

In contrast to the project area, the adjacent remnant vegetation is considered to provide potential habitat for a variety of native flora and fauna species, including threatened species. Hollow-bearing trees occur within this area, as well as regenerating Bulloak and eucalypts. Disturbances present include past clearing, weed species and cattle grazing.

Two threatened bird species, the Grey-crowned Babbler (*Pomatostomus temporalis*) and Varied Sittella (*Daphoenositta chrysoptera*) were recorded during the field investigations. Four Grey-crowned Babbler nests were recorded within Bulloak trees within this area.

The Anabat recorded two threatened microbats and two non-threatened microbats:

- Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) (listed as vulnerable under the TSC Act);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (listed as vulnerable under the TSC Act);
- Gould's Wattled Bat (*Chalinolobus gouldii*) (non-threatened); and
- Chocolate Wattled Bat (*Chalinolobus morio*) (non-threatened).

The vegetation of this adjacent area is considered to consist of two threatened ecological communities; Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions and Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion. A vegetation map of the project area and adjacent remnant vegetation is provided as Figure 3.1. Locations of threatened species recorded during the field investigations are also shown on Figure 3.1.

Other signs of fauna within this area included signs of cattle grazing (scats and waterbodies showing evidence of disturbance from cattle), macropod scats and evidence of gliders and possums in the form of scratches on trees.

3.2.3 Threatened species and ecological communities

Two threatened fauna species, the Speckled Warbler (*Pyrrholaemus sagittatus*) and the Spotted Harrier (*Circus assimilis*) (both listed as vulnerable under the TSC Act) were recorded within the project area during the field investigations. Two Speckled Warblers were recorded during point census surveys foraging within leaf litter. Two Spotted Harriers were incidentally observed foraging over the project area. No other threatened fauna species were detected within the project area. Locations of threatened species recorded during the field investigations are shown on Figure 3.1. A fauna species list is provided as Table B.2 in Annex B.

Despite not having been recorded at the location previously, it is considered that the Green and Golden Bell Frog could utilise the sediment dams to the north-west of the project area. These dams are outside the proposed disturbance footprint. The smaller dam in the north-east and the ephemeral soaks recorded within the project area are unlikely to be utilised by the species as they were dry during the January survey periods. These areas have been mapped and are shown on Figure 3.1.

No threatened flora species were detected and it is considered that the project area does not provide suitable habitat for threatened flora species.

There were no threatened ecological communities recorded within the project area, and the site would not regenerate to any threatened ecological community.

3.2.4 EPBC ACT significant impact criteria

Actions that have the potential to impact upon a matter of environmental significance under the EPBC Act require approval from the Minister for Environment Protection, Heritage and the Arts. A self assessment has been made in accordance with the *Significant Impact Guidelines 1.1: Matters of National Environmental Significance* (DEWHA, 2009), to ascertain whether the proposal has the potential for a significant impact on a matter of national significance and whether a referral would be required.

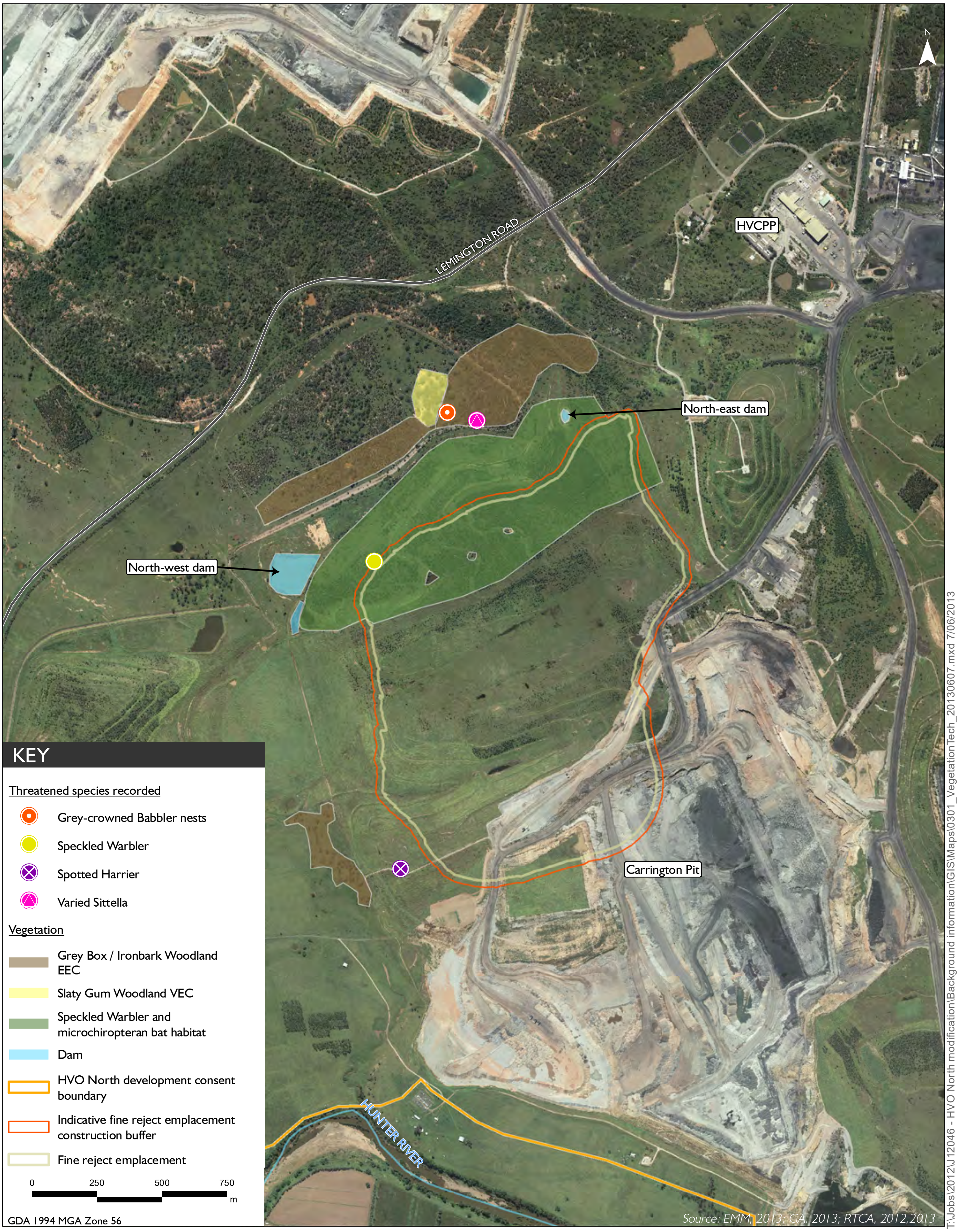
No EECs listed under the EPBC Act were recorded in or adjoining the study area. No threatened plant species listed under the EPBC Act were recorded in the study area. Three fauna species listed as Endangered under the EPBC Act have potential habitat in the study area, the Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolour*) and Spotted-tailed Quoll (*Dasyurus maculatus*). No breeding or foraging habitat for any of these species is expected to be impacted. Accordingly, the proposal is unlikely to have a significant impact on these three species.

Four fauna species listed as Vulnerable under the EPBC Act have known and/or potential habitat in the study area, the Australian Painted Snipe (*Rostratula australis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Green and Golden Bell Frog (*Litoria aurea*); and Large-eared Pied Bat (*Chalinolobus dwyeri*) (the latter recorded during field surveys). No breeding or foraging habitat for these species is expected to be impacted. If present within the study area, individuals of these species are not considered 'important populations' as they are not likely to be key source populations either for breeding or dispersal, populations that are necessary for maintaining genetic diversity, and/or populations that are near the limit of the species range. The proposal is unlikely to have a significant impact on these species.

Pursuant to the EPBC Act, an assessment of significance was carried out for the Green and Golden Bell Frog, a vulnerable species covered by the Commonwealth legislation (see Appendix E C.2 for details). The assessment concluded that the project is unlikely to significantly impact the Green and Golden Bell Frog and that a referral to the DSEWPC for impacts to the Green and Golden Bell Frog was not necessary.

No migratory species were recorded during the field survey, however, potential habitat exists in the study area for 11 migratory species. Given the low importance of potential habitat for these species within the study area and that habitat connectivity would not be impacted, it is considered that significant impacts on these species would be unlikely.

The EPBC Act self-assessment indicates that a referral to the Minister for Sustainability, Environment, Water, Population and Communities is not considered necessary for the proposal.



EMM
EMGA Mitchell McLennan

Vegetation habitats and threatened species

HVO North - Fine reject emplacement modification

Figure 3.1

3.2.5 Noxious weeds

Sixteen weed species were recorded within the project area. Of these species, two are declared as noxious weeds in the Upper Hunter County Council control area. These were Prickly Pear *(Opuntia stricta)* and Tiger Pear *(Opuntia aurantiaca)*. These species are Class 4 noxious weeds meaning the growth of the plants must be managed in a manner that reduces numbers, spread and incidence, and continuously inhibit reproduction. In addition, the plant must not be sold, propagated or knowingly distributed. Both species were also recorded within the adjacent remnant vegetation.

3.2.6 Pipelines

In accordance with the criteria outlined in Section 1.2, the proposed pipelines will traverse developed areas and will be generally within easements of existing haul roads. The construction of pipelines is not expected to adversely impact any areas of native vegetation.

4 Potential Impacts

This chapter provides a consideration of the potential impacts of the proposed modification on the ecology of the project area and adjacent areas, prior to mitigation being implemented.

4.1 Construction

Potential direct impacts associated with the construction of the fine reject emplacement include the removal of:

- habitat for small woodland birds, macropods, amphibians and reptiles;
- potential foraging habitat for microchiropteran bats;
- habitat used by threatened bird species (Speckled Warbler and Spotted Harrier);
- a small dam in the north-east of the project area and ephemeral soaks that provide habitat for amphibian species during periods of heavy rain; and
- vegetation that provides a buffer to remnant vegetation from haul roads and mining activities.

Potential indirect impacts associated with the construction of the modification include:

- sedimentation of adjacent sediment dams that provide habitat for native amphibians and birds and provide potential habitat for the Green and Golden Bell Frog; and
- disturbance to EECs to the north of the project area, outside the disturbance area, from personnel or machinery.

4.1.1 Vegetation clearance

Approximately 161 ha of vegetation consisting of planted *Acacia* and eucalypt and pasture species of approximately five to six years of age will be removed to enable the construction of the fine reject emplacement. This vegetation does not conform to any known vegetation type or threatened ecological community.

4.1.2 Habitat connectivity

Given its location, the removal of vegetation and habitats from the project area is not expected to impact connectivity or habitat corridor function for local or transient species. The area may, however, be utilised as stepping stone habitat by these species as they move across the landscape from adjacent stands of remnant vegetation.

4.1.3 Pest animals

The proposed modification is unlikely to increase the abundance or distribution of feral animal species, given the already disturbed nature of the project area and its surrounds. In addition, the works will not create additional shelter or den sites or create tracks or other movement corridors for pest species.

4.1.4 Key threatening processes

Key threatening processes (KTPs) are the events and processes that threaten, or could threaten, the survival or evolutionary development of species, populations or ecological communities. Thirty six KTPs are currently listed in NSW under the TSC Act and nineteen KTPs are listed under the EPBC Act. The project does not constitute, and is unlikely to exacerbate, any of the listed KTPs.

4.1.5 Threatened species and communities

Assessments of significance under Part 5A of the EP&A Act (seven part tests) have been conducted for the following threatened species, whose habitat is considered to have the potential to be impacted by the proposed modification:

- Spotted Harrier (*Circus assimilis*);
- Speckled Warbler (*Pyrrholaemus sagittatus*);
- Hooded Robin (*Melanodryas cucullata*);
- Green and Golden Bell Frog (*Litoria aurea*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Southern Myotis (*Myotis macropus*); and
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*).

The assessments found that the proposed modification is unlikely to significantly impact on any threatened species. Avoidance and mitigation measures to further reduce the potential for impacts to threatened species and native flora and fauna are provided in Chapter 5.

No threatened ecological communities within adjacent remnant vegetation will be impacted by the project. Therefore these were not assessed further.

4.2 Operation

Once constructed, the disposal of fine reject within the fine reject emplacement is not expected to adversely impact native flora and fauna.

5 Mitigation and management

Management and monitoring of ecology at HVO North will continue to be undertaken in accordance with Coal & Allied's existing environmental procedures including those for flora and fauna, disturbance and rehabilitation, erosion and sediment control, and weed and feral animal control.

In addition, a Ground Disturbance Permit application must also be completed prior to any works associated with the construction of the fine reject emplacement and commencement of the pipeline installation. This will provide further assurance that appropriate environmental management procedures are assigned to all disturbance areas.

Mitigation and management measures will include:

- minimising disturbance areas by planning for plant laydown and access routes in cleared areas, prior to works beginning;
- clearly delineating and flagging all disturbance areas and access routes in the field so that no areas outside of those assessed will be affected by machinery or personnel;
- sourcing equipment used for construction works from within the operation to prevent the transfer of soil pathogens and weed seeds where possible; and
- implementation of erosion and sediment control plans for the operation.

6 Conclusion

The project area is highly disturbed consisting of plantings and pasture and does not conform to any Biometric vegetation type or threatened ecological community. However, the vegetated areas are providing habitat for small woodland birds, including the threatened Speckled Warbler.

Surveys for the Green and Golden Bell Frog were undertaken to determine if the species is using the habitat of the project area. While the species was not detected within the project area, it is considered that the sediment control dams to the north-west could provide habitat for the species during times of optimal weather and breeding conditions. These areas are outside the disturbance footprint.

Measures to avoid and mitigate impacts of the proposed modification will be implemented to minimise potential impacts on native species.

The proposed modification will not significantly impact threatened species or native species within the local area, given the availability of suitable habitats within proximity to the project area, the current condition of the project area and the avoidance and mitigation measures to be implemented as part of the proposal.

References

Churchill S 2008, Australian Bats Second Edition, Jacana Books, Chatswood.

DEC 2005, Draft Recovery Plan for the Green and Golden Bell Frog (*Litoria aurea*), DEC NSW, Hurstville

DECC 2007, Management Plan for the Green and Golden Bell Frog Key Population in the Upper Hunter. Department of Environment and Climate Change (NSW), Sydney.

DECCW 2008, Biometric vegetation types database - Detailed data: Definitions of vegetation types for CMA areas - updated June 2008

EMM 2010, Carrington West Wing Modification Environmental Assessment prepared for Coal & Allied by EMGA Mitchell McLennan.

Environment Australia 1999, The Action Plan for Australian Bats, Environment Australia, Canberra.

ERM 2003, West Pit Extension and Minor Modification Environmental Impact Statement prepared for Coal & Allied by Environmental Resources Management Australia.

Gardner 2004, Winter flocking behaviour of speckled warblers and the Allee effect, Biological Conservation 118 (2004) 195–204.

HBOC 2011, Checklist of Birds of the Hunter Region of NSW 2011 Produced by Hunter Bird Observers Club Inc PO Box 24 New Lambton NSW 2305.

Niche 2011, Hunter Valley Operations Vegetation Mapping Report prepared for Coal and Allied by Niche Environment and Heritage Pty Ltd Hunter Valley NSW.

OEH 2011, Spotted Harrier *Circus assimilis* Jardine and Selby 1828 - vulnerable species listing NSW Scientific Committee - final determination online resource: http://www.environment.nsw.gov.au/determinations/spottedharrierFD.htm accessed August 2012.

OEH 2012, Office of Environment and Heritage Threatened species, populations and communities of NSW, online resource: http://www.environment.nsw.gov.au/threatenedspecies

Peake, T. 2006, A report on the findings of the Hunter Remnant Vegetation Project. Hunter- Central Rivers Catchment Authority, Paterson.

Travers 2012, Green and Golden Bell Frog Target Survey Proposed Mine Expansion Area - Hunter Valley Operations North prepared for Rio Tinto Coal Australia by Travers Bushfire and Ecology.

Appendix A

Database search results

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
BIRDS						
Hooded Robin	*Melanodryas cucullata*	V		• Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. • Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. • Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey. • Territories range from around 10 ha during the breeding season, to 30 ha in the non-breeding season.	Not recorded but could visit the project area to forage. However, the project area does not provide preferred habitat, there are no mature eucalypts or dead timber and only sparse native grasses.	Yes
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	V		• Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. • Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. • Feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. • Territories range from one to fifty hectares (usually around ten hectares) and are defended all year.	Recorded in adjacent remnant vegetation. Unlikely to occur within the project area given the distance over cleared land from remnant vegetation. Not recorded and unlikely to nest within the project area.	No
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V		• Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*). • Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees. • Feeding territories are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 has.	Not recorded. Unlikely to occur in project area given the young age of vegetation.	No

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
Brown Treecreeper	*Climacteris picumnus*	V		• Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer. • fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. • Hollows in standing dead or live trees and tree stumps are essential for nesting.	Not recorded and unlikely to occur given the lack of dead timber and mature vegetation.	No
Diamond Firetail	*Stagonopleura guttata*	V		• Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum (*Eucalyptus pauciflora*) Woodlands. • Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. • Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. • Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). • Birds roost in dense shrubs or in smaller nests built especially for roosting. • Appears to be sedentary, though some populations move locally, especially those in the south. • Has been recorded in some towns and near farm houses.	Not recorded and project area does not provide suitable vegetation.	No

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
Little Eagle	*Hieraaetus morphnoides*	V		• Occupies open eucalypt forest, woodland or open woodland. Sheoak or *Acacia* woodlands and riparian woodlands of interior NSW are also used. • Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. • Lays two or three eggs during spring, and young fledge in early summer. • Preys on birds, reptiles and mammals, occasionally adding large insects and carrion. • Uses Grey Box - Narrow-leaved Ironbark Woodland and Bull Oak forests in the Hunter Valley.	Not recorded and unlikely to occur in the project area given the young age of the vegetation.	No
Little Lorikeet	*Glossopsitta pusilla*	V		• Forages primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in *Angophora*, *Melaleuca* and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. • Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. • Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards. • Roosts in treetops, often distant from feeding areas. • Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like *Allocasuarina*.	Not recorded and unlikely to occur in the project area given the young age of the vegetation.	No

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
Speckled Warbler	*Pyrrholaemus saggitatus*	V		• The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. • Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. • Large, relatively undisturbed remnants are required for the species to persist in an area. • The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. • Pairs are sedentary and occupy a breeding territory of about 10 ha, with a slightly larger home-range when not breeding. • The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside.	Recorded	Yes
Varied Sittella	*Daphoenositta chrysoptera*	V		• Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. • Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.	Recorded in adjacent remnant vegetation. No preferred habitat present due to young vegetation and unlikely to occur.	No
Masked Owl	*Tyto novaehollandiae*	V		• Lives in dry eucalypt forests and woodlands from sea level to 1100 m. • A forest owl, but often hunts along the edges of forests, including roadsides. • The typical diet consists of tree-dwelling and ground mammals, especially rats. • Pairs have a large home-range of 500 to 1000 hectares. • Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. - roosts and breeds in moist eucalypt forested gullies.	No preferred habitat present and unlikely to occur.	No

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
Powerful Owl	*Ninox strenua*	V		• The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. • The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine (*Syncarpia glomulifera)*, Black She-oak (*Allocasuarina littoralis)*, Blackwood (*Acacia melanoxylon*), Rough-barked Apple (*Angophora floribunda*), Cherry Ballart (*Exocarpus cupressiformis*) and a number of eucalypt species. • The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. • Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. During the breeding season, the male Powerful Owl roosts in a "grove" of up to 20-30 trees, situated within 100-200 metres of the nest tree where the female shelters.	No preferred habitat present due to young vegetation and unlikely to occur	No
MAMMALS						
Brush-tailed Rock-wallaby	*Petrogale penicillata*	E	E	• Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. • Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. • Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night.	No preferred habitat present and unlikely to occur	No
Spotted-tailed Quoll	*Dasyurus maculatus maculatus*	V	V	• Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. • Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	No preferred habitat present and unlikely to occur	No

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
Large-eared Pied Bat	*Chalinolobus dwyeri*	V		• Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. • Found in well-timbered areas containing gullies.	No roosting habitat available, does not forage over open areas.	No
Little Bentwing-bat	*Miniopterus australis*	V		• Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. • Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	No roosting habitat available and unlikely to forage over open area.	No
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V		• Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. • Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. • Hunt in forested areas, catching moths and other flying insects above the tree tops - foraging habitat available, no breeding habitat (maternity caves) present, potential roosting habitat available.	No roosting habitat available. Recorded in adjacent area and can forage over open areas.	Yes
Eastern Freetail-bat	*Mormopterus norfolkensis*	V		• Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. • Roost mainly in tree hollows but will also roost under bark or in man-made structures.	No roosting habitat available but could forage over the project area.	Yes

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		• Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. • Although this species usually roosts in tree hollows, it has also been found in buildings. • Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. • Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.	No roosting habitat available and does not forage over open areas.	No
Greater Long-eared Bat	*Nyctophilus timoriensis* (South-eastern form)	V		• Inhabits a variety of vegetation types, including mallee, bulloak (*Allocasuarina leuhmanni*) and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. • Roosts in tree hollows, crevices, and under loose bark. • Slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground.	No roosting habitat available and does not forage over open areas.	No
Grey-headed Flying-fox	*Pteropus poliocephalus*	V		• Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. • Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. • Feed on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines. • Also forage in cultivated gardens and fruit crops	Not recorded and unlikely to occur given the young age of the vegetation.	No

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
Southern Myotis	*Myotis macropus*	V		• Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. • Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	No roosting habitat available but could forage over waterbodies and dams in and adjacent to the project area.	Yes
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V		• Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. • When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. • Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	No roosting habitat available but could forage over the project area.	Yes
FROG						
Green and Golden Bell Frog	*Litoria aurea*	E	V	• Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). • Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. • Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. • The species is active by day and usually breeds in summer when conditions are warm and wet.	Potential habitat in dams adjacent to the project area.	Yes

Table A.1 Threatened species previously recorded within 10 km of the project area (OEH 2012)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology (OEH 2012)	Potential Occurrence	Assessment Required?
FLORA						
Acacia pendula population in the Hunter catchment		E	-	• Within the Hunter catchment the species typically occurs on heavy soils, sometimes on the margins of small floodplains, but also in more undulating locations. • It is not known to occur within any conservation areas.	Not recorded within the project area and unlikely to occur.	No
Eucalyptus camaldulensis population in the Hunter catchment		E	-	• May occur with *E. tereticornis, E. melliodora, Casuarina cunninghamiana* subsp. *cunninghamiana* and *Angophora floribunda* • Most of the occurrences are on private land and there are no known occurrences in conservation reserves.	Not recorded within the project area and unlikely to occur.	No

E Endangered, CE = Critically Endangered, V = Vulnerable

Table A.2 Threatened species with potential to occur within the project area (DSEWPC 2012) (additional to those shown in Table A.1)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology	Potential occurrence	Assessment required?
BIRDS						
Regent Honeyeater	*Anthochaera phrygia*	CE	E	• The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. • There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions.	No potential habitat available.	No

Table A.2 Threatened species with potential to occur within the project area (DSEWPC 2012) (additional to those shown in Table A.1)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology	Potential occurrence	Assessment required?
Australasian Bittern	*Botaurus poiciloptilus*	E	E	• Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.). • Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails.	Potential habitat in adjacent waterbodies.	Yes
Swift Parrot	*Lathamus discolor*	E	E	• Migrates to the Australian south-east mainland between March and October. • On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. • Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*). • Commonly used lerp infested trees include Inland Grey Box (*E. microcarpa*), Grey Box (*E. moluccana*) and Blackbutt (*E. pilularis*).	Not recorded and no suitable foraging habitat available.	No
Malleefowl	*Leipoa ocellata*	E	V	• Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300 - 450 mm mean annual rainfall) areas. Utilises mallee with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey. Less frequently found in other eucalypt woodlands, such as Inland Grey Box, Ironbark or Bimble Box Woodlands with thick understorey, or in other woodlands such dominated by Mulga or native Cypress Pine species. • Prefers areas of light sandy to sandy loam soils and habitats with a dense but discontinuous canopy and dense and diverse shrub and herb layers.	No mounds present and no suitable habitat recorded. Unlikely to occur.	No

Table A.2 Threatened species with potential to occur within the project area (DSEWPC 2012) (additional to those shown in Table A.1)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology	Potential occurrence	Assessment required?
Australian Painted Snipe	*Rostratula australis*	E	V	• Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. • Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. • The nest consists of a scrape in the ground, lined with grasses and leaves. • Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter.	Potential habitat in adjacent waterbodies.	Yes
FROG						
Booroolong Frog	*Litoria booroolongensis*	E	E	• Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. • Adults occur on or near cobble banks and other rock structures within stream margins. • Shelter under rocks or amongst vegetation near the ground on the stream edge.	No habitat available and no potential to occur.	No
MAMMALS						
New Holland Mouse	*Pseudomys novaehollandiae*	-	V	• Found from coastal areas and up to 100 km inland on sandstone country	No habitat available and unlikely to occur.	No
FLORA						
Finger panic Grass	*Digitaria porrecta*	E	E	• In NSW, the most frequently recorded associated tree species are *Eucalyptus albens* and *Acacia pendula.* Common associated grasses and forbs in NSW sites include *Austrostipa aristiglumis, Enteropogon acicularis, Cyperus bifax, Hibiscus trionum* and *Neptunia gracilis.* • Native grassland, woodlands or open forest with a grassy understorey, on richer soils. • Often found along roadsides and travelling stock routes where there is light grazing and occasional fire.	Not recorded and no habitat in project area due to highly disturbed nature of the site.	No

Table A.2 Threatened species with potential to occur within the project area (DSEWPC 2012) (additional to those shown in Table A.1)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology	Potential occurrence	Assessment required?
Slaty Red Gum	*Eucalyptus glaucina*	V	V	• Grows in grassy woodland and dry eucalypt forest. • Grows on deep, moderately fertile and well-watered soils.	Not recorded and unlikely to occur.	No
-	*Euphrasia arguta*	CE	CE	• Historic records of the species noted the following habitats: 'in the open forest country around Bathurst in sub humid places', 'on the grassy country near Bathurst', and 'in meadows near rivers'. • Plants from the Nundle area have been reported from eucalypt forest with a mixed grass and shrub understorey.	Unlikely to occur in highly disturbed site and only known from Nundle area.	No
-	*Olearia cordata*	V	V	• Populations are typically small and scattered. • Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges.	Not recorded and no suitable habitat.	No
A Leek Orchid	*Prasophyllum* sp. *Wybong*	-	CE	• Leek orchids are generally found in shrubby and grassy habitats in dry to wet soil. *Prasophyllum* sp. Wybong is known to occur in open eucalypt woodland and grassland.	Not recorded and unlikely to occur in highly disturbed site.	No
Illawarra Greenhood	*Pterostylis gibbosa*	E	E	• All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. • In the Illawarra region, the species grows in woodland dominated by Forest Red Gum, Woollybutt and White Feather Honey-myrtle *Melaleuca decora*. Near Nowra, the species grows in an open forest of Spotted Gum a, Forest Red Gum and Grey Ironbark *E. paniculata*. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark *E. crebra*, Forest Red Gum and Black Cypress Pine *Callitris endlicheri.*	Not recorded and unlikely to occur in highly disturbed site.	No
Austral Toadflax	*Thesium australe*	V	V	• Occurs in grassland or grassy woodland. • Often found in damp sites in association with Kangaroo Grass *(Themeda australis).* • A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.	Not recorded, no Kangaroo grass present, no preferred habitats, unlikely to occur.	No

Table A.2 Threatened species with potential to occur within the project area (DSEWPC 2012) (additional to those shown in Table A.1)

Common Name	Scientific Name	TSC Act	EPBC Act	Habitat and Ecology	Potential occurrence	Assessment required?
THREATENED ECOLOGICAL COMMUNITIES						
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		E	CE	-	Not recorded, no potential for occurrence.	No
Weeping Myall - Coobah - Scrub Wilga Shrubland of the Hunter Valley		E	CE	-	Not recorded, no potential for occurrence.	No

E Endangered, CE = Critically Endangered, V = Vulnerable

Appendix B

Species lists

Table B.1 Flora Species recorded during field investigations

Scientific Name	Common Name	Project Area	Adjacent Woodland
Acacia decurrens	Sydney Green Wattle	x	-
Acacia implexa	Lightwood	x	-
Acacia rubida	Red Stemmed Wattle	x	-
Acacia saligna	Golden Wreath Wattle	x	-
Allocasuarina luehmannii	Bulloak	x (2)	x
Austrodanthonia sp.	Wallaby Grass		x
Austrostipa scabra	Speargrass	x	-
Austrostipa verticillata	Slender Bamboo Grass		x
Brachychiton populneus	Kurrajong		x
Calotis lappulacea	Yellow Burr Daisy	x	-
Cheilanthes sieberi	Mulga Fern	x	-
Chloris truncata	Windmill Grass	x	-
Cotula australis	Common Cotula	x	-
Cynodon dactylon (naturalised)	Couch	x	-
Dichondra repens	Kidneyweed	x	x
Einadia nutans subsp. *linifolia*	Climbing Saltbush	x	
Eleocharis sphacelata		x	
Eragrostis sp.	Lovegrass	x	
Eucalyptus crebra	Narrow leaved Ironbark	x	x
Eucalyptus dawsonii	Slaty Gum		x
Eucalyptus moluccana	Grey Box		x
Eucalyptus sp.	Unidentified eucalypts	x	
Eucalyputs tereticornis	Forest Red Gum	x	
Euchiton sphaericus		x	
Galium gaudichaudii	Rough Bedstraw	x	
Geranium solanderi	Native Geranium	x	
Juncus usitatus	Common Rush	x	
Notelaea microcarpa var. *microcarpa*	Native Olive		x
Sclerolaena muricata var. *muricata*	Black Rolypoly	x	
Sporobolus creber	Slender Rat's Tail Grass	x	
Typha domingensis	Narrow leafed Cumbungi	x	
Exotic Species			
Chloris gayana	Rhode's Grass	x	
Galenia pubescens	Galenia	x	
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	x	
Lepidium africanum		x	
Modiola caroliniana	Red Flowered Mallow	x	
Opuntia aurantiaca	Tiger Pear	x	x
Opuntia stricta	Prickly Pear	x	x
Plantago lanceolata	Plantain	x	
Senecio madagascariensis	Fireweed	x	x

Table B.1 Flora Species recorded during field investigations

Scientific Name	Common Name	Project Area	Adjacent Woodland
Setaria sp.	Pigeon grass	x	
Sida rhombifolia	Paddy's Lucerne	x	
Solanum nigrum	Deadly Nightshade	x	
Sonchus asper	Prickly Sowthistle	x	
Sonchus oleraceus	Common Sowthistle	x	
Verbena brasiliensis	Purpletop	x	
Vicia sp.	Vetch	x	

Table B.2 Fauna species recorded during field investigation

Common Name	Scientific Name	Project Area	Remnant vegetation	TSC Act	EPBC Act	Regional Information (Hunter Bird Observers Club)
Birds						
Australian Magpie	*Gymnorhina tibicen*	x				Common resident. Widely and regularly recorded as counts of up to 20 birds, and occasionally as 21-50 birds especially during Mar-Aug.
Australasian Pipit	*Anthus novaeseelandiae*	x				Usual resident. Widely and moderately often recorded, mostly as counts of 1-5 birds.
Australian Raven	*Corvus coronoides*	x				Common resident. Widely and regularly recorded as counts of up to 20 birds and occasionally as counts of up to 50 birds.
Australian Reed Warbler	*Acrocephalus australis*	dam adjacent to project area				Usual summer migrant; some birds are resident. 1-10 birds are often recorded near medium to large waters during Jan-Apr and Sep-Dec.
Australian Wood Duck	*Chenoetta jubatta*	dam adjacent to project area				Common resident. Widely and regularly recorded as up to 20 birds near fresh to brackish waters.
Brown Quail	*Coturnix ypsilophora*	x				Breeding - resident - moderately often recorded.
Brown Thornbill	*Acanthiza pusilla*		x			Resident - widely and commonly recorded.
Common Bronzewing	*Phaps chalcoptera*	x				Common resident.
Crimson Rosella	*Platycercus elegans*	x				Common resident. Up to 20 birds moderately often recorded in the central & east of the Region.
Double-barred Finch	*Taeniopygia bichenovii*		x			Widely and moderately often recorded as counts of up to 20 birds.
Dusky Moorhen	*Gallinula tenebrosa*	dam adjacent to project area				Common resident. Widely and frequently recorded, in counts of up to 20 birds at small to medium waters and up to 50 birds at medium to large waters.
Eastern Rosella	*Platycercus eximius*	x	x			Common resident. Widely and regularly recorded as counts of up to 20 birds.
Eurasian Coot	*Fulica atra*	dam adjacent to project area				Usual resident. Up to 50 birds widely and often recorded at medium to large waters.
Galah	*Cacatua roseicapilla*	fly over	x			Common resident. Widely and regularly recorded, as counts of up to 10 birds in the east of the Region and up to 20 birds further inland.
Grey Fantail	*Rhipidura albiscapa*	x	x			Common resident. Widely and regularly recorded as counts of up to 20 birds.

Table B.2 Fauna species recorded during field investigation

Common Name	Scientific Name	Project Area	Remnant vegetation	TSC Act	EPBC Act	Regional Information (Hunter Bird Observers Club)
Grey-crowned Babbler	***Pomatostomus temporalis temporalis***		**x**	**V**		Resident. Parties of up to 5 birds are moderately often recorded in the central and west of Region.
Hardhead	*Aytha australis*	dam adjacent to project area				Usual resident and irruptive visitor. Widely and moderately often recorded at medium to large waters as counts of up to 20 birds.
Hoary-headed Grebe	*Poliocephalus poliocephalus*	dam adjacent to project area				Resident.
Jacky Winter	*Microeca fascinans*	x	x			Usual resident. Widely and often recorded as counts of 1-5 birds.
Laughing Kookaburra	*Dacelo novaeguineae*	x				Common resident. Widely and regularly recorded, mainly as <10 birds and usually as 1-5 birds.
Leaden Flycatcher	*Myiagra rubecula*	x				Summer migrant. Up to 5 birds moderately often recorded over Jan-Mar and from mid-Sep onwards
Nankeen Kestrel	*Falco cenchroides*	x				Usual resident. Widely and frequently recorded, usually as single birds or pairs.
Noisy Miner	*Manorina melanocephala*	x	x			Common resident. Widely and regularly recorded as counts of up to 20 birds.
Pied Butcherbird	*Cracticus nigrogularis*	x				Usual resident. Widely and often recorded as counts of 1-5 birds.
Purple Swamphen	*Porhyrio porphyrio*	dam adjacent to project area				Common resident. Up to 20 birds are widely and frequently recorded at small-large waters.
Red-capped Robin	*Petroica goodenovii*	x				Uncommon resident.
Rufous Whistler	*Pachycephala rufiventris*	x				Common summer migrant, some birds over-winter. Widely and regularly recorded over Jan-Apr and Sep-Dec as counts of up to 20 birds but mostly as 1-5 birds.
Speckled Warbler	***Cthonicola saggitata***	**x**		**V**		Resident. Often recorded in the west and central parts of the Region as counts of up to 10 birds.
Spotted Harrier	***Circus assimilis***	**x**		**V**		Uncommon resident. Not recorded breeding.
Spotted Pardalote	*Pardalotus punctatus*	x	x			Common resident. Widely and regularly recorded, mostly as counts of 1-5 birds but with counts of up to 20 birds being not uncommon.
Superb Fairy Wren	*Malurus cyaneus*	x	x			Common resident. Widely and regularly recorded as counts of up to 20 birds.

Table B.2 Fauna species recorded during field investigation

Common Name	Scientific Name	Project Area	Remnant vegetation	TSC Act	EPBC Act	Regional Information (Hunter Bird Observers Club)
Varied Sittella	***Daphoenositta chrysoptera***		**x**	**V**		Resident. Widely and moderately often recorded as counts of 1-5 birds.
Wedge-tailed Eagle	*Aquila audax*	fly over				Usual resident. Often recorded throughout the Region, mostly as 1-2 birds.
Welcome Swallow	*Hirundo neoxena*	x				Common resident. Widely and regularly recorded as counts of up to 20 birds, and as counts of up to 50 birds near medium to large waters.
Western Gerygone	*Gerygone fusca*	x	x			Uncommon resident in the west and central parts of the Region.
White-plumed Honeyeater	*Lichenostomus penicillatus*	x	x			Usual resident. Moderately often recorded in the west and central parts as counts of up to 20 birds.
White-throated Gerygone	*Gerygone olivacea*	x				Summer migrant. Widely and frequently recorded over Jan-Mar and Sep-Dec as 1-5 birds.
Yellow Thornbill	*Acanthiza nana*	x	x			Usual resident. Widely and regularly recorded as counts of up to 20 birds.
Black-shouldered Kite	*Elanus axillaris*	foraging over adjacent area				Usual resident. Moderately often recorded in the east and central parts of the Region as 1-2 birds.
Mammals						
Rabbit*	*Oryctolagus cuniculus*	x (scats)				
Eastern Grey Kangaroo	*Macropus giganteus*	x	x			
Domestic Cattle*	*Bos taurus*		x (scat)			
Gould's Wattled Bat	*Chalinolobus gouldii*		x			
Chocolate Wattled Bat	*Chalinolobus morio*		x			
Dog*	*Canis familiaris*	x (tracks)				
Eastern Bentwing Bat	***Miniopterus schreibersii oceanensis***		**x**	**V**		
Eastern False Pipistrelle	***Falsistrellus tasmaniensis***		**x**	**V**		
Amphibians						

Table B.2 Fauna species recorded during field investigation

Common Name	Scientific Name	Project Area	Remnant vegetation	TSC Act	EPBC Act	Regional Information (Hunter Bird Observers Club)
Common Eastern Froglet	*Crinia signifera*	sediment dam adjacent to project area				
Eastern Sign-bearing Froglet	*Crinia parinsignifera*	sediment dam adjacent to project area				
Eastern Dwarf Sedge Frog	*Litoria fallax*	sediment dam adjacent to project area				
Broad-palmed Frog	*Litoria latopalmata*	sediment dam adjacent to project area				
Striped Marsh Frog	*Limnodynastes peroni*	sediment dam adjacent to project area				
Spotted Grass Frog	*Limnodynastes tasmaniensis*	sediment dam adjacent to project area				
Macroinvertebrates						
Freshwater Yabby	*Cherax destructor*	shells recorded next to sediment dam adjacent to project area				

Species in bold are listed as threatened under the TSC Act : V = vulnerable

** = feral species*

Appendix C

Assessments of significance

C.1 Assessments of Significance

C.1.1 Significant impact criteria in accordance with the TSC Act

Section 5A of the EP&A Act provides the criteria that must be considered in the assessment of the significance of potential impacts on all threatened species listed under the TSC Act. The Assessment of Significance (known as the seven-part test) is made up of the following seven questions:

1. *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

2. *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

3. *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

    a) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

    b) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

4. *In relation to the habitat of a threatened species, population or ecological community:*

    a) *the extent to which habitat is likely to be removed or modified as a result of the action proposed;*

    b) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;*

    c) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;*

5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and*

7. *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Assessments of significance are undertaken in accordance with *Threatened species assessment guidelines: The assessment of significance* (DEC 2007).

This appendix provides assessments of significance under part 5a of the EP&A Act for the following species:

- Spotted Harrier (*Circus assimilis*);

- Speckled Warbler (*Pyrrholaemus sagittatus*);
- Green and Golden Bell Frog (*Litoria aurea*);
- Hooded Robin (*Melanodryas cucullata*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Southern Myotis (*Myotis macropus*); and
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*).

i Bird Species

a. Spotted Harrier

The Spotted Harrier is listed as vulnerable under the TSC Act. The species occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population.

The Spotted Harrier occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods). It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. The species builds a stick nest in a tree and lays eggs in spring (or sometimes autumn).The diet of the Spotted Harrier includes terrestrial mammals, birds and reptiles, occasionally large insects and rarely carrion (OEH 2011).

Threats to this species include:

- secondary poisoning from rabbit baiting;
- secondary poisoning from rodenticides; and
- clearing and degradation of foraging and breeding habitat, particularly that which affects prey densities.

Two Spotted Harriers were recorded foraging in the project area. No suitable nest sites were identified within the project area for this species.

1. *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The proposed action will result in the modification of approximately 161 ha of land that is currently a mixture of *Acacia* and eucalypt plantings over a weedy understorey, and pasture. No trees that would be used for nesting by the Spotted Harrier will be impacted either directly or indirectly by the project, and the project is unlikely to impact breeding birds, if these occur in adjacent woodland areas.

The proposed action is also unlikely to adversely impact the density of prey species for the Spotted Harrier. Adjacent areas of vegetation will remain to provide adequate habitat for prey species to move into. Therefore, the action is unlikely to impact the life cycle of the species such that a local viable population would be placed at risk of extinction.

2. *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

Not applicable to a species.

3. *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

    a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

    b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable to a species.

4. *In relation to the habitat of a threatened species, population or ecological community:*

    a) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

    b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;

    c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Approximately 161 ha of potential foraging habitat will be developed for the proposed modification. No other areas of habitat will be impacted by the proposal.

The project area exists to the north of haul roads and a mine pit. Its removal will not result in fragmentation or isolation of habitat for the Spotted Harrier.

The habitat of the project area is not unique and is unlikely to be considered important to the long-term survival of the species within the locality. There are large expanses of similar habitats within the Upper Hunter and within the immediate area.

5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

No critical habitat has been declared for this species.

6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and*

No specific recovery actions have been identified for the Spotted Harrier. However, activities to assist the species include:

- protect areas of habitat from overgrazing;
- protect areas of habitat from development; and
- retain and protect nesting and foraging habitat.

The proposed action will result in the removal of foraging habitat for the species, however, larger areas of more suitable habitat exist directly to the north.

7. *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action does not constitute a key threatening process as listed under the TSC Act.

Conclusion:

The proposed action is not expected to significantly impact the Spotted Harrier because:

- it will not impact breeding habitat for the species;
- it removes a relatively small area of potential foraging habitat;
- the habitat to be removed is common to the area; and
- the proposed action is not expected to impact significantly on the density of prey species available for the Spotted Harrier.

b. Speckled Warbler

The Speckled Warbler is listed as vulnerable under the TSC Act. The species has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100ha survive.

The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside. A clutch of 3-4 eggs is laid, between August and January, and both parents feed the nestlings. Due to the fragmented nature of the populations and their small size the species is susceptible to catastrophic events and localised extinction.

Threats to the species include:

- clearance of remnant grassy woodland habitat for paddock management reasons and for firewood;
- poor regeneration of grassy woodland habitats;
- modification and destruction of ground habitat through removal of litter and fallen timber, introduction of exotic pasture grasses, heavy grazing and compaction by stock and frequent fire;
- nest predation increases significantly, to nest failure rates of over 80%, in isolated fragments; and
- nest failure due to predation by native and non-native birds, cats, dogs and foxes particularly in fragmented and degraded habitats.

The Speckled Warbler was recorded foraging in the project area. Approximately 50 ha of suitable habitat occurs for the species within the project area.

1. *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The proposed action will result in the modification of approximately 161 ha of land that is currently a mixture of *Acacia* and eucalypt plantings over a weedy understorey, and pasture. The Speckled Warbler was recorded foraging within the project area and could potentially breed there. No nests were recorded during the field investigations.

Pairs are sedentary and can occupy a territory of up to 10 ha when breeding (this increases where habitat condition is poor (Gardner 2004)). The project could remove breeding habitat for up to two flocks of Speckled Warblers (based on calculations of home ranges in Gardner 2004), if they cannot find alternative breeding habitat and territories in adjacent woodlands.

Suitable breeding habitat exists in adjacent woodland areas and the species is known to occur within a few kilometres of the project area, often being recorded in the western and central parts of the Hunter Region as counts of up to 10 birds (HBOC 2011). It is therefore considered that the loss of up to two pairs of breeding birds (using the precautionary principle and worse-case scenario) as a result of the proposed action is unlikely to impact the life cycle of the species such that a viable local population would be placed at risk of extinction.

2. *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

Not applicable to a species.

3. *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

   a) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

   b) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

Not applicable to a species.

4. *In relation to the habitat of a threatened species, population or ecological community:*

   a) *the extent to which habitat is likely to be removed or modified as a result of the action proposed;*

   b) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;*

   c) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;*

Approximately 50 ha of habitat for the Speckled Warbler will be removed for the proposed modification. No other areas of habitat will be impacted by the proposal.

The project area exists to the north of haul roads and a mine pit. Remnant woodland exists to the north of the site. The removal of habitat from the project area will not isolate existing vegetation from other vegetated areas and will not result in fragmentation or isolation of habitat for the Speckled Warbler.

The habitat of the project area would be considered to be of low importance to the long-term survival of the Speckled Warbler in the locality because:

- the habitat is of simple structural complexity being regrowth *Acacia* and eucalypts over a weedy understorey;
- the understorey is dominated by exotic grass and forbs;
- there are no fallen logs or woody debris;
- there are other similar habitats and habitats more suited to the species directly adjacent to the project area and within the greater locality; and
- dogs have been recorded within the project area (although these are also likely to be present in adjacent areas).

5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

No critical habitat has been declared for this species.

6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and*

No recovery plan has been developed for the Speckled Warbler. However, activities to assist the species have been identified for the Speckled Warbler including:

- keep domestic dogs and cats indoors at night. Desex domestic dogs and cats. Assess the appropriateness of dog and cat ownership in new subdivisions;
- undertake fox and feral cat control programs;
- NPWS should be consulted when planning development to minimise impact on populations;

- retain existing vegetation along roadsides, in paddocks and remnant stands of native trees;
- retain dead timber on the ground in open woodland areas;
- limit firewood collection;
- encourage regeneration of habitat by fencing remnant stands;
- fence suitable woodland habitats, particularly those with unimproved pasture and an intact native ground plant layer;
- increase the size of existing remnants, planting trees and establishing buffer zones of unimproved uncultivated pasture around woodland remnants;
- assess the importance of the site to the species' survival. Include the linkages the site provides for the species between ecological resources across the broader landscape; and
- report any new sightings of the Speckled Warbler to the Office of Environment and Heritage.

7. *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action does not constitute, and will not increase the impact of any key threatening process as listed under the TSC Act.

Conclusion:

The proposed action is not expected to significantly impact the Speckled Warbler because:

- the habitat to be removed is not preferred habitat for the species;
- the species is a commonly recorded resident within the Upper Hunter;
- alternative habitats are available in adjacent areas; and
- the species is known to occur in remnant vegetation within proximity to the project area.

c. Hooded Robin

The Hooded Robin is listed as vulnerable under the TSC Act. It inhabits dry eucalypt and *Acacia* woodlands and shrublands, with an open understorey, some grassy areas, and a complex ground layer. The robin's occurrence is positively associated with patch size, and with components of habitat complexity that include the amount of tree canopy cover, shrub cover, ground cover, logs, fallen branches and litter.

The Hooded Robin builds an open cup nest of plant fibres and cobweb, sited on low, live or dead forks or branches of trees or stumps, or occasionally on fallen trees or limbs. A clutch of two or three eggs is laid in spring and summer, with multiple attempts per season, though usually only one successful brood in a season. There is a high rate of nest predation, by native predators, including artificially inflated numbers of Pied Currawongs (*Strepera graculina*), but also probably by cats and foxes on low nests.

The Hooded Robin feeds on invertebrates (mostly insects), some small vertebrates (skinks, froglets) and occasionally seeds, taken from the ground, trunks, branches and in the air. On the ground, prey is commonly taken from or among logs and coarse woody debris. Foraging substrate and prey are adversely affected by 'tidying up' in farmland, and by firewood collection.

The Hooded Robin occurs in pairs or family groups; it sometimes breeds co-operatively, with helper(s) (usually immature sons) assisting the pair to feed new young.

Threats to the species include:

- clearing of woodlands, resulting in loss and fragmentation of habitat;
- modification and destruction of ground habitat through heavy grazing and compaction by stock, removal of litter and fallen timber, introduction of exotic pasture grasses and frequent fire; and
- modification and destruction of ground habitat through removal of litter and fallen timber, introduction of exotic pasture grasses, heavy grazing and compaction by stock and frequent fire.

The Hooded Robin was not recorded within the project area and no nests were recorded there. The project area provides approximately 50 ha of potential habitat for the species.

1. *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The proposed action will result in the modification of approximately 161 ha of land that is currently a mixture of *Acacia* and eucalypt plantings over a weedy understorey, and pasture. This area would provide some limited foraging habitat (approximately 50 ha) for the Hooded Robin, but does not contain the required structural complexity for the long term support of the species. There are other more suitable woodland remnants in adjacent areas and it is considered unlikely the species would breed in the project area. Therefore the proposed action is unlikely to have an adverse impact on the life cycle of the species such that a viable local population would be placed at risk of extinction.

2. *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

Not applicable to a species.

3. *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

    a) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

    b) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

Not applicable to a species.

4. *In relation to the habitat of a threatened species, population or ecological community:*

   a) *the extent to which habitat is likely to be removed or modified as a result of the action proposed;*

   b) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;*

   c) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;*

Approximately 50 ha of potential foraging habitat for the Hooded Robin will be removed for the proposed modification. No other areas of habitat will be impacted by the proposal.

The project area exists to the north of haul roads and a mine pit. Its removal will not result in fragmentation or isolation of habitat for the Speckled Warbler.

The habitat of the project area would be considered to be of low importance to the long-term survival of the Hooded Robin in the locality because:

- the habitat is of simple structural complexity being regrowth *Acacia* and eucalypts over a weedy understorey;
- the understorey is dominated by exotic grass;
- there are no fallen logs or woody debris; and
- the species is unlikely to breed within the project area.

5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

No critical habitat has been declared for this species.

6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and*

No recovery plan has been developed for the Hooded Robin. However, activities to assist the species have been identified including:

- retain dead timber on the ground in open woodland areas;
- enhance potential habitat through regeneration by reducing the intensity and duration of grazing;
- fence habitat to protect from long-term, intense grazing; and
- increase the size of existing remnants, by planting trees and establishing buffer zones of un-modified, uncultivated pasture around woodland remnants.

The proposed action is consistent with the above activities.

7. *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action does not constitute any key threatening process as listed under the TSC Act.

Conclusion:

The proposed action is not expected to significantly impact the Hooded Robin because:

- the habitat to be removed is not preferred habitat for the species;
- the species was not recorded within the project area;
- alternative, more suitable habitats are available in adjacent areas; and
- the project area does not provide preferred breeding habitat and there were no robin nests recorded within the project area.

ii Amphibians

a. Green and Golden Bell Frog

The Green and Golden Bell Frog is listed as endangered under the TSC Act. The species inhabits marshes, dams and stream-sides, particularly those containing *Typha* spp. or *Eleocharis* spp.. Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. The species is active by day and usually breeds in summer when conditions are warm and wet. Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation. Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs. The species is preyed upon by various wading birds and snakes.

Threats to the species include:

- destruction of wetlands;
- alteration of drainage patterns and stormwater runoff;
- a fungal pathogen known as frog chytrid fungus;
- predation by feral animals such as foxes;
- herbicides and other weed-control measures;
- road mortality, where populations are already small due to other threats;
- predation by exotic fish such as plague minnow; and
- loss of suitable breeding habitat through alteration by infilling and destruction of wetlands.

The following is an assessment of the required habitats for the species, in relation to the habitat recorded within the project area:

- Breeding habitat - potential breeding habitat for the Green and Golden Bell Frog exists within the sediment dams located to the north-west of the project area.

- Foraging habitat – includes areas of native or introduced grasses, tussock vegetation and emergent sedges and reeds. Vegetated dams or ponds (farm or industry) and creeks not subject to cattle grazing also provide this habitat element in the Upper Hunter. Areas adjacent to the project area provide potential foraging habitat in the form of dams and soaks with some sedges and rushes and exotic tussock grasses.

- Shelter habitat - includes similar vegetation to that used for foraging and, most particularly, rock piles, ground timber, tussock forming vegetation and other features that are difficult to categorise (eg crevices and earth cracks, around root systems of plants and beneath ground debris). The project area provides exotic tussock grasses but other habitat is absent from the project area.

- Movement habitat - where frogs do move within the upper Hunter, they presumably do so along drainage lines or after rain, using periodically damp areas. The nearest movement corridor is identified in Travers (2012) as Farrells Creek, which is located more than one kilometre to the north-east. It is unknown whether the Upper Hunter key population has been able to disperse to the project area from this potential movement corridor, but it is considered unlikely, given that the potential habitats are located atop a steep, artificially created hill and individuals would have to cross haul roads or Lemington Road.

- Overwintering habitat - some of this habitat is most likely similar to shelter habitat, such as rock and rubble piles, ground timbers and logs and dense tussock vegetation. The project area provides dense exotic tussock vegetation but does not provide any other sheltering habitat.

1. *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

Potential impacts of the proposed action include removal of grassed areas that provide potential habitat for movement from suitable breeding areas. Two sediment dams to the north-west of the project area provide suitable breeding habitat (see Figure 3.1). If the species is using these areas as breeding habitat it is likely that they are also utilising other dams and soaks within proximity to the project area.

Targeted surveys for the species during the breeding period failed to detect the species within the project area or within the sediment dams adjacent to the project area. As the species was not detected at the project area it is considered unlikely to be breeding there and the proposed modification is considered unlikely to have an adverse impact on the life cycle of the species such that a local population would be placed at risk of extinction.

Indirect impacts could occur to potential habitat within the sediment dams to the north-west of the project area, including sedimentation of waterbodies or trampling from machinery or personnel. These potential impacts could reduce water quality or directly remove suitable basking sites, and will be controlled during the construction period. The project area will be delineated and disturbance outside the designated area avoided. Trampling is not likely to have a major impact given that the dams are outside of the project area and any impact would be expected to be minor and accidental. Given the ability of the species to breed in polluted sites, potential sedimentation is unlikely to have adverse impacts on the life cycle of the species such that a local viable population would be placed at risk of extinction.

2. *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

Not applicable to a species.

3. *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

   a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

   b) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

Not applicable to a species.

4. *In relation to the habitat of a threatened species, population or ecological community:*

   a) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

   b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;

   c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

No known habitat will be removed as a result of the proposed action. Potential habitat is provided by two sediment dams to the north-west of the project area. These dams will not be removed, and will not be fragmented or isolated from other potential habitat areas as a result of the proposed action. Movement of the species can still occur through remnant areas to the north and west of the project area.

If the species did occur within the project area the habitat could be considered moderately important to the long-term survival of the species in the locality.

5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

No critical habitat has been declared for the Green and Golden Bell Frog.

6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and*

The specific objectives of the draft Green and Golden Bell Frog recovery plan (DEC 2005) are:

- increase the security of key Green and Golden Bell Frog populations by way of preventing the further loss of GGBF habitat at key populations across the species range and where possible secure opportunities for increasing protection of habitat areas;

- ensure extant Green and Golden Bell Frog populations are managed to eliminate or attenuate the operation of factors that are known or discovered to be detrimentally affecting the species;

- implement habitat management initiatives that are informed by data obtained through investigations into the general biology and ecology of the Green and Golden Bell Frog through a systematic and coordinated monitoring program;

- establish, within more than one institution, self-sustaining and representative captive populations (particularly 'at risk' populations) of the Green and Golden Bell Frog for the primary purpose of maintaining 'insurance' colonies for re-establishment and supplementation of populations of the species; and

- increase the level of regional and local awareness of the conservation status of the Green and Golden Bell Frog and provide greater opportunity for community involvement in the implementation of this recovery plan.

The project will retain potential habitats for the species within the local area and is consistent with the objectives of the recovery plan.

7. *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action does not constitute any key threatening process as listed under the TSC Act.

Conclusion:

The proposed action is not expected to significantly impact the Green and Golden Bell Frog because:

- potential habitat for the species will be retained in the two sediment dams to the north-west of the project area;

- there are no movement corridors to the dam and soaks of the project area;

- the project area has a long history of disturbance through agricultural grazing and mining impacts;

- targeted surveys failed to detect the species during the breeding period; and

- alternative, more suitable habitats are available in adjacent areas and it is likely the species would use these areas (such as within the Farrells Creek corridor and tributaries) rather than the project area.

iii Microchiropteran bats

a. Microchiropteran bats that forage over open areas: Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) and Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)

The Eastern Bentwing Bat, Eastern False Pipistrelle and Yellow-bellied Sheathtail Bat are listed as vulnerable species under the TSC Act.

The Eastern Bentwing Bat roosts primarily in caves, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. They form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. The species hunts in forested areas, catching moths and other flying insects above the tree tops.

The Eastern False Pipistrelle prefers moist habitats, with trees taller than 20 m. It generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. It hunts beetles, moths, weevils and other flying insects above or just below the tree canopy.

The Yellow-bellied Sheathtail Bat Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, the species flies high and fast over the forest canopy, but lower in more open country. It forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.

Threats to the species include:

- damage to or disturbance of roosting caves or trees, particularly during winter or breeding;
- loss of trees for foraging and roosting habitat;
- application of pesticides in or adjacent to foraging areas; and
- predation by feral cats and foxes.

The Eastern Bentwing Bat and Eastern False Pipistrelle were recorded in remnant vegetation adjacent to the project area. The project area contains approximately 50 ha of foraging habitat for these species. Roosting habitat is absent from the project area. It is likely that these species roost to the north of the project area in the remnant woodland.

This Yellow-bellied Sheathtail Bat was not recorded during field investigations. As above, while the project area contains potential foraging habitat, potential roosting habitat is absent from the project area and can be found in the remnant vegetation to the north of the project area.

1. *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

These microbat species breed in caves (Eastern Bentwing Bat) and tree hollows (Eastern False Pipistrelle and Yellow-bellied Sheathtail Bat) (Churchill 2008). Potential roosting and breeding sites are present in the remnant woodland to the north of the project area. No hollow-bearing trees or caves will be removed or disturbed as part of the project. Therefore, no direct impacts are expected to the breeding success of these species as a result of the proposed action.

Indirect impacts to breeding habitat including noise and vibration during construction of the dam would be temporary, and unlikely to affect the breeding success of these species within and surrounding the project area.

Therefore the proposed action is unlikely to have an adverse effect on the life cycle of the species such that viable local populations would be placed at risk of extinction.

2. *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

Not applicable to a species.

3. *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

   a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

   b) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

Not applicable to a species.

4. *In relation to the habitat of a threatened species, population or ecological community:*

   a) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

   b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;

   c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Approximately 50 ha of vegetation constituting potential foraging habitat for the Eastern Bentwing Bat and Eastern False Pipistrelle, and Yellow-bellied Sheathtail Bat will be removed as a result of the proposal.

The removal of habitat from the project area is not expected to isolate or fragment habitat for these mobile species, as it is located on the edge of remnant woodland.

This project area is not considered to be important foraging habitat for these species given the large areas of remnant woodland to the north of the project area, and on either side of Lemington Road. The remnant woodland areas would contain a greater variety and abundance of prey items for these microchiropteran species and as such the loss of habitat from the project area is not considered critical to the long-term survival of the species in the locality.

5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

Critical habitat has not been declared for these microbat species.

6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and*

These microbat species do not currently have recovery plans. High priority recovery actions identified by OEH (2012) include monitoring of breeding success, research roosting ecology, and retain large hollow-bearing trees. The project is not inconsistent with these recovery actions.

7. *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The project does not constitute, and is unlikely to exacerbate, any of the KTPs listed under the TSC Act.

Conclusion:

The proposed action is not expected to significantly impact these microbat species because:

- there is no breeding or roosting habitat within the project area;
- alternative foraging habitat is available in adjacent areas; and
- the habitat to be removed is not unique for these species within the locality; and
- the proposal will not isolate habitat for these species.

b. Southern Myotis (*Myotis macropus*)

The Southern Myotis is listed as a vulnerable species under the TSC Act. It generally roosts in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. The species forages over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December.

Threats to the species include:

- loss or disturbance of roosting sites;
- clearing adjacent to foraging areas;
- application of pesticides in or adjacent to foraging areas; and
- reduction in stream water quality affecting food resources.

The Southern Myotis was not recorded during field investigations. However it has previously been recorded to the north of the project area. Potential foraging habitat is present in a large dam to the north-west of the project area. Potential roosting habitat is present in remnant woodland to the north of the project area.

1. *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The Southern Myotis breeds in caves and tree hollows (Churchill 2008). Potential roosting and breeding sites are present in remnant woodland to the north of the project area. No hollow-bearing trees or caves will be removed or disturbed as part of the proposed modification. Therefore, no direct impacts are expected to the life cycle of the species.

Indirect impacts to breeding habitat including noise and vibration during construction of the dam are considered temporary and unlikely to affect the breeding success of the species in areas adjacent to the project area.

2. *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

Not applicable to a species.

3. *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

   a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

   b) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

Not applicable to a species.

4. *In relation to the habitat of a threatened species, population or ecological community:*

   a) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

   b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;

   c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

One large dam to the north-west of the project area containing potential foraging habitat for the Southern Myotis may be indirectly impacted by the project. Although unlikely due to sediment and erosion controls, the proposed action has the potential to cause sedimentation of the dam, a decrease in water quality and therefore a decrease in the quality of potential foraging habitat for the Southern Myotis.

The project is not expected to isolate or fragment habitat for this mobile species, as no habitat will be removed and appropriate safeguards will be implemented to minimise the risk of habitat degradation.

The potential foraging habitat would be considered to be of low importance to the long-term survival of the species within the locality, given the availability of other similar habitat within proximity to the project area, and within the wider locality.

5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

Critical habitat has not been declared for the Southern Myotis.

6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and*

The Southern Myotis does not currently have a recovery plan. Recovery actions identified for the species by OEH (2012) include research into their ecology, habitat requirements and distribution. The Southern Myotis is identified in the *Action Plan for Australian Bats* (Environment Australia 1999). Recommended recovery actions focus on research into habitat requirements, population dynamics, threatening processes and sensitivity to changes in water quality.

The project does not interfere with these recovery actions.

7. *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The project does not constitute, and is unlikely to exacerbate, any of the KTPs listed under the TSC Act.

Conclusion:

The proposed action is not expected to significantly impact the Myotis because:

- there is no breeding or roosting habitat within the project area;
- alternative foraging habitat is available in adjacent areas; and
- the habitat to be removed is not unique for this species within the locality; and
- the proposal will not isolate habitat for this species.

C.2 EPBC Act Assessment of significance – Green and Golden Bell Frog

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

a) lead to a long-term decrease in the size of an important population of a species

b) reduce the area of occupancy of an important population

c) fragment an existing important population into two or more populations

d) adversely affect habitat critical to the survival of a species

e) disrupt the breeding cycle of an important population

f) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

g) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

h) introduce disease that may cause the species to decline, or

i) interfere substantially with the recovery of the species.

The Green and Golden Bell Frog is listed as a vulnerable species under the EPBC Act. Potential habitat for the species exists within the large dams to the north-west of the project area (see Figure 3.1).

With regard to the points identified above;

a) It is considered unlikely that the project would lead to a long-term decrease in the size of an important population of the species because:

- individuals are not known from sites in proximity to the project area (Travers 2012);
- there are no identifiable movement corridors to the habitat of the project area;
- the project area provides potential habitat that is not considered optimal; and
- surveys during the breeding season did not detect the species at the project area.

b) The project could result in indirect impacts to potential breeding sites. However, these will be controlled through the construction period and there are other suitable habitats in adjacent areas (such as within the Farrells Creek corridor) where frogs could breed, from which they are currently absent. Therefore, the proposed action will not reduce the overall area of occupancy available for the species within the locality or Upper Hunter region.

c) The location of the project area is such that its removal would not result in the isolation or fragmentation of an existing important population into two or more populations.

d) The project area is considered to provide suboptimal habitat and is not considered to be habitat critical to the survival of the species. No critical habitat has been identified for the Green and Golden Bell Frog.

e) Surveys for the species in the breeding period were undertaken to detect the species use of the area. The species was not detected within or adjacent to the project area and therefore the proposed modification is unlikely to disrupt the breeding cycle of an important population.

f) The action is considered unlikely to lead to the species decline because:

- other suitable habitats exist within adjacent areas;
- the species has not been recorded in proximity to the project area (Travers 2012) or within the project area; and
- mitigation and management measures to protect the potential habitat in the north-west of the site, and in the minor amendment of the development boundary encompassing Cumnock void 3, are included as part of the proposed action.
- a minor amendment to the HVO North development boundary to encompass Cumnock void 3.
-

g) The proposed action will not result in additional invasive species being introduced to the area. Specific weed management and pest animal management protocols will form part of the works.

h) There will be no opportunity for the introduction of disease that affects the Green and Golden Bell Frog, as part of the proposed action.

i) The proposed action will be undertaken within a site that is not considered to provide preferred or suitable habitat for the Green and Golden Bell Frog. The removal of this habitat is not expected to interfere substantially with the recovery of the species or the ongoing viability of the Upper Hunter key population.

Conclusion

The project is unlikely to significantly impact the Green and Golden Bell Frog because:

- alternative and more suitable habitats are available in proximity to the project area;
- it is unlikely to lead to a long-term decrease in the size of the local population;
- it is unlikely to reduce the area of occupancy of the local population; and
- it will not fragment or isolate any known populations or individuals.

A referral to the DSEWPC for impacts to the Green and Golden Bell Frog is not considered necessary.

SYDNEY
Ground floor, Suite 1, 20 Chandos Street
St Leonards, New South Wales, 2065
T 02 9493 9500   F 02 9493 9599

NEWCASTLE
Level 1, 6 Bolton Street
Newcastle, New South Wales, 2300
T 02 4927 0506   F 02 4926 1312

BRISBANE
Suite 1, Level 4, 87 Wickham Terrace
Spring Hill, Queensland, 4000
T 07 3839 1800   F 07 3839 1866

APPENDIX F

Noise study

3 June 2013

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

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

www.emgamm.com

Luke Stewart / Andrew Wiltshire
EMGA Mitchell McLennan Pty Limited
Ground Floor, Suite 1
20 Chandos Street
St Leonards NSW 2065

Re: Noise study for Hunter Valley Operations North - Fine Reject Emplacement

1 Introduction

EMGA Mitchell McLennan Pty Limited (EMM) has been engaged by Rio Tinto Coal Australia to prepare a noise study for the proposed modifications to the Hunter Valley Operations North (HVO North) mining operations.

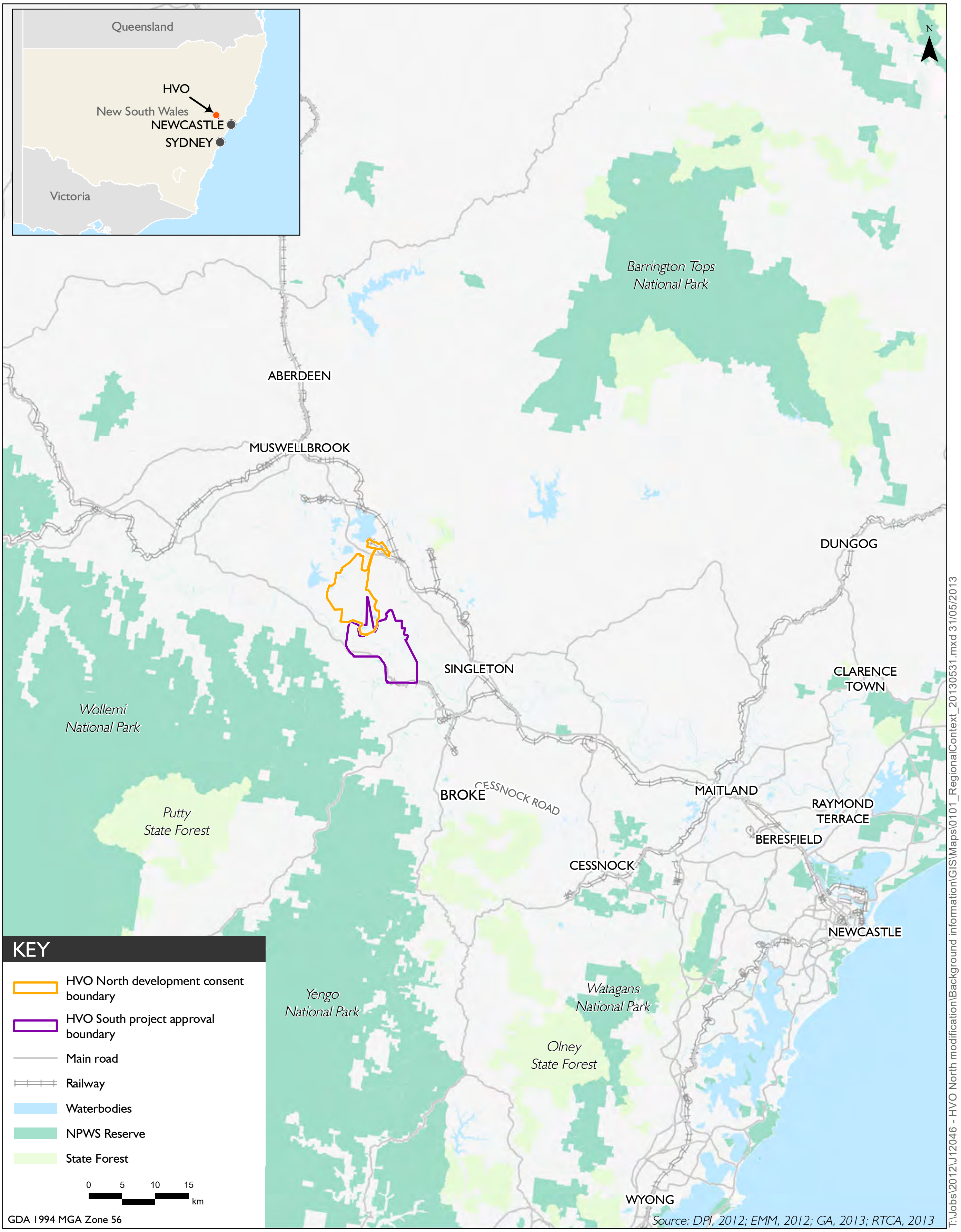
HVO North currently operates under Development Consent No. DA 450-10-2003 (DA 450-10-2003), which was issued by the then Minister for Infrastructure and Planning in 2004, under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The proposed modifications to DA 450-10-2003, referred to collectively as the HVO North Modification – Fine reject emplacement, are described in the Section 1.2. This study provides a quantitative assessment of potential noise impacts from the proposed modifications.

1.1 Background

The HVO mining complex is located approximately 24 kilometres (km) north-west of Singleton, New South Wales (NSW) (Figure 1.1). The site comprises the active Carrington, North, West and Mitchell Pits and related mining activities and infrastructure such as overburden emplacement areas. Within the HVO North complex, there are two coal preparation plants (CPP) operating; the Hunter Valley CPP and Howick CPP. Run-of-mine (ROM) coal from active pits is trucked via internal haul roads to either of the CPPs for processing.

Coarse reject from HVO North can be hauled between any pit, CPP and emplacement within HVO, as required, on existing private haul roads. Similarly, fine rejects are approved to be pumped from any CPP to any tailings storage facility within HVO, as required. There are various tailings storage emplacements located across HVO. These are in different stages of development including rehabilitated, closed, drying and active. Active tailings emplacements located within HVO North are located in North Pit (North Pit Void Tailings Dam) and West Pit (Bob's Dump Tailings Dam). These emplacements are nearing capacity. Additional tailings capacity has recently become available with the construction of Dam 6W in April 2012, however, this will only provide a limited amount of capacity for the Hunter Valley and Howick CPPs.



EMM

Regional context

HVO North - Fine reject emplacement modification

Figure 1.1

1.2 Proposed modification

The proposed modification comprises two main elements, namely:

- the construction and operation of a fine reject emplacement to the north of the existing Carrington Pit; and
- fine reject emplacement in the Cumnock void 3, located to the north-east of West Pit, via pipelines from HVO North CPPs.

A minor amendment to the HVO North development consent boundary to encompass Cumnock void 3 is also proposed.

The 'project area' comprises the fine reject emplacement and areas of associated disturbance, including pipelines (see Figure 1.2).

The fine reject emplacement will occupy an area of approximately 161ha and will be on land that has been previously mined and cleared of remnant native vegetation. The emplacement will have a life of approximately five years and would be completed within the existing development consent period which is currently 2025.

The Cumnock void 3 is located outside of the HVO North development consent boundary and within a mining lease held by the Cumnock Joint Venture. Fine reject emplacement in Cumnock void 3 will utilise about 25 per cent of the void's emplacement capacity in accordance with an agreement between Coal & Allied and the Cumnock Joint Venture. Tailings emplacement within the void was assessed in the *Ravensworth Operations Project Environmental Assessment* prepared by Umwelt 2010 and approved under Project Approval DA 09_0176.

Fine reject will be transported to the emplacement via an overland pipeline adjacent to existing haul roads on previously disturbed land direct from the Hunter Valley CPPs. No substantial vegetation disturbance will be required for the construction of the overland pipelines.

1.3 Existing environment

The land use surrounding the project area is predominately characterised by large-scale open-cut coal mining operations, including HVO South and Wambo to the south and Ravensworth Operations to the east. Other notable features include the Plashett Reservoir to the west, Lake Liddell and the Bayswater Power Station to the north.

The closest privately owned residences to the proposed modification are located within the village of Jerrys Plains and along the Golden Highway approximately 4km to the south-west. The existing ambient noise environment at these properties is typical of rural residential locations, with influence from agricultural activities, road traffic noise, existing mining noise and natural sounds.

Coal and Allied operates an extensive network of real time noise monitoring equipment in and around HVO North, which provides data on existing noise levels in the local area. This network of real time noise monitors is supported by quarterly attended noise monitoring. Real time noise monitor and attended noise monitoring locations are provided in Figure 1.2**.** Latest results from real time noise monitors and attended noise monitoring can be found in the 2012 Annual Environmental Management Report (AEMR) for the site.

1.4 Representative receptors

A total of ten privately owned and one mine owned (Wambo Mine) residences (ie receptors) were considered representative of assessable locations surrounding the project area. These receptors were assessed in the *West Pit Extension and Minor Modifications EIS* (ERM 2003) and the *Carrington West Wing EA* (EMM 2010) and are contained within Table 1 and shown on Figure 1.2. The receptor number convention has been kept consistent with DA 450-10-2003.

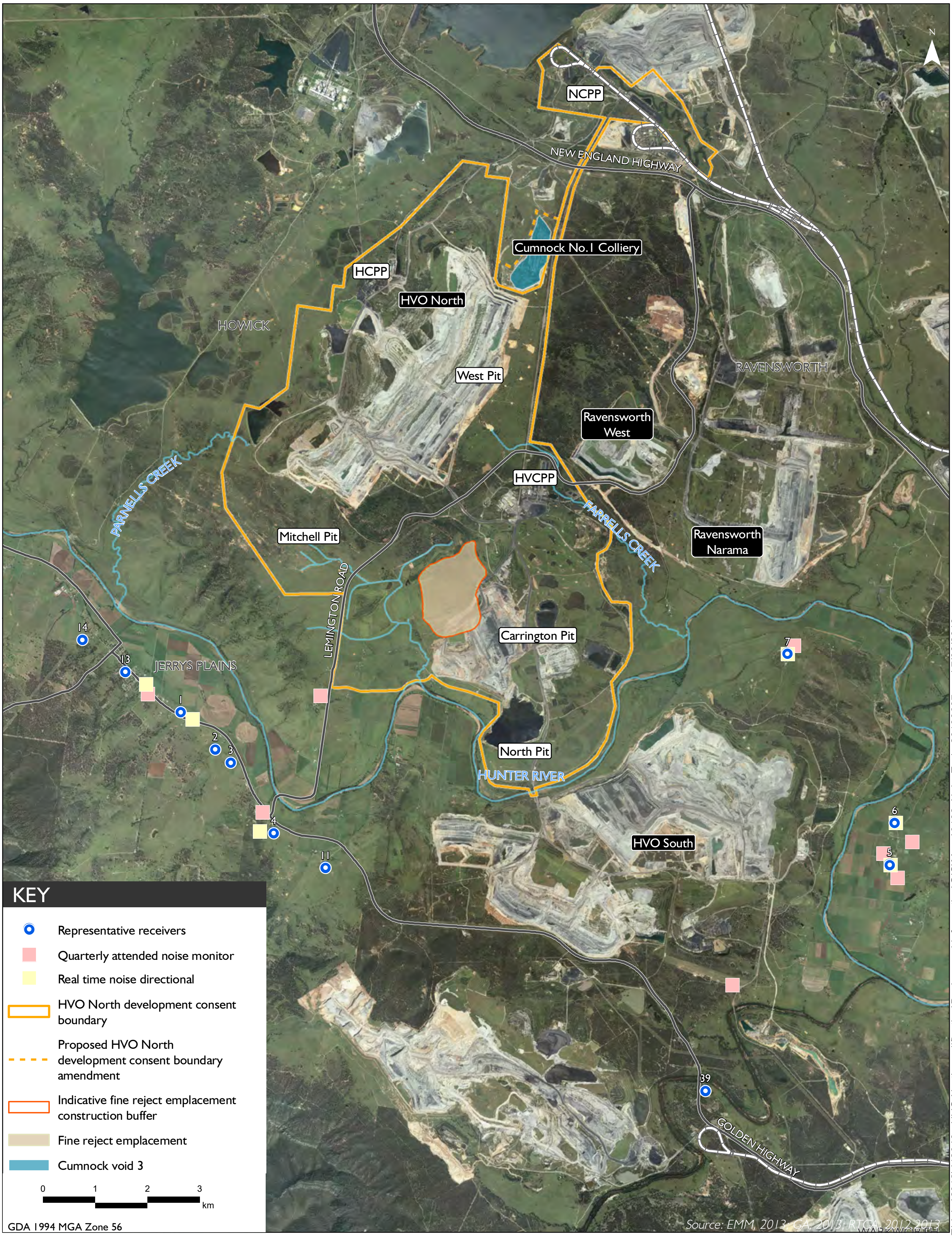
Table 1 Surrounding representative receptors used for modelling purposes

Receptors		**MGA coordinates**		**Direction from Tailings Emplacement**
No.	**Property Owner**	**Easting**	**Northing**	**Compass Point**
1	Hayes (Jerrys Plains closest residence)	304370	6402057	SW
2	Skinner	305031	6401340	SW
3	Gee	305309	6401091	SW
4	Muller	306145	6399742	SW
5	Bowman	317920	6399141	SE
6	Moxey	318008	6399952	SE
7[1]	Stapleton	315949	6403170	E
11[2]	Wambo Owned	307123	6399079	S
13[3]	Jerrys Plains Centre	303294	6402832	WSW
14[3]	Jerrys Plains North	302484	6403431	WSW
39[3]	Warkworth Village Representative	314396	6394821	SSE

Notes: *1. This private residence is currently in a zone of affectation or subject to a private land holder agreement with a mine other than HVO.*

2. Mined owned.

3. Privately owned receptors and representative of other privately owned receptors in the area.



T:\Jobs\2012\J12046 - HVO North modification\GIS\Maps\0102_NoiseTech_20130607.mxd 7/06/2013

EMM
EMGA Mitchell McLennan

Noise monitoring network and representative receivers

HVO North - Fine reject emplacement modification

Figure 1.2

1.5 Acoustic glossary

A number of technical terms used in this report. These are explained in Table 2.

Table 2 Acoustic glossary

Term	Definition
ABL	Assessment Background Level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{90} statistical noise levels.
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
L_1	The noise level exceeded for 1% of a measurement period.
L_{10}	A noise level which is exceeded 10% of the time. It is approximately equivalent to the average of maximum noise levels.
L_{90}	Commonly referred to as the background noise. This is the level exceeded 90% of the time.
Leq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
Lmax	The maximum root mean squared (RMS) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABLs.
sigma-theta (σ_θ)	The standard deviation of horizontal wind fluctuation.
Sound power level	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment.
Temperature inversion	A positive temperature gradient. A meteorological condition where atmospheric temperature increases with altitude to some height.

The following indicates what an average person perceives about noise levels in practice:

- noise differences of less than approximately 2dB are generally imperceptible; and
- a difference of around 10dB is perceived as a doubling or halving of loudness.

2 Noise limits

Schedule 4 Condition 7 of DA 450-10-2003 prescribes the HVO North noise limits. These are reproduced in Table 3 below and are based on the Industrial Noise Policy (INP) (Environmental Protection Authority, 2000) approach to the development of project specific criteria. The INP provides criteria for the control industrial noise sources and activities in New South Wales and has two key objectives:

1. Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term; and

2. Maintaining noise level amenity for particular land uses for residents and sensitive receivers in other land uses.

Table 3 Development consent noise limits

Day/Evening/Night $L_{Aeq(15\ minute)}$	Night $L_{A1(1\ minute)}$	Property number
40	46	4 – (from year 1 to year 7)
36	46	4 – (from year 8 to year 21)
40	46	Jerrys Plains Village –residence locations 13 and 14 (years 20 and 21)
39	46	2, 3, 11, 19, 31, 36, 54
38	46	1,18, 51 and 52 (from year 1 to year 19)
40	46	1, 18, 51 and 52 (years 20 and 21)
35	46	All other residential or sensitive receptors, excluding the receptors listed above.

2.1 Land acquisition criteria

Schedule 4 Condition 8 of DA 450-10-2003 relates to land acquisition criteria and is reproduced below.

"If the noise generated by the development exceeds the criteria provided in Table 2.2 (Table 4), the Applicant shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in conditions 9-11 of schedule 5 of the consent."

Table 4 Land acquisition criteria

Day/Evening/Night ($L_{Aeq(15\ minute)}$)	Property number
43	11
42	7
41	1,2,3,4,5,6,13,14 and 39

3 Assessment method

Construction of the new fine reject emplacement will involve trucks transporting waste material to develop the bunding walls that would otherwise be hauled and emplaced at alternative waste dump locations. A dozer and a grader will be used to develop waste material into the final fine reject emplacement formation. Such activity would be temporary in nature, however, in-line with industry practice, the activity has been assessed together with mining operations using INP operational noise limits contained in the DA 450-10-2003.

The operational phase of this modification will not involve additional acoustically significant plant and equipment and noise levels from the site will not be perceptible when compared to the approved operations.

Cumnock void 3 is an existing void and requires no substantial construction works to enable the emplacement of fine reject from HVO North. Further, no discernible noise will be generated by this activity. Therefore, this element of the proposed modification has not been considered further in this study.

3.1 Meteorological conditions

Under various wind and temperature gradient conditions, noise levels may increase or decrease compared with calm conditions, ie zero wind and negligible temperature gradient. This is due to refraction of sound propagating through the atmosphere, brought about by a change in sound speed with height. Sound levels increase when the wind blows from source to receiver or under temperature inversion conditions and decrease when the wind blows from receiver to source or under temperature lapse conditions.

The INP sets out recommended procedures to assess noise under a range of meteorological conditions. These conditions were determined in the *West Pit Extension and Minor Modifications Environmental Impact Statement*, ERM 2003 and have been further used in this assessment as summarised in Table 5**.**

Table 5 Assessable INP Wind Conditions

Wind (Origin) Direction	Upper 10% Night Wind Speed, m/s
E	1.8
ESE	2.3
SE	2.6
SSE	2.7
S	2.5
SSW	2.1
SW	1.5

'F' class temperature inversions, which have been identified in previous studies to be a feature of the area, have also been included in noise predictions.

3.2 Plant and equipment noise levels

Typical plant and equipment used to construct the fine reject emplacement together with corresponding sound power levels and quantities used in modelling are listed in Table 6. These are indicative and are based on measurements obtained from equipment at the existing operation. These are consistent with those adopted for the *West Pit Extension and Minor Modifications EIS* (ERM, 2003) and *Carrington West Wing EA* (EMM, 2010).

Table 6 Plant and equipment noise levels

Typical item	Number assessed	Representative $L_{eq,15minute}$ sound power level, dB(A)
Haul truck (with noise attenuation)	3	114
Dozer	1	116
Grader	1	113
Light plant	1	104

3.3 Calculation procedures

Consistent with previous studies, the noise levels from the site were predicted at nearest receptors using Environmental Noise Model (ENM) software. The model takes into account distance, ground effects, atmospheric absorption and topographic detail. The software package is accepted by NSW Environmental Protection Authority (EPA).

The intent is to generally use equipment associated with Carrington West Wing operation to construct the fine reject emplacement. However, in order to allow for worst-case scenarios and to provide a conservative assessment approach, plant and equipment associated with fine reject emplacement construction have been modelled separately as additional plant items and incrementally added to past modelling results for HVO North (ie current approved and proposed Carrington West Wing operations).

Three-dimensional digitised ground contours for the surrounding land and mine plans was incorporated into the model. The contours reflect the Year 8 mine plan as assessed in *West Pit Extension and Minor Modifications EIS* (ERM, 2003) and Year 1 in the *Carrington West Wing EA* (EMM, 2010). These years were selected to directly compare predicted fine reject emplacement construction noise levels to previous worst case predictions for current approved and proposed HVO North operations.

Contours of the fine reject emplacement were superimposed on surrounding base topography. Construction equipment was placed at various locations and heights which were chosen to represent worst case operating locations, relative to the nearest privately-owned residential receptors.

Calculations were performed using calm and prevailing (ie winds and temperature inversions) weather scenarios. As fine reject emplacement construction is to occur 24 hours the night-time period becomes most critical due to the presence of prevailing weather conditions. Therefore, in accordance with previous studies, a night time air temperature and relative humidity of 10°C and 80 per cent were assigned respectively in conjunction with calm and identified prevailing weather conditions.

The noise model predicts L_{eq} noise levels based on equipment sound power levels determined from measurements conducted at West Pit. The results assume all modelled plant and equipment operate simultaneously. In practice, such an operating scenario would be unlikely to occur. The results are therefore considered conservative.

4 Results and discussion

4.1 Results

Table 7 summarises noise modelling results for calm and worst prevailing weather conditions from the fine reject emplacement construction in combination with the most representative previous noise predictions for HVO North operations.

Table 7 Noise predictions – $L_{eq,15minute}$, dB(A)

Receptor No.	Mining - Carrington and West Pit (Mitigated)[1]		Tailings emplacement construction		Combined mining and tailings emplacement construction		Consent limits	
	Calm	Prevailing	Calm	Prevailing	Calm	Prevailing	D/E/N[2]	Acquisition
1	20	38	< 20	29	20	39	38-40	>41
2	21	37	< 20	30	21	38	39	>41
3	23	37	< 20	30	23	38	39	>41
4	30	38	23	30	31	39	36-40	>41
5	21	30	< 20	20	21	30	35	>41
6	20	28	< 20	< 20	20	29	35	>41
7	30	38	20	25	30	38	36-40	>42
11	31	38	29	30	33	39	39	>43
13	14	41	< 20	27	15	41	40	>41
14	12	41	< 20	26	13	41	40	>41
39	16	31	< 20	< 20	17	31	35	>41

Notes: *1. Year 1 scenario from the Carrington West Wing EA and includes noise levels from Carrington pit, Carrington West Wing pit extension and West pit*

2. D/E/N = Day/Evening/Night

The predicted incremental noise from the construction of the fine reject emplacement is well below the consent limits.

Once combined with previous noise predictions there is a minor increase (1 dB(A)) in noise levels at receptors 1 to 4, 6 and 11. The construction activity is proposed to occur over a relatively short timeframe and this study has been prepared to demonstrate the negligible impact that the construction of the fine reject emplacement has on overall mine noise levels.

In all cases the combined noise level is below the applicable acquisition criteria, and predictions at all receptors from the construction of the fine reject emplacement in isolation are greater than 10 dB(A) below the acquisition criteria. Therefore, the contribution cannot theoretically cause exceedance of the acquisition criteria as the addition of a noise level 10 dB below another, does not change the higher value. Overall, noise levels from the temporary construction of the fine reject emplacement in conjunction with whole site operation are not expected to cause an offsite noise impact and not considered a risk for the project.

4.2 Sleep disturbance

Transient noise sources, such as truck engines revving high and vehicle reversing alarms, have the potential for sleep disturbance to nearby residents. A single truck movement may also cause sleep disturbance, particularly if it is isolated from other mine-related noise.

Sleep disturbance impacts were assessed in the *Carrington West Wing EA* (EMM 2010) which found maximum noise level events from such activities to be below the noise limits. Plant and equipment associated with the fine reject emplacement construction will be distanced at least 1.5 km further from receptors in Jerrys Plains and along the Golden Highway (nearest receptors) in comparison to the assessed Carrington West Wing plant locations. Therefore, maximum noise levels from fine reject emplacement construction will be less than those presented in the *Carrington West Wing EA,* and accordingly, the DA 450-10-2003 noise limits.

5 Conclusion

EMM has prepared a quantitative noise assessment for the HVO North Modification - Tailings Emplacement project.

Construction of the fine reject emplacement will require waste truck transport, dozer and grader operation, for which the noise emission has been assessed. The intent is to generally use equipment associated with Carrington West Wing operations to construct the fine reject emplacement. However, in order to allow for worst-case scenarios and to provide a conservative assessment approach, plant and equipment associated with fine reject emplacement construction have been modelled separately as additional plant items and incrementally added to past modelling results for all current and proposed HVO North operations.

For representative receiver locations potentially most affected by HVO North, the assessment of the fine reject emplacement construction found that noise levels are likely to be negligible in comparison to current and potential future mining operations.

Sleep disturbance impacts from dozer and truck operation from the fine reject emplacement construction are also likely to be less than those predicted in previous studies and unlikely to cause sleep disturbance impacts at nearest receptors in Jerrys Plains and along the Golden Highway.

The operations phase of the project will not introduce any acoustically significant plant and equipment and there will be no increase in overall noise levels from the proposed modification.

Overall noise levels from the proposed modification will not be perceptible when compared to the approved operations.

Yours sincerely,

Daniel Weston

dweston@emgamm.com | D +61 (0)2 9493 9543 | M +61 (0)499 788 878
Reviewed by: N. Ishac

APPENDIX G

Air quality study

TODOROSKI AIR SCIENCES
Suite 2B, 14 Glen Street Eastwood,
NSW 2122
Phone: 02 9874 2123
Fax: 02 9874 2125
Email: info@airsciences.com.au
Web: www.airsciences.com.au
ACN: 151 202 765 | ABN: 74 955 076 914

06 June 2013

Andrew Wiltshire
EMGA Mitchell McLennan
VIA EMAIL: awiltshire@emgamm.com

RE: Air Quality Study for Hunter Valley Operations North - Fine Reject Emplacement

Dear Andrew,

Todoroski Air Sciences (TAS) has completed an air quality study for the proposed modifications to the Hunter Valley Operations North (HVO North) mining operations.

HVO North currently operates under Development Consent No. DA 450-10-2003, which was issued by the then Minister for Infrastructure, Planning and Natural Resources in 2004, under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The proposed modifications to DA 450-10-2003, referred to collectively as the HVO North Modification – Fine Reject Emplacement, are described in more detail below.

The proposed modifications include a limited period of construction activity and ongoing pumping of wet fine reject. The proposed modifications are located on previously disturbed land, centrally within the existing operations and therefore would have limited capacity to influence air quality to any significant degree. Accordingly, this study provides a qualitative analysis of the potential dust emissions and associated impacts that may arise due to the proposed modifications.

Introduction

HVO North is comprised of four active mine pits; the Carrington, North, West and Mitchell Pits, and related mining activities and infrastructure. It is situated approximately 24 kilometres (km) northwest of Singleton and 4km northeast of Jerrys Plains in the Hunter Valley Region of NSW. Within the HVO North complex there are two coal preparation plants (CPP) operating; the Hunter Valley CPP and Howick CPP. ROM coal from active pits is trucked via internal haul roads to either of the CPP for processing (refer to Figure 1).

Coarse reject material and fine reject from HVO North may be hauled between any pit, CPP and reject emplacement within HVO as required. Various fine reject storage emplacements are located across HVO. These emplacements are in different stages of development including rehabilitated, closed and drying and active. Active fine reject emplacements are currently located in North Pit (North Pit Void Tailings Dam) and West Pit (Bob's Dump Tailings Dam). These emplacements are nearing capacity and additional emplacement capacity has recently become available with the construction of Dam 6W in April 2012; however, this would only provide a limited additional capacity that is insufficient for the operations of the Hunter Valley CPP and Howick CPP.

The land use surrounding the proposed modification is predominately characterised by large-scale open-cut coal mining operations, including HVO South and Wambo to the south and Ravensworth Operations to the east. Other notable features include the Plashett Reservoir to the west, Lake Liddell and the Bayswater Power Station to the north. The closest privately owned residences to the proposed modification are located within the village of Jerrys Plains and along the Golden Highway approximately 4km to the southwest.

Figure 2 presents a representative three-dimensional visualisation of the terrain in the general vicinity of the Project area. Hilly terrain characterises the topography to the northeast, northwest and southwest. To the southeast the terrain is generally open and gently undulating towards the lower Hunter Valley area. A large ridge line is located to the southwest between the proposed modification and the village of Jerrys Plains and would provide protection against potential adverse environmental impacts originating from the proposed modifications.

Proposed Modification

The proposed modification comprises three elements, namely:

- the construction and operation of a fine reject emplacement to the north of the existing Carrington Pit;
- fine reject emplacement in the Cumnock void 3, located to the northeast of West Pit, via pipelines from HVO North CPPs; and,
- a minor amendment to the HVO North development consent boundary to encompass the Cumnock void 3 to accommodate the modifications.

The 'Project area' comprises the fine reject emplacement and areas of associated disturbance, including fine reject pipelines (see Figure 1).

The fine reject emplacement will occupy an area of approximately 161ha and will be on land that has been previously mined and cleared of remnant native vegetation. The emplacement will have a life of approximately six years and would be completed within the existing development consent period which is currently 2025.

The Cumnock void 3 is located outside of the HVO North development consent boundary and within a mining lease held by the Cumnock Joint Venture. Fine reject emplacement originating from Coal & Allied will utilise about 25 per cent of the Cumnock void's emplacement capacity. The emplacement within the void was assessed in the *Ravensworth Operations Project Environmental Assessment* prepared by Umwelt (**Umwelt, 2010**) and approved under Project Approval DA 09_0176.

Fine reject will be transported to the emplacement via an overland pipeline adjacent to existing haul roads on previously disturbed land direct from the Hunter Valley CPPs. No substantial vegetation disturbance will be required for the construction of the overland pipelines.

Local Meteorology

Long-term climate data collected at the nearest Bureau of Meteorology (BOM) station, Jerrys Plains Post Office (Station Number 061086), are summarised in Table 1 and Figure 3. These data assist in characterising the local climatic conditions near the Project area based on the long-term meteorological parameters.

The climatic data indicate that on average, January is the hottest month of the year and July is the coldest month of the year with mean maximum and minimum temperatures of 31.7ºC and 3.8ºC.

Rainfall data show that January is the wettest month of the year and August the driest month with average falls of 76.7mm and 36.5mm respectively.

Mean 9am humidity levels range from 59% in October to 80% in June. Mean 3pm humidity levels range from 42% in October, November and December to 54% in June.

Mean 9am wind speeds range from 8.6km/h in April to 11.7km/h in September. Mean 3pm wind speeds range from 11.0km/h in May to 14.7km/h in September.

Table 1: Monthly climate statistics summary - Jerrys Plains Post Office

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean max. temperature (ºC)	31.7	30.9	28.9	25.3	21.3	18.0	17.4	19.4	22.9	26.2	29.1	31.2
Mean min. temperature (ºC)	17.2	17.1	15.0	11.0	7.4	5.3	3.8	4.4	7.0	10.3	13.2	15.7
Rainfall												
Rainfall (mm)	76.7	72.8	58.8	44.3	40.8	48.1	43.5	36.5	42.0	52.2	61.1	67.9
Mean No. of rain days (≥1mm)	6.5	6.0	5.8	4.9	4.9	5.5	5.2	5.2	5.2	5.9	6.2	6.4
9am conditions												
Mean temperature (ºC)	23.4	22.7	21.2	18.0	13.6	10.6	9.4	11.4	15.3	19.0	21.1	23.0
Mean relative humidity (%)	67	72	72	72	77	80	78	71	65	59	60	61
Mean wind speed (km/h)	9.6	9.0	8.8	8.6	9.0	9.4	10.6	11.0	11.7	10.9	10.5	9.9
3pm conditions												
Mean temperature (ºC)	29.8	28.9	27.2	24.1	20.1	17.1	16.4	18.2	21.2	24.2	26.9	29.0
Mean relative humidity (%)	47	50	49	49	52	54	51	45	43	42	42	42
Mean wind speed (km/h)	13.2	13.0	12.4	11.3	11.0	11.5	13.0	14.3	14.7	14.1	14.2	14.2

Source: **Bureau of Meteorology, 2012**

Meteorological data are collected at two automatic weather stations situated within the HVO mining complex; the HVO weather station and the Cheshunt weather station. The location of these stations is shown in Figure 1. Data collected between the periods of 2009 to 2011 have been analysed and windroses generated from these data are presented in Figure 4 to 9.

On an annual basis, the meteorological data from the HVO weather station typically show winds from the west and east-southeast. During summer, winds from the east-southeast are predominant in the 2009 and 2011 data, during 2010 winds from the south-southeast was predominant. The wind field trends in the autumn and spring seasons in 2009 and 2010 are a combination of the annual and summer trends for the respective years, the 2011 data show a similar wind distribution pattern to the annual windrose in these seasons. In winter, winds from the west dominate the wind distribution.

The annually prevailing Cheshunt weather station data are aligned on a northwest and southwest/south-southeast axis which is typical of the Hunter Valley region. The Cheshunt weather station shows similar trends to the HVO weather station, other than there is a north westerly component rather than westerly component, and also a south easterly wind component rather than east south easterly component. Very little to no winds originate from the northeast and southwest axis. During summer, winds are predominantly from the south-southeast and southeast with few winds originating from the northeast. During winter, this pattern is reversed with the majority of winds occurring from the northwest. The seasons of autumn and spring have a fairly similar wind distribution to the annual windrose with varying levels of wind frequency.

These wind patterns indicate the proposed modifications are not likely to be a significant issue for the nearby sensitive receptors located in the village of Jerrys Plains and along the Golden Highway. This is because the receptors are not located downwind of any dominant prevailing wind direction relative to the Project area.

Local air quality

The main sources of particulate matter in the wider area of the proposed modification include active mining, agricultural activities, emissions from local anthropogenic activities such as motor vehicle exhaust and domestic wood heaters and various other industrial activities.

The air quality monitors reviewed in this study include three Tapered Element Oscillating Microbalances (TEOMs) operated by HVO and two TEOMs operated by the New South Wales Office of Environment and Heritage (NSW OEH), six High Volume Air Samplers (HVAS) measuring PM_{10}, and ten dust deposition gauges sited in locations surrounding the proposed modification. The location of these monitors is shown in Figure 1.

A summary of the results from the three TEOM monitoring stations operated by HVO, collected from January 2010 to December 2011 is presented in Table 2 and Figure 10. The data indicate that annual average PM_{10} levels recorded at these monitors are below the criterion of 30µg/m³, however the maximum recorded 24-hour average PM_{10} concentrations are above the 50µg/m³ criterion (see Figure 10).

The recorded levels above criteria at these monitors occurred on a number of days during the monitoring period, in particular during the spring and summer months. Mining activities from HVO North operations and other nearby mining operations would have contributed to the recorded dust levels.

Table 2: Summary of PM_{10} concentrations from HVO TEOM monitoring stations (µg/m³)

Year	Annual average				Maximum 24-hour average			
	Cheshunt East	Maison Dieu	Wandewoi	Criteria	Cheshunt East	Maison Dieu	Wandewoi	Criteria
2010	22	17	13	**30**	80	80	56	**50**
2011	19	19	13	**30**	66	70	40	**50**

A summary of the available data from the two TEOM monitoring stations operated by the NSW OEH, collected between April 2011 and July 2012 is presented in Table 3 and Figure 11. The monitoring results indicate that annual average PM_{10} levels from these monitors are below the criterion of 30µg/m³. The maximum 24-hour average PM_{10} concentrations recorded at the Maison Dieu TEOM monitor were above the 50µg/m³ criterion (see Figure 11); the Jerrys Plains TEOM did not record concentrations above the criterion during the monitoring period reviewed.

The recorded exceedances at the Maison Dieu monitor occurred predominantly during the 2011 period and would have been influenced by mining activities as well as contributions from other anthropogenic sources. Figure 11 indicates that during the 2012 period the levels appear lower.

Table 3: Summary of PM_{10} concentrations from OEH TEOM monitoring stations (µg/m³)

Year	Annual average			Maximum 24-hour average		
	Maison Dieu*	Jerrys Plains**	Criteria	Maison Dieu*	Jerrys Plains**	Criteria
2011	22	13	**30**	78	17	**50**
2012***	20	10	**30**	51	21	**50**

*Data available from March 2011
**Data available from December 2011
***Data available till July 2012

A summary of the data from the six PM_{10} HVAS monitoring stations collected between January 2006 and January 2012 is presented in Table 4 and Figure 12.

The data presented in Table 4 indicates that the annual average PM_{10} concentrations for each monitoring station were below the OEH criteria of 30µg/m³. The maximum 24-hour average PM_{10} concentrations recorded by the HVAS monitors were above the 50µg/m³ criterion on a number of occasions at all monitors.

It can be seen from Figure 12 that concentrations are nominally highest in the spring and summer months. This is attributed to the warmer weather leading to drier ground and elevating the amount of windblown dust, the occurrence of bushfires and also increased pollen levels which would contribute to the recorded levels.

Table 4: Summary of PM_{10} concentrations from HVAS monitoring (µg/m³)

Year	Annual average						
	Cheshunt East	Kilburnie South	Knodlers Lane	Long Point	Wandewoi	Jerrys Plains	Criteria
2006	24.8	17.0	-	-	17.9	14.7	30
2007	24.2	20.1	-	-	19.4	18.0	30
2008	21.5	14.7	-	-	16.6	15.8	30
2009	27.3	17.8	-	21.9	17.6	19.4	30
2010	19.1	18.9	-	14.8	13.4	14.0	30
2011	22.9	14.3	22.4	16.2	15.1	14.2	30
2012*	17.0	15.1	16.1	8.7	13.6	12.3	30
Year	**Maximum 24-hour average**						
	Cheshunt East	**Kilburnie South**	**Knodlers Lane**	**Long Point**	**Wandewoi**	**Jerrys Plains**	**Criteria**
2006	58.7	34.2	-	-	57.9	39.3	50
2007	71.2	48.8	-	-	45.7	45.5	50
2008	77.9	44.1	-	-	54.4	65.5	50
2009	78.1	58.4	-	54.7	48.3	53.0	50
2010	56.7	36.1	-	32.9	46.7	40.3	50
2011	107.0	36.0	74.7	55.6	42.0	36.0	50
2012*	38.0	34.0	28.0	16.0	32.0	29.0	50

*Data available till April 2012

Dust deposition levels in the vicinity of HVO are measured by a network of ten dust depositional gauges on private land. The location of each of these gauges is shown in Figure 1 and annual average dust deposition levels from 2007 to 2011 are presented in Table 5.

Field notes accompanying the monitoring data indicate that some of the samples were contaminated with materials such as bird droppings, insects or plant matter. This is a relatively common occurrence for this type of monitoring, and contaminated samples have been excluded from the reported annual average results.

The data in Table 5 indicate that all gauges recorded an annual average insoluble deposition level below the OEH criteria of 4g/m²/month and in general, the air quality in terms of dust deposition is considered good.

Table 5: Summary of dust deposition levels (g/m²/month)

Year	D110	D112	D118	D119	DL14	DL2	DL21	DL22	Knodlers Lane	Warkworth	Criteria
2007	1.9	1.7	1.6	1.4	3.2	1.8	1.4	2.2	1.5	-	4
2008	1.3	0.8	2.5	1.2	2.8	1.6	1.5	1.6	1.1	-	4
2009	2.1	2.0	2.0	2.0	2.8	2.7	2.8	2.9	2.3	-	4
2010	2.2	1.2	1.4	2.0	2.6	3.1	2.5	3.5	1.6	3.6	4
2011	2.0	1.5	1.4	2.7	2.4	2.9	2.4	2.5	1.3	3.1	4

Potential for Dust Emissions

The proposed modifications would involve the temporary disturbance of the areas immediately surrounding the fine reject emplacement to the north of the existing Carrington Pit with the construction of an embankment (see Figure 1). The construction activity is proposed to occur over a relatively short timeframe and would generally utilise existing equipment from the current on-site operations. Materials required for the construction of the embankment would be sourced from suitable material types generated during approved open cut mining operations.

The proposed embankment would require approximately 14.4Mbcm of material to construct. Potential dust emissions may be generated from loading, transport, emplacement and shaping operations during the construction phase of the embankment. In addition, windblown dust may be generated from the construction area during periods of high wind speeds.

In regard to potential dust emissions, the majority of the equipment required to construct the embankment is presently carrying out essentially the same activity on the site. It is intended that the equipment for construction would be re-directed from the existing activity to the embankment for a period of time. Therefore, there is generally no particular change in the activity on the site overall, other than some equipment being directed to the construction of an embankment. For this reason, it would be reasonable to assume that there would be limited if any increase in emissions from the site.

However, to consider a worst-case scenario, it has been assumed that additional plant equipment may be required to assist with the construction of the embankment. The timing of the proposed construction activity and the equipment availability would determine this requirement. The additional plant equipment that may be required to construct the embankment under this scenario would include three haul trucks, a grader and a bulldozer operating at 50 per cent capacity.

Therefore, it is necessary to assess in more detail the potential for impact that may arise due to the construction activity. This has been done by estimating the quantity of dust that may be generated by handling the total amount of material required for the construction, and comparing this with the quantity of dust generated by the surrounding HVO North mine activity. It is important to note that during construction, the majority of the equipment being used would have been redirected from mining activity, thus reducing mining dust and largely off-setting the additional construction dust.

The estimated dust emissions for all construction activity, based on the worst-case scenario, are presented in Table 6 and the corresponding emission factors from AP42 (**USEPA, 1985 and Updates**) that were applied to estimate the potential dust emissions are outlined below the table.

Table 6: Estimated annual TSP emission rate - worst-case scenario

Activity	TSP emissions (kg/year)
Excavator loading overburden material to haul trucks	52,547
Hauling to emplacement area	225,818
Emplacing overburden material	52,547
Dozer shaping overburden material	40,315
Grading	11,861
Total	**335,011**

Loading/Unloading overburden material

$$EF_{TSP} = k \times 0.0016 \times \left(\left(\frac{U}{2.2}\right)^{1.3} / \left(\frac{M}{2}\right)^{1.4}\right) kg/tonne$$

Where k = 0.74, U = wind speed (m/s), M = moisture content (%)

Hauling overburden material

$$EF_{TSP} = \left(\frac{0.4536}{1.6093} \times \left(\frac{s}{12}\right)^{0.7} \times 4.9 \times \left(M \times \frac{1.1023}{3}\right)^{0.45}\right) kg/VKT$$

Where S = silt content (%), M = average GVM of haul truck (tonnes)

Dozer activity

$$EF_{TSP} = \frac{2.6(s^{1.2})}{M^{1.3}}$$

Where S = silt content (%), M = moisture content (%)

Grading activity

$$EF_{TSP} = 0.0034(S)^{2.5}$$

Where S = mean vehicle speed (km/h)

When comparing the estimated construction dust emissions presented in Table 6 with the estimated total dust emission for the HVO North operations (**PAEHolmes, 2010**), it was found that the construction dust may equate to approximately 3 per cent of the dust emissions from the HVO North operations.

As the construction process would utilise overburden materials generated from the open cut operations that would simply be re-directed to the embankment rather than existing overburden emplacements, the majority of estimated dust emissions would already be accounted for in the approved operation. As such it is unlikely that the proposed modifications would produce any significant additional amount of dust from HVO North.

The proposed construction activity is centrally located within the HVO North operations and also the prevailing wind is not towards receptors. There would also be a reduction in mining dust during the proposed modification as the majority of the equipment used would be redirected from mining activity to construction activity (i.e. to a location further from receptors). It is reasonable therefore to conclude that it is unlikely that the proposed modification would cause any significant additional impact at any surrounding sensitive receptor locations.

The other component of the proposed modification involves the use of the Cumnock Void 3, which is an existing void and requires no substantial construction works to enable the emplacement of fine reject from HVO North. Therefore, there would not be any tangible additional emissions for this part of the proposed modification.

Overland pipelines will be used to deliver fine reject to the voids. The pipelines would generally be laid on top of previously disturbed land adjacent to existing haul roads. The dust emissions generated during this activity would be insignificant in comparison to the total dust burden of the operations.

The fine reject material deposited within the void would be wet and essentially would not produce dust emissions. Once construction activities on the fine reject emplacement is completed, it is not expected that there would be any tangible dust emissions from the proposed modification.

Conclusion

This report has assessed the potential additional effects on air quality from the proposed modification, relative to the current HVO North operations.

A review of the meteorological conditions indicates that given the prevailing winds, the Project area is favourably located relative to the nearest sensitive receptors, with little prevailing wind from the proposed modification location towards receptors

The dust generating activities associated with the proposed modifications are unlikely to generate any significant additional dust, as they mainly involve simple re-direction of the existing activity to the proposed project location.

In a practical sense this means that dust from existing "mining" activity nearer to receptors would slightly reduce (by approximately 3 per cent), and a similar amount of "construction" activity would instead occur centrally within the HVO North mining area, further away from receptors. As a worst case there may be a few additional plant items used in the construction, but these would only be a small fraction of the 3% total construction dust emissions (relative to existing dust emissions).

Therefore, it is reasonable to conclude that the proposed modification is unlikely to cause any significant additional impact at any surrounding sensitive receptor locations.

It is also noted that once the construction is complete, dust emissions from the operation of the fine reject emplacement would be minimal as the deposited material is wet. Therefore, the operation of the emplacement is unlikely to add to the dust level at any sensitive receptor locations.

Yours faithfully,

Todoroski Air Sciences

Aleks Todoroski   Philip Henschke

References

Bureau of Meteorology (2012)
Climate Averages Australia, Bureau of Meteorology website.
http://www.bom.gov.au/climate/averages

PAEHolmes (2010)
"Air Quality Impact Assessment Carrington West Wing", Prepared by PAEHolmes for EMGA Mitchell McLennan. August 2010.

Umwelt (2010)
"Ravensworth Operations Project Environmental Assessment", Prepared by Umwelt (Australia) Pty Limited on behalf of Ravensworth Operations Pty Limited, February 2010.

US EPA (1985 and updates)
"Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711. Note this reference is now a web-based document.

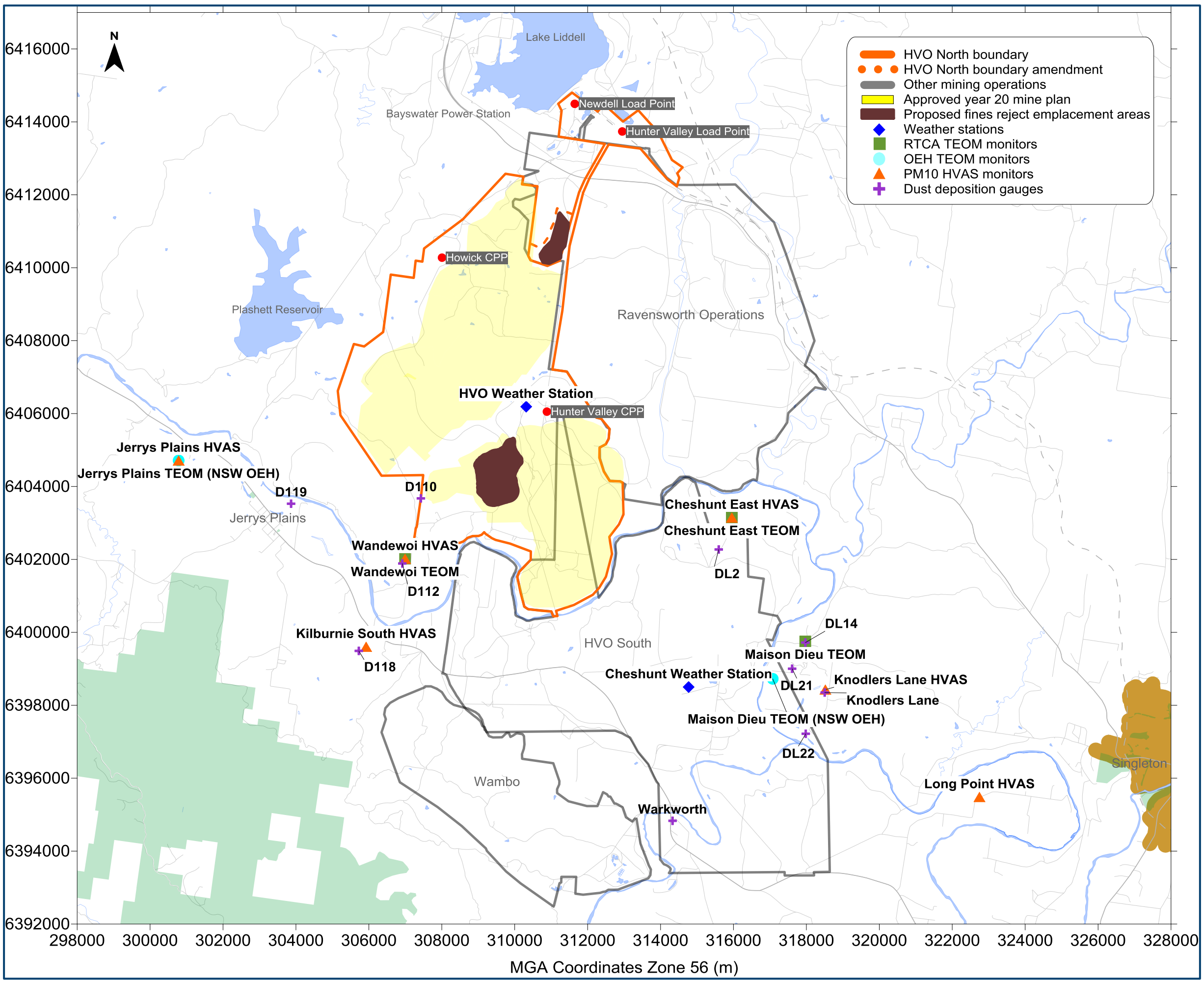


Figure 1: Project location and monitoring locations

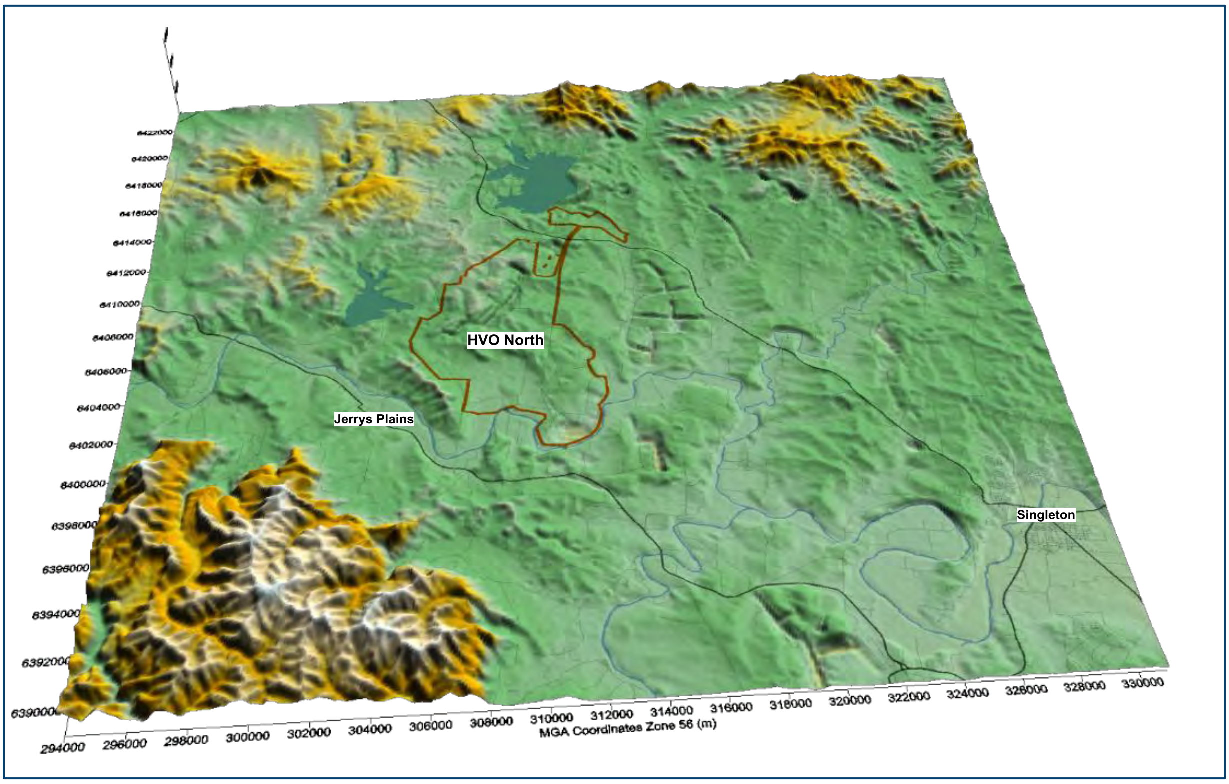


Figure 2: Representative three dimensional terrain view of Project location

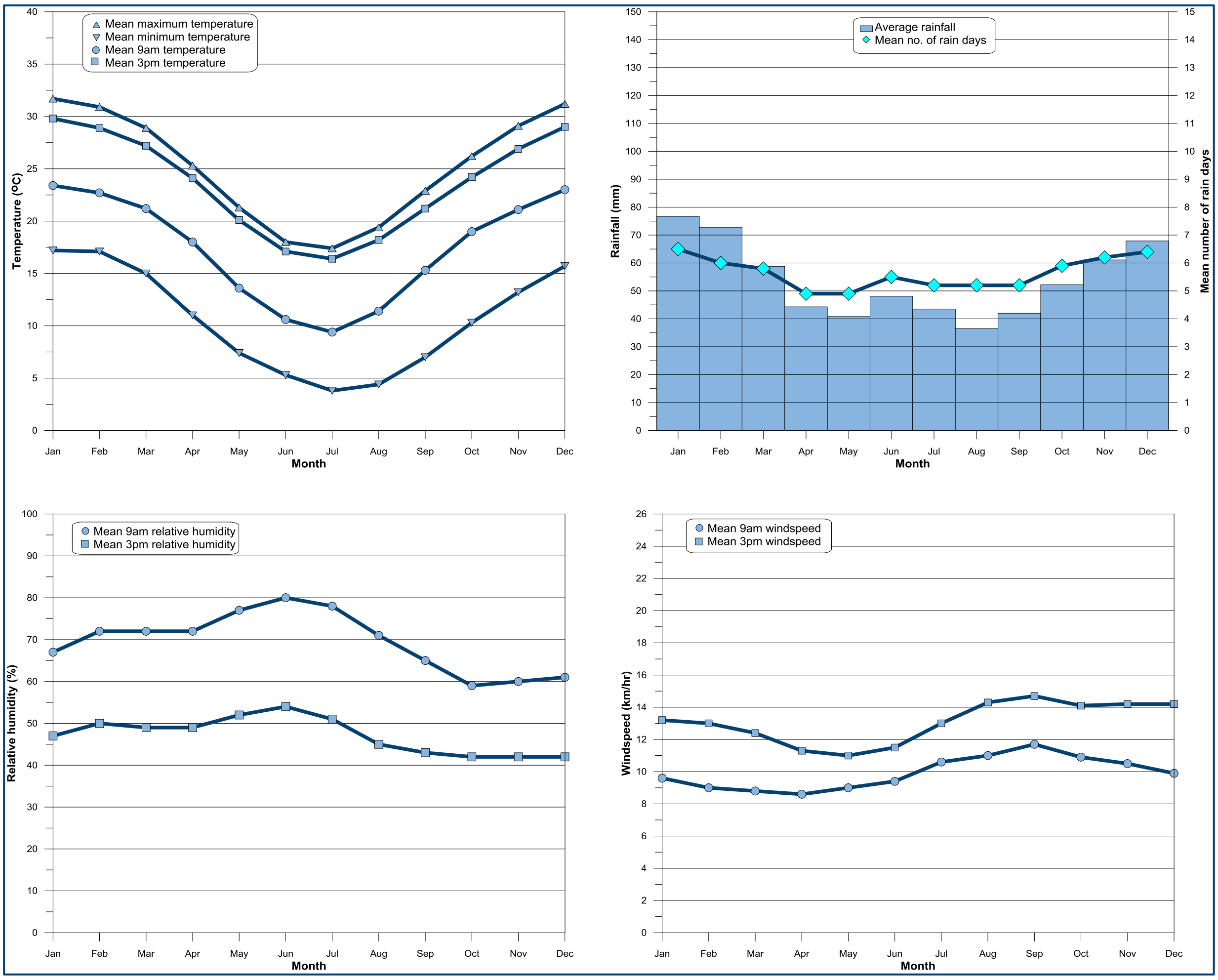


Figure 3: Monthly climate statistics summary - Jerrys Plains Post Office

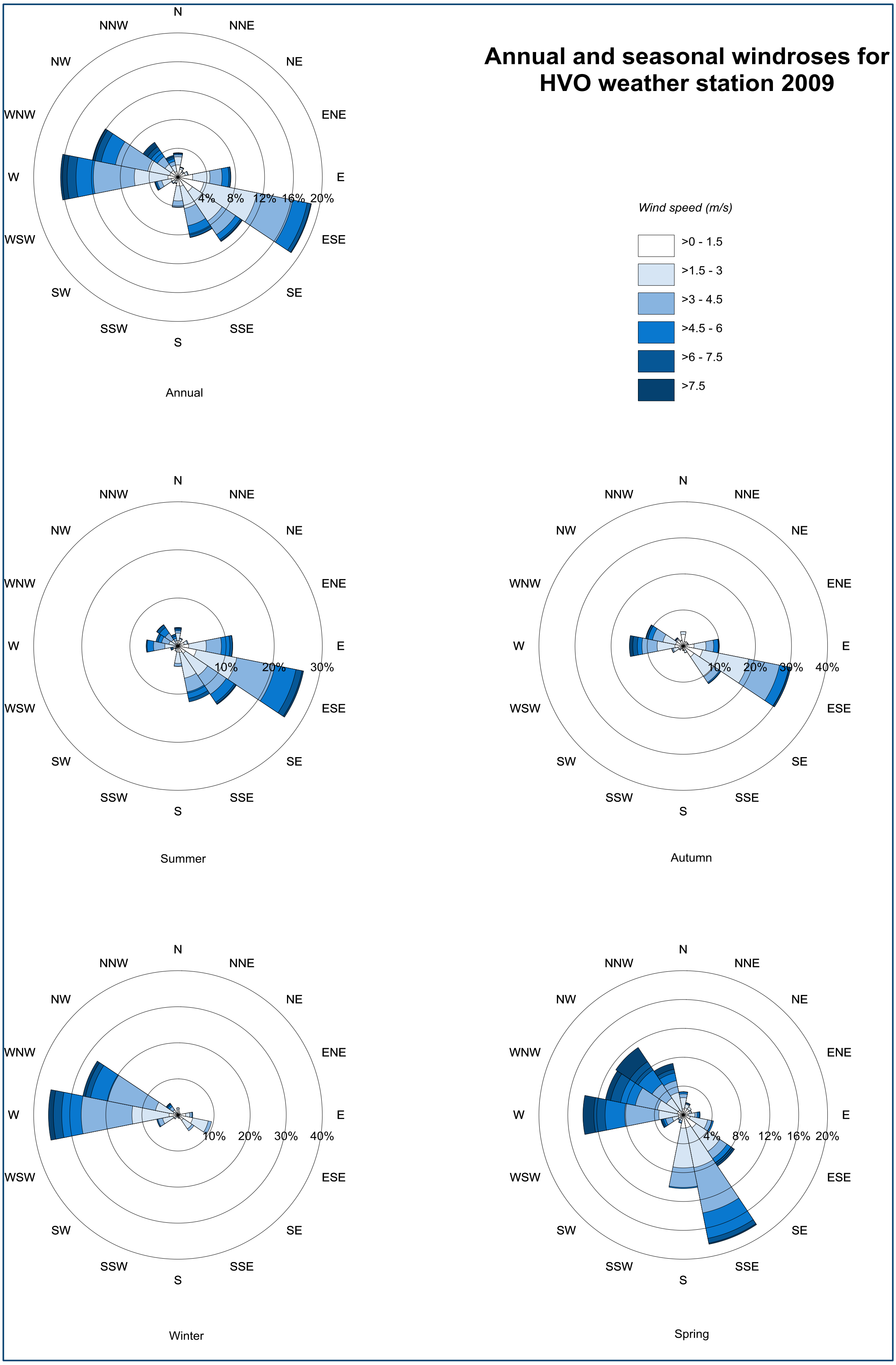


Figure 4: Annual and seasonal windroses - HVO weather station 2009

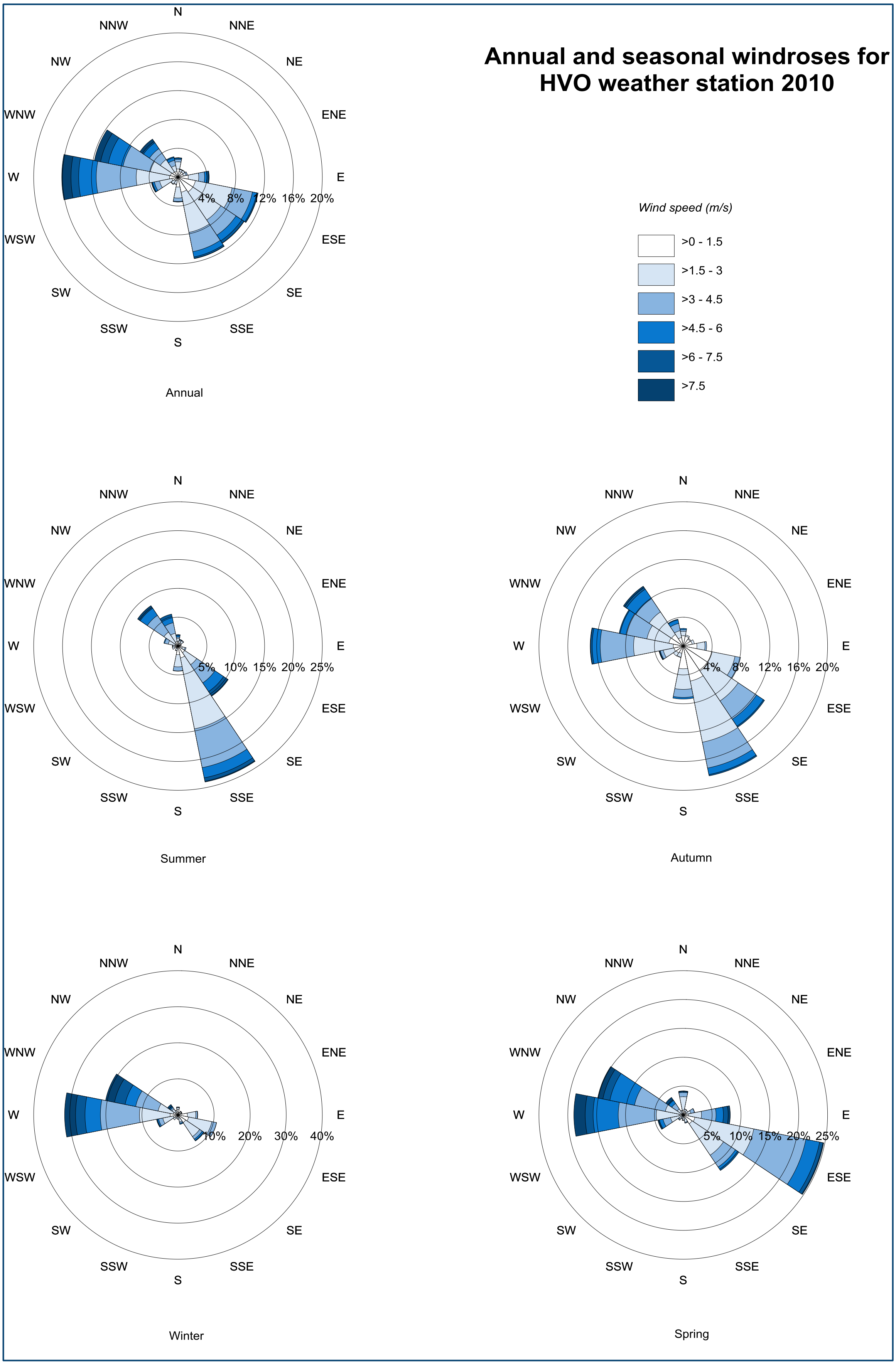


Figure 5: Annual and seasonal windroses - HVO weather station 2010

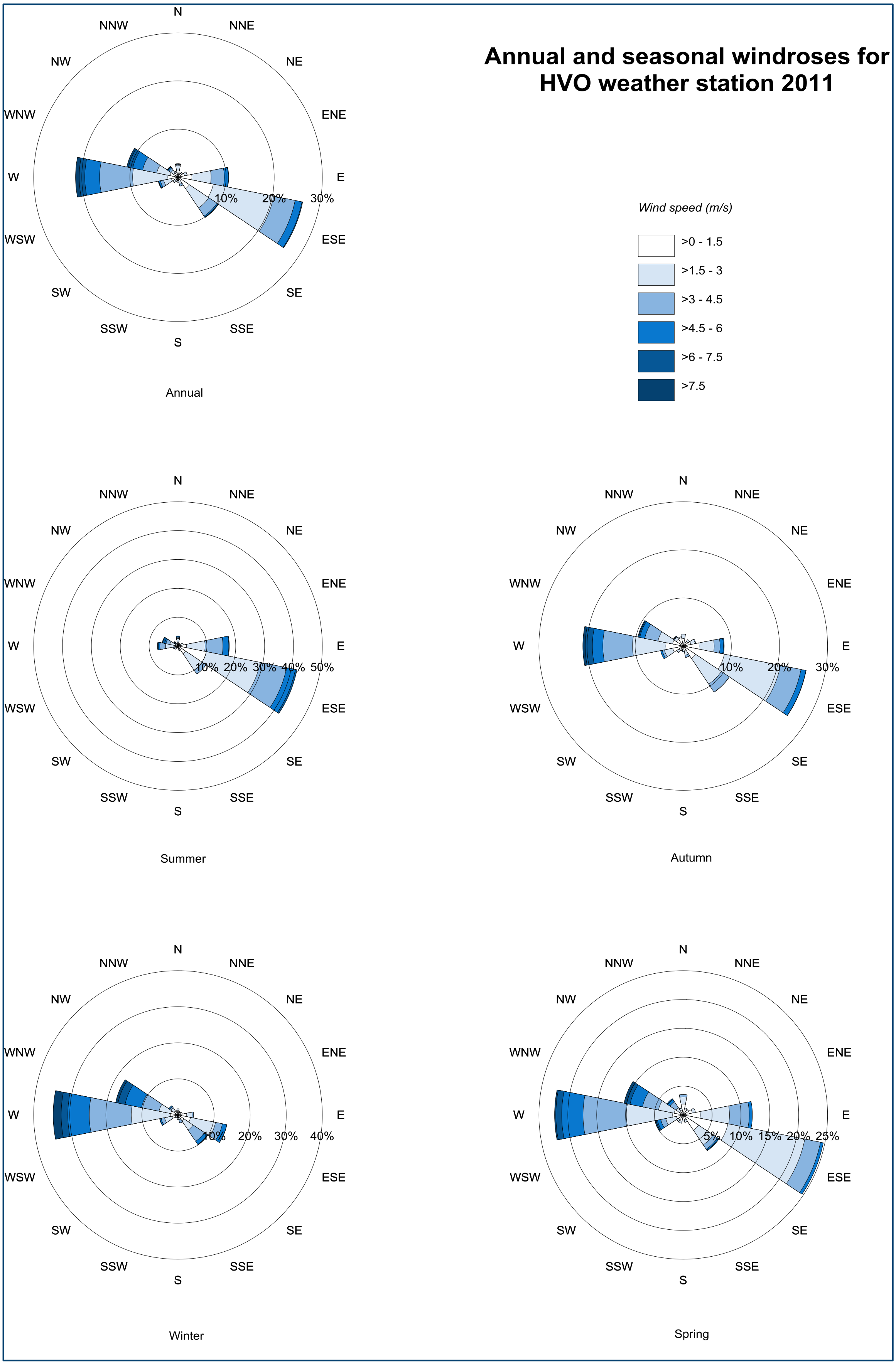


Figure 6: Annual and seasonal windroses - HVO weather station 2011

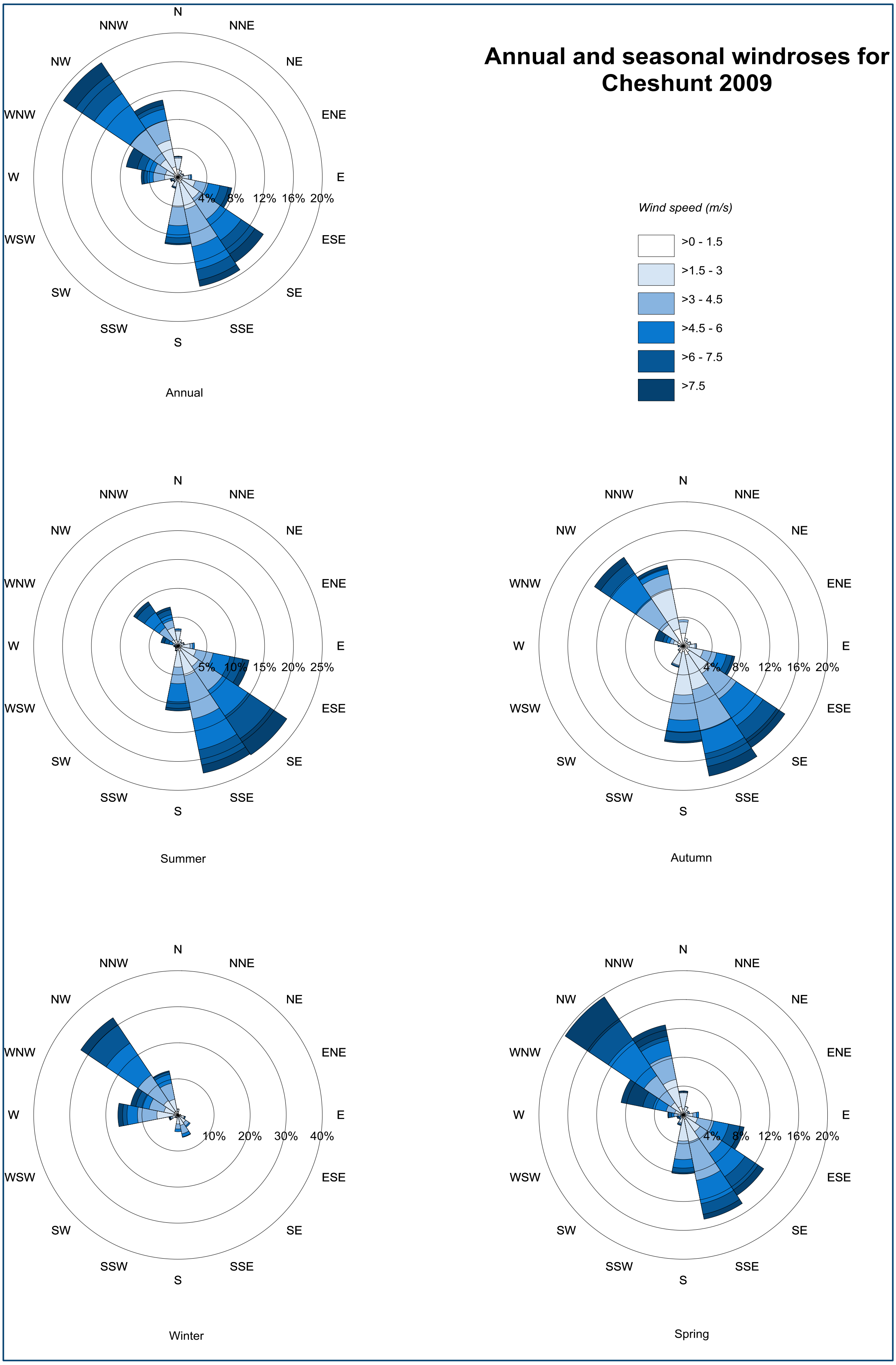


Figure 7: Annual and seasonal windroses - Cheshunt weather station 2009

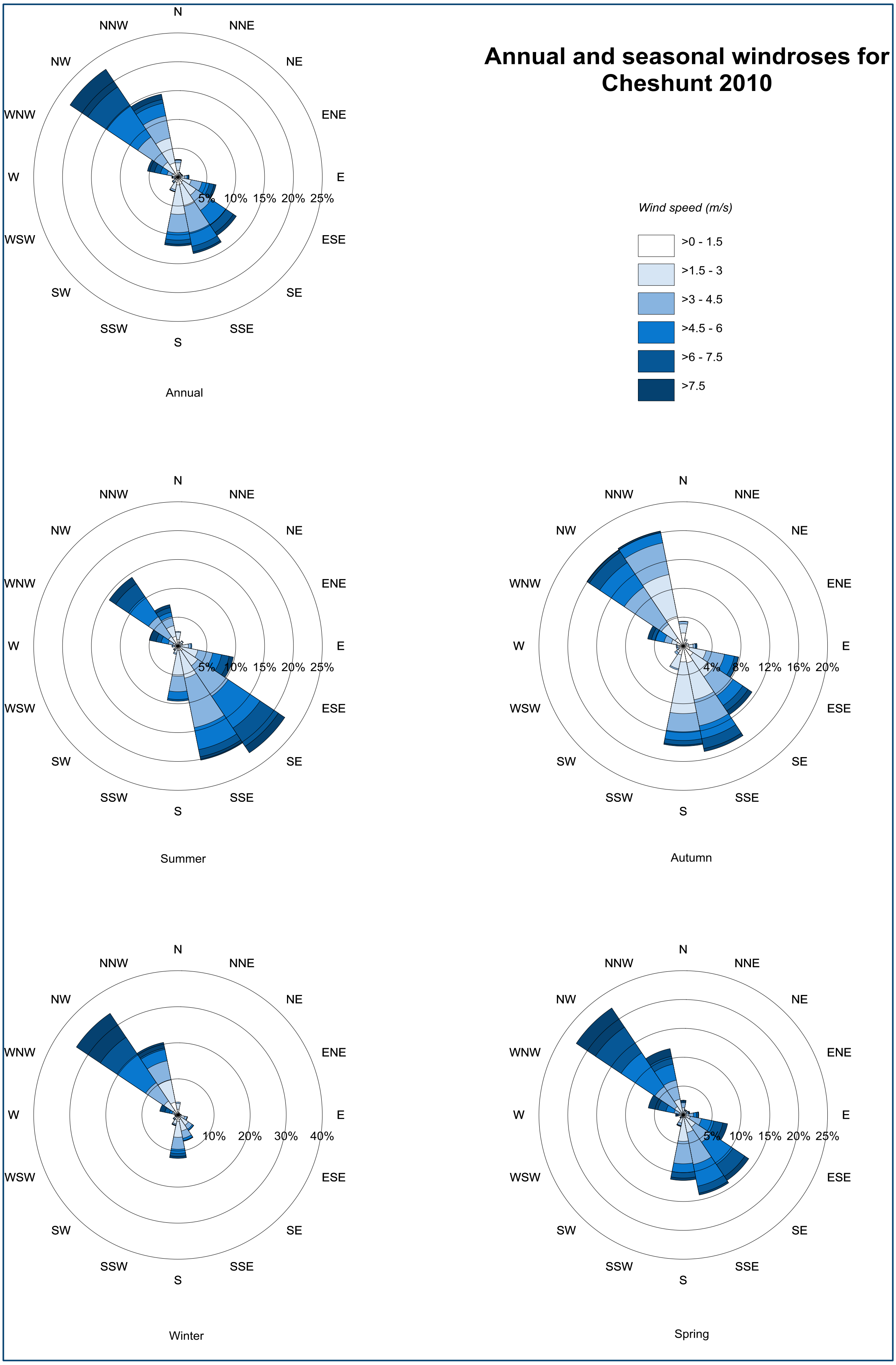


Figure 8: Annual and seasonal windroses - Cheshunt weather station 2010

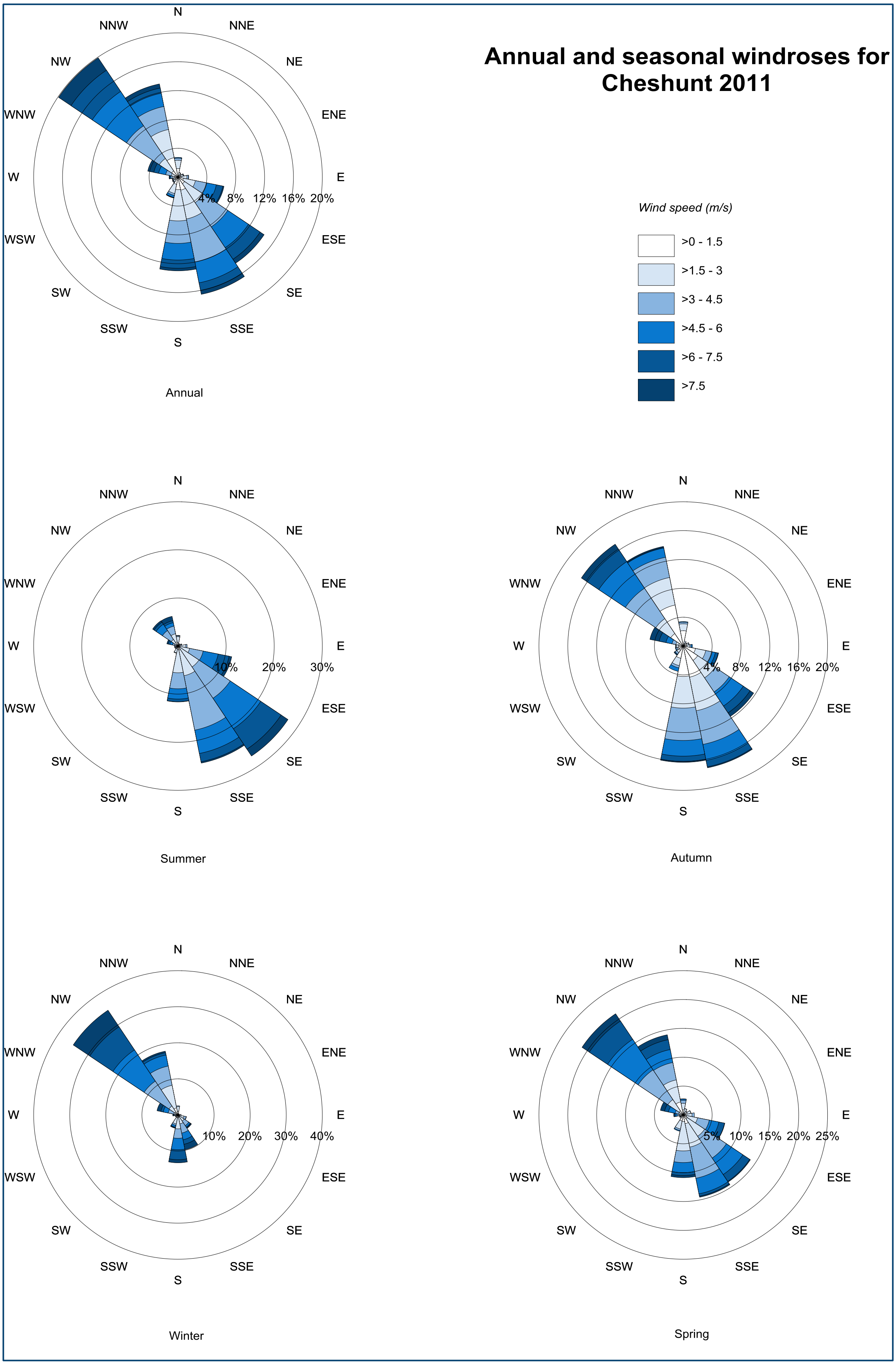


Figure 9: Annual and seasonal windroses - Cheshunt weather station 2011

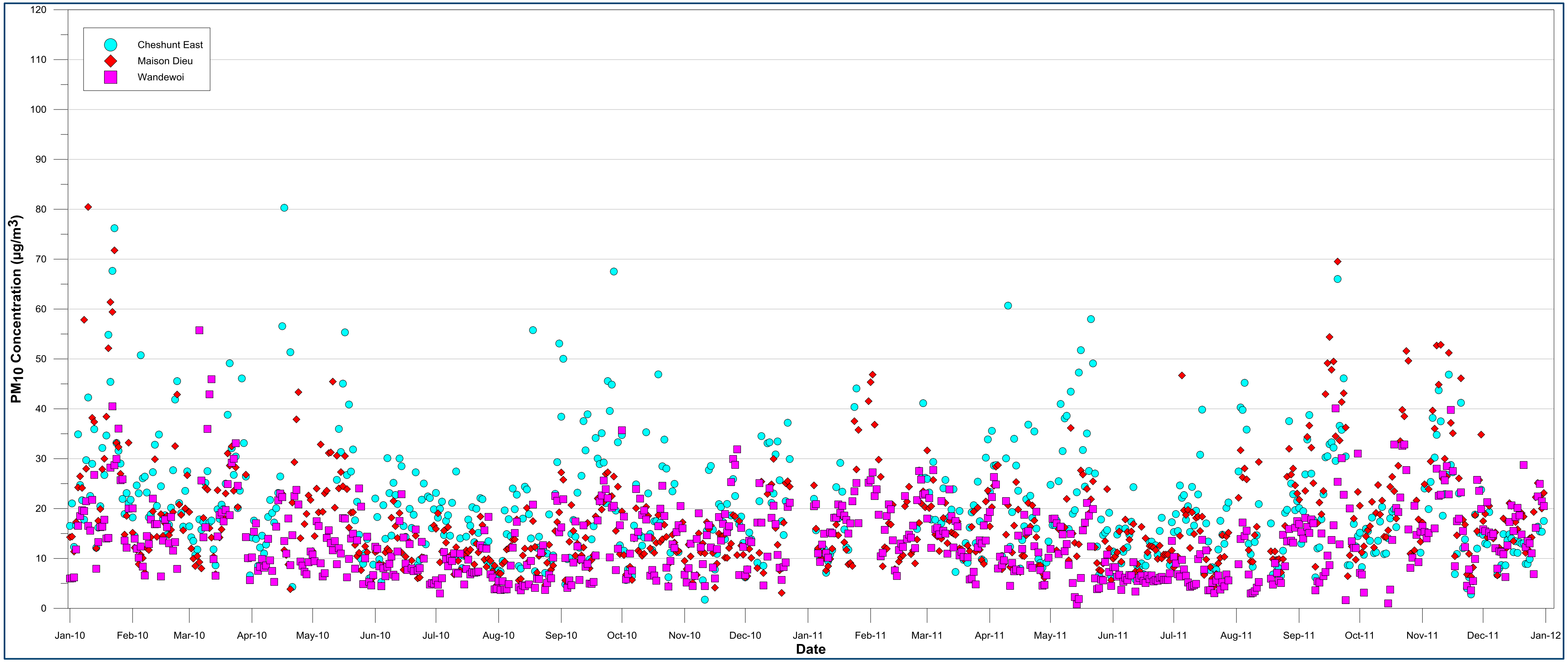


Figure 10: 24-hour average PM10 concentrations from TEOM monitoring

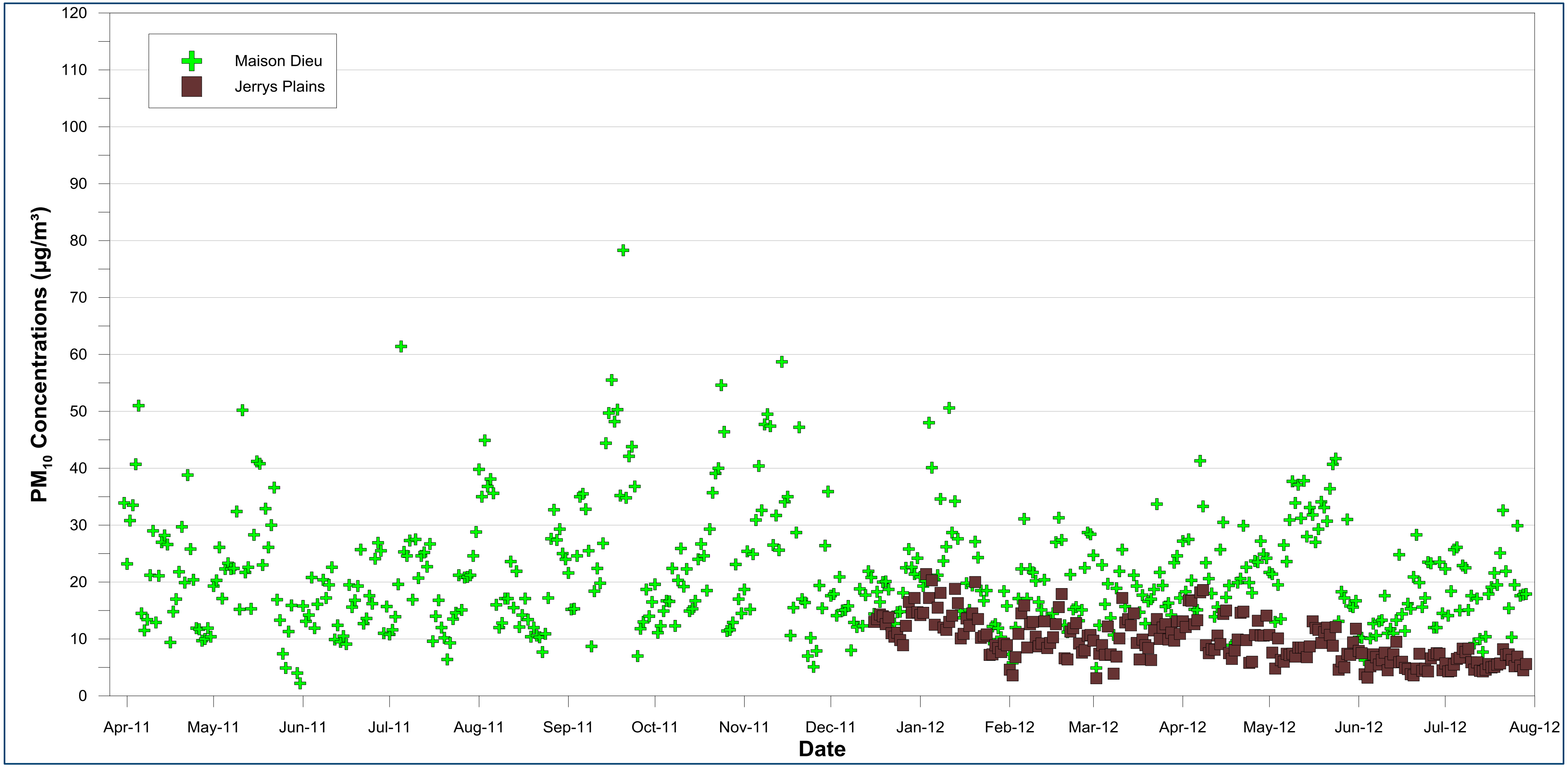


Figure 11: 24-hour average PM10 concentrations from OEH TEOM monitoring

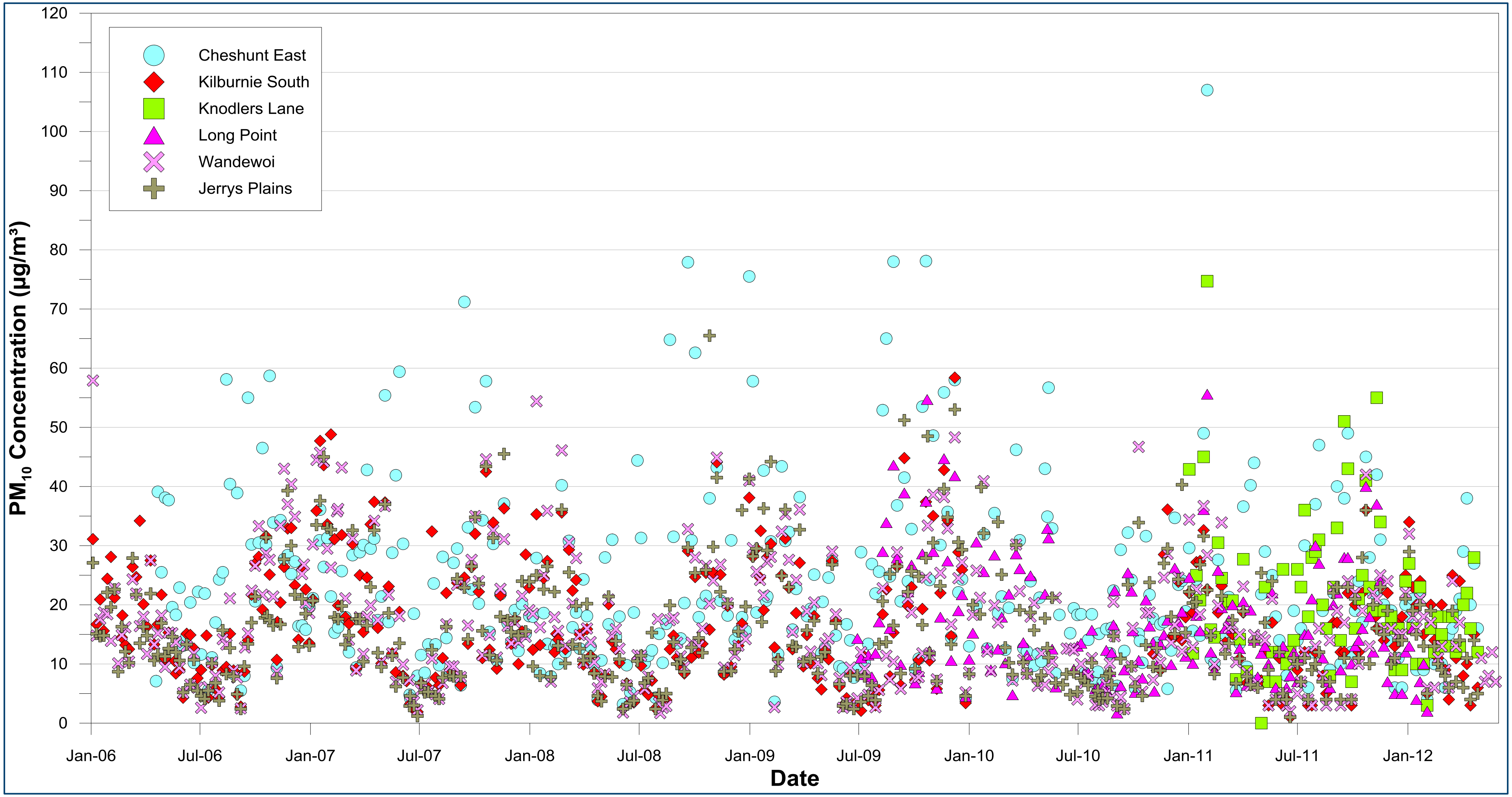


Figure 12: 24-hour average PM10 concentrations from HVAS monitoring

APPENDIX H

Soils and land capability assessment

EMM

EMGA Mitchell McLennan

HVO North

Fine Reject Emplacement Modification

Soil and Land Resource Assessment

March 2013

EMG00-010

GSS ENVIRONMENTAL

Environmental, Land and Project Management Consultants

GSS ENVIRONMENTAL
PO Box 907
Hamilton NSW 2303

Project Manager: **Clayton Richards**
B. Nat Res, Dip Ed, CPSS 2
Associate

Project Officer: **Rhys Worrall**
BSc (Hons)
Senior Environmental Scientist

Project Officer: **Matt Hemingway**
B Env Mgmt, CPSS 1
Environmental Scientist

Date of Issue: March 2013

GSSE Reference: EMG00-010

ISSUE AND AMENDMENT CONTROL HISTORY

Issue	Date	Description	Author	QA/QC
1	18/03/2013	Soil & Land Resource Assessment Draft 1	MH / RW	CR
2	25/03/2013	Soil & Land Resource Assessment Draft 2	RW	CR
3	2/04/2013	Soil & Land Resource Assessment Final	RW	CR

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Overview

GSS Environmental (GSSE) was commissioned by EMGA Mitchell McLennan Pty Limited (EMM) on behalf of Coal & Allied Operations Pty Limited (Coal & Allied) to undertake a Soil and Land Resource Assessment for the proposed HVO (Hunter Valley Operations) North - Fine reject emplacement modification (the proposed modification). This will form part of a modification to the existing relevant Development Consent No. DA 450-10-2003, which was issued by the then Minister for Infrastructure and Planning in 2004, under Part 4 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act).

HVO North is located in the Upper Hunter Valley of NSW, approximately 24 km north-west of Singleton, and approximately 4 km to the northeast of the village of Jerrys Plains (**Figure 1**). Mine planning has identified that capacity for fine reject within the HVO North complex is constrained and is likely to reach capacity in quarter one of 2015. Alternative storage is required by this date. The preferred option at this stage is the construction and operation of a fine reject emplacement to the north of the existing Carrington Pit, in conjunction with the limited 'in pit' reject disposal.

As such, the main components of the proposed modification are:

- the construction and operation of a fine reject emplacement to the north of the existing Carrington Pit;
- the emplacement of fine reject in the Cumnock void 3, located to the north east of the Carrington Pit; and
- a minor amendment to the development consent boundary to encompass Cumnock void, is proposed to accommodate the modification.

The proposed fine reject emplacement will occupy land predominantly cleared of native vegetation and which has already been largely disturbed by past mining operations (**Figure 2**). The proposed modification will provide an additional six years of capacity and therefore is critical to the viability of HVO North. Once filled, the emplacement will be capped with suitable material and the land rehabilitated.

1.2 Study Area

Approximately 161 ha proposed disturbance footprint for the fine reject emplacement area constitutes the Study Area for this Assessment (**Figure 2**). The proposed emplacement will be constructed to the north of the adjacent Carrington Pit. The Carrington Pit is a truck and shovel operation, approved to mine 10 million tonnes (Mt) of ROM coal per annum. The pit is well developed with areas of rehabilitation well established.

1.3 Assessment Objectives and Standards

The key objectives of this Assessment are listed below:

Objective 1 Classify and determine the soil profile types within the Study Area

To satisfy Objective 1, the soil taxonomic classification system used was the Australian Soil Classification (ASC) system (Isbell 1996).

Objective 2 Provide a description of the land capability within the Study Area

To satisfy Objective 2, the relevant guideline applied was the *Land and Soil Capability Assessment Scheme: Second approximation* (OEH, 2012a). This is the guideline recommended by the NSW Office of

Environment and Heritage (OEH) and supersedes the former NSW Rural Land Capability Classification (Emery 1986).

Objective 3 Provide a description of the agricultural land suitability within the Study Area

To satisfy Objective 3 of, the relevant guideline applied was the *Agricultural Suitability Maps – Uses and Limitations* (NSW Agriculture & Fisheries 1990). This is the guideline approved by the Department of Primary Industries (DPI). Biophysical Strategic Agricultural Land (BSAL) was assessed against two standards - the *Strategic Regional Land Use Plan for the Upper Hunter* (DP&I 2012) and the *Interim Protocol for Site verification and mapping of biophysical strategic agricultural land* (OEH 2012b)

Objective 4 Provide selective topsoil and subsoil management recommendations

To satisfy Objective 4, the Guide for Selection of Topdressing Material for Rehabilitation of Disturbed Areas (Elliot and Reynolds 2007, derived from Elliot and Veness 1981) was utilised to determine which soil types in the Study Area are suitable for conserving and reuse during site rehabilitation. The approach described in this guideline remains the benchmark for land resource assessment in the Australian mining industry.

Objective 5 Provide recommendations to mitigate soil erosion and sedimentation associated with the works or soil stockpiles

To satisfy Objective 5, the Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2E Mines and Quarries (DECC 2008) were used as a basis for recommendations of soil erosion and sedimentation mitigation associated with the proposed works.

To be printed A4

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

HVO North Fine Reject Emplacement Modification
Regional Locality

FIGURE 1

V:\EMG00-010\Figures\CAD\Current\CAD\Fg1_EMG00-010_Regional Locality_130605.dwg

To be printed A4

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

HVO North Fine Reject Emplacement Modification
Study Area

FIGURE 2

V:\EMG00-010\Figures\CAD\Current\CAD\Fg2_EMG00-010_Study Area_130605.dwg

2.0 EXISTING ENVIRONMENT

2.1 Climate

The Study Area is located in the Hunter region of NSW, typically having a cool temperate climate with moderately dry winters and wetter summers. The annual average rainfall is 644.5 mm with the peak rainfall season being the summer months of December to February (Jerrys Plains Post Office BOM station No. 061086, 2012, BOM Product Code: IDCJAC0001). Temperatures within the region range from an average monthly maximum of 31.7 degrees Celsius in January to an average monthly minimum of 3.8 degrees Celsius in July (Jerrys Plains Post Office BOM station No. 061086, 2012). The average annual evaporation within the Study Area ranges between 1,400-1,800 mm (Average Pan Evaporation (Annual) Map 2006 BOM Product Code: IDCJCM0006).

The BOM classifies the Study Area within a Temperate Climate Zone, with no designated wet season; however, the area can be susceptible to occasional heavy showers and thunderstorms due to easterly troughs in the region during warmer months.

2.2 Hydrology and Topography

The region is characterised topographically by low undulating hills that range from 80-180 m. Slopes vary between 2-10% and are typically 6%. The Hunter River meanders to the south of the Study Area and flows in an easterly direction.

2.3 Soil Landscape Units

The soils originally occurring in the Study Area consisted of the Liddell and Dartbook soil landscapes as described in Kovac & Lawrie (1991). However, it is important to note that almost the entirety of the Study Area is within a post-mining rehabilitated area proposed to be re-disturbed to construct the wall and floor of the fine reject emplacement. It is likely that the topsoil that was used in rehabilitation at Carrington was derived from, and therefore is similar to, the original Liddell soil types due to the Liddell Soil Landscape being the predominant soil type in the area. The dispersive nature of some of the sodic soils could create an erosion risk if reused. It is unlikely, however, that the sodic subsoil of these soils would have been salvaged for reuse in the rehabilitated area and, therefore, any topsoil present in rehabilitated areas is expected to be suitable for stripping and reuse for a second time.

2.4 Vegetation and Landuse

The study area consists of rehabilitated areas (areas that have been planted with native overstorey species) and pasture areas (areas that have not been planted out). The planted species consist of a variety of acacias and eucalypts (approximately 5-6 years of age), existing over a weedy understorey and ground cover. The ground cover within the rehabilitated areas contains very few native forbs or native grasses and is dominated by dense growth of Rhode’s Grass (*Chloris gayana*).

The vegetation of the study area cannot be assigned to a formal vegetation type in the Biometric database, as it is not a naturally occurring community and does not conform to any known vegetation type, or ecological community. The dominant land use of the Study Area is rehabilitation from previous mining activity.

3.0 SOIL SURVEY AND ASSESSMENT

3.1 Soil Survey Methodology

A field survey and a desktop study were undertaken for the Study Area. This process is outlined in the following sub-sections:

3.1.1 Reference Mapping

An initial soil map (reference map) was developed using the following resources and techniques:

- *Aerial photographs and topographic maps* - aerial photo and topographic map interpretation was used as a remote sensing technique allowing detailed analysis of the landscape and mapping of features expected to be related to the distribution of soils within the Study Area.
- *Reference information* - source materials were used to obtain correlations between pattern indicators and soil properties that may be observable in the field. These materials included cadastral data, geological, vegetation and water resources studies.
- *Previous soils information* - previous studies were taken into consideration for soils mapping and land assessment, including:
    - *Soil Landscapes of Singleton 1:250,000 Sheet* (Kovac and Lawrie); and
    - Land Capability Spatial Data (Department of Natural Resources 2005).
- *Stratified observations* - following production of a broad soil map, surface soil exposures, topography and vegetation throughout the Study Area was visually assessed to verify potential soil types, delineate soil type boundaries and determine preferred locations for targeted subsurface investigations (hereafter referred to as soil pits).

3.1.2 Field Survey

3.1.2.1 Scale

The field survey was undertaken at a medium intensity scale of 1:100,000. This survey scale enables the production of a map that is suitable for major types of landuse such as mining (NCST, 2008). This survey scale was adopted to offer an adequate dataset of soil types within the Study Area and to assess the potential impact on these soils following the works proposed as part of the proposed modification.

3.1.2.2 Survey Type

The field survey undertaken was an integrated and qualitative survey. The specific type of integrated survey undertaken was a ‘free survey’. A free survey is a conventional form of integrated survey and its strength lies in its ability to assess soil and land at medium to detailed-scales. Survey points are irregularly located according to the survey team’s judgement to enable the delineation of soil boundaries.

3.1.2.3 Survey Observations

Survey observations undertaken comply with the 1:100,000 scale survey criteria prescribed in the *Guidelines for Surveying Soil and Land Resources* (NCST, 2008).

3.1.2.4 Detailed Soil Profile Observation

Soil profiles were assessed in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST 2009). Information was recorded for the major parameters specified in **Table 1** with one to three samples taken from three profiles for laboratory analysis (refer **Section 3.1.3**). Each soil profile exposure pit was excavated, samples collected to be analysed and the pit photographed. The soil pits were backfilled post-analysis.

Global Positioning System (GPS) readings were taken for all sites where detailed soil descriptions were recorded. Vegetation type and land use were also recorded. Soil pits were photographed during field operations, with photographs being a useful adjunct to description of land attributes.

Table 1 – Field Assessment Parameters

Descriptor	Application
Horizon Depth	Weathering characteristics, soil development
Field Colour	Permeability, susceptibility to dispersion /erosion
Field Texture Grade	Erodibility, hydraulic conductivity, moisture retention, root penetration
Boundary Distinctness and Shape	Erosional / dispositional status, textural grade
Consistence Force	Structural stability, dispersion, ped formation
Structure Pedality Grade	Soil structure, root penetration, permeability, aeration
Structure Ped and Size	Soil structure, root penetration, permeability, aeration
Stones – Amount and Size	Water holding capacity, weathering status, erosional / depositional character
Roots – Amount and Size	Effective rooting depth, vegetative sustainability
Ants, Termites, Worms etc.	Biological mixing depth

Soil layers at each profile site were also assessed according to a procedure devised by Elliot and Reynolds (2007) for the recognition of suitable topdressing material in the event surface disturbance occurs in the future. This procedure assesses soils based on grading, texture, structure, consistence, mottling and root presence. A more detailed explanation of the Elliot and Reynolds (2007) procedure is presented in **Section 4** of this report.

3.1.3 Soil Laboratory Assessment

Soil samples from three of the soil assessment sites were utilised in the laboratory testing program. Samples were analysed in order to:

- Classify soil taxonomic classes; and
- Determine suitability of soil as topdressing material in future rehabilitation works.

Soil was collected from each major soil horizon (soil layer), as appropriate, and in total seven soil samples were sent to the Scone Research Centre for analysis. Certificate of Analyses for these results are contained in **Appendix 1**. The selected physical and chemical laboratory analysis parameters and their relevant application are listed in **Table 2**.

Table 2 – Laboratory Analysis Parameters

Property	Application
Coarse fragments (>2mm)	Soil workability; root development;
Particle-size distribution (<2mm)	Determine fraction of Clay (Cl), Silty (Si), Fine Sand (Fs) and Coarse Sand (Cs); Nutrient retention; exchange properties; erodibility; workability; permeability; sealing; drainage; interpretation of most other physical and chemical properties and soil qualities
Aggregate stability (Emerson Aggregate Test (EAT))	Susceptibility to surface sealing under rainfall or irrigation; effect of raindrop impact and slaking; permeability; infiltration; aeration; seedling emergence; correlation with other properties
Soil reaction (pH)	Nutrient availability; nutrient fixation; toxicities (especially aluminium (Al) and manganese (Mn)); liming; sodicity; correlation with other physical, chemical and biological properties
Electrical conductivity (EC)	Appraisal of salinity hazard in soil substrates or groundwater; total soluble salts
Cation Exchange Capacity (CEC) and exchangeable cations	Nutrient status; calculation of exchangeable cations including Sodium (Na), Calcium (Ca), Magnesium (Mg), K Potassium (K) and exchangeable sodium percentage (ESP); assessment of other physical and chemical properties, especially dispersivity, shrink – swell, water movement, aeration
Munsell Colour Chart (Munsell)	Drainage, oxidation, fertility, correlation with other physical, chemical and biological properties

The laboratory methods used by Scone Research Centre for key physical and chemical parameters are provided below in **Table 3.**

Table 3 – Laboratory Test Methods

Parameter	Method
Particle Size Analysis (PSA)	Sieve and hydrometer
pH	1:5 soil/water extract
EC	1:5 soil/water extract
Emerson Rating	Emerson Aggregate Test
CEC and exchangeable cations	(AgTU)+ extraction

3.1.4 Soil Type Nomenclature

The applicable technical standard adopted by GSSE for the proposed modification is the ASC system. The standard is routinely used as the soil classification system in Australia.

3.2 Soil Survey Results

Given the highly disturbed nature of the Study Area and the need to infer and interpret data (due to altered field site areas), only one soil type was identified. **Table 4** provides an overview of this soil type and a quantitative distribution within the Study Area. **Figure 3** illustrates the spatial distribution of mapped soils.

Table 4 – Soil Types

Soil Type No.	Soil Landscape	Representative ASC Name	Study Area	
			Area (ha)	Area (%)
1	Liddell and Dartbrook	Spolic Anthroposol	160.6	100
		Total	**160.6**	**100**

The physical and chemical characteristics of the soil type and management recommendations are provided below.

3.2.1 Representative Soil Type 1 – Spolic Anthroposol

Soil Type Overview: Representative Soil Type 1 is a Spolic Anthroposol. The entire Study Area consists of land that has been heavily modified by previous mining activity (and subsequent rehabilitation). The soil survey revealed the soil profile has been disturbed to an extent that it falls outside the classification for naturally occurring soils.

Anthroposols are soils that result from human activities, which have caused a profound modification, mixing, truncation or burial of the original soil horizons. The Spolic sub order indicates these soils have formed or are forming on mineral materials that have been moved by earthmoving equipment in mining, highway construction or dam building. Spolic materials are frequently capped with pre-stripped topsoil.

Disturbance Management: The topsoil material (0 – 0.30 m) is suitable for stripping and reuse on other landforms. As this material is marginally sodic, it would benefit from treatment with gypsum, while the addition of organic material would improve soil structure and water holding capacity. The subsoil material, whilst unsuitable for use as topdressing material, could be reused as an intermediate layer between spoil and topsoil, as it appears to have been on the current rehabilitated landform. It can be stripped to 0.80 m from the original surface level.

Table 5 – Site Description for Soil Type 1

Site Description

Plate 2 – Profile (Site 4)

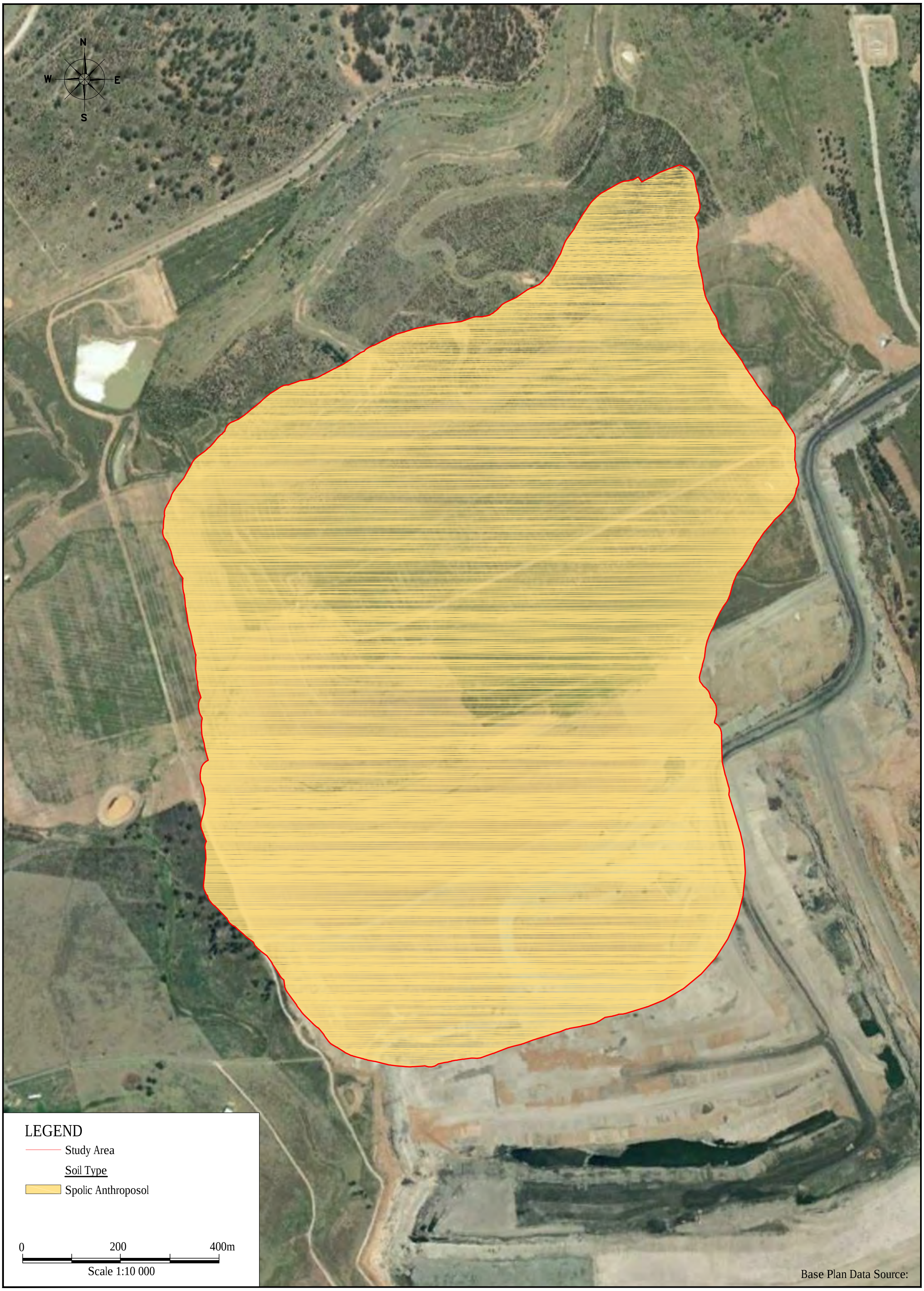
Plate 3 – Landscape (Site 4)

ASC Name	Spolic Anthroposol
Representative Site	Site 4
Associated Soil Landscape	Not Applicable
Dominant Slope Association	Lower slope
Land Use and Vegetation	Rehabilitation, grasses and scattered trees
Soil Stripping Recommendation	The topsoil is suitable for stripping to a depth of 0.30 m, while the structure of the subsoil would only be suitable for stripping and re-use as an intermediate layer between spoil and topsoil due to its high clay content.

Horizon	**Depth (m)**	**Description**
A1	0.0–0.03	Yellowish-brown (10YR5/4) clay loam, moderate structure grade of 20 – 30 mm sub-angular blocky peds with a moderate consistence. Moderately alkaline (pH 8.3) and very low salinity (EC 0.05 dS/m). Well drained with a diffuse boundary.
A2	0.03–0.30	Light brown (7.5YR6/4) sandy loam, weak structure grade of 1 – 5 mm sub-angular blocky peds with a weak consistence. Strongly alkaline (pH 9.0) and very low salinity (EC 0.07 dS/m). Well drained with a diffuse boundary.
B2	0.30–0.80	Reddish-brown (7.5YR6/6) clay, apedal and massive. Strongly alkaline (pH 8.8) and very low salinity (EC 0.08 dS/m). Poorly drained.

Horizon	**CEC**		**ESP**		**K Factor**		**EAT**	
	meq/100g	rating	%	rating	factor	rating	class	rating
A1	21.4	Moderate	7.5	Marginally sodic	0.032	Moderate	5	Slight
A2	9	Low	2.2	Non sodic	0.032	Moderate	5	Slight
B2	15	Moderate	3.2	Non sodic	0.031	Moderate	3(1)	Slight

CEC – Cation Exchange Capacity – affects soil structure stability, plant nutrient availability, soil pH
ESP – Exchangeable Sodium Percentage – a measure of sodicity
K Factor – measure of soil erodibility based on Universal Soil Loss Equation factors and soil texture
EAT – Emerson Aggregate Test – refers to stability/dispersability of soil structural units (aggregates) when immersed in water



To be printed A4

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

HVO North Fine Reject Emplacement Modification
Study Area Soil Type

FIGURE 3

V:\EMG00-010\Figures\CAD\Current\CAD\Fg3_EMG00-010_Study Area Soil Type_130605.dwg

4.0 LAND ASSESSMENT

In NSW, rural lands are currently being mapped according to two different land classification systems. The first of these was developed by the NSW Office of Environment and Heritage (OEH) and classifies land into eight classes (Classes 1 to 8) known as Land and Soil Capability (LSC) classes. This system has been recently introduced to replace the former Rural Land Capability System (Emery 1986) that was formerly the benchmark for land capability assessments in NSW. The second of these, developed by the former NSW Department of Agriculture (now part of the DPI), classifies land into five classes (Classes 1 to 5) known as Agricultural Suitability classes.

The Study Area has been assessed for:

- Land and Soil Capability (LSC);
- Agricultural Suitability classification; and
- Biophysical Strategic Agricultural Land (BSAL).

The methods and results for these assessments are presented in this section, fulfilling report Objectives 2 and 3.

4.1 Land and Soil Capability

4.1.1 Land and Soil Capability Methodology

The LSC classification applied to the Study Area was in accordance with the OEH guideline *The Land and Soil Capability Assessment Scheme: Second approximation* (OEH 2012a) (referred to as the LSC Guideline). This scheme uses the biophysical features of the land and soil to derive detailed rating tables for a range of land and soil hazards. The scheme consists of eight classes, which classify the land based on the severity of long-term limitations. The LSC classes are described in **Table 6** and their definition has been based on two considerations:

- the biophysical features of the land to derive the LSC classes associated with various hazards; and
- the management of the hazards including the level of inputs, expertise and investment required to manage the land sustainably.

Table 6 – Land and Soil Capability Classes

Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: 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.
3	**High capability land**: 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.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: 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 specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land**: Land has high limitations for high-impact land 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.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6	**Low capability land**: 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 environmental degradation
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: 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 not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land**: 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

Calculating LSC Classes

The biophysical features of the land that are associated with various hazards are broadly soil, climate and landform and more specifically: slope, landform position, acidity, salinity, drainage, rockiness; and climate.

The eight hazards associated with these biophysical features that are assessed by the scheme are:

1. Water erosion
2. Wind erosion
3. Soil structure decline
4. Soil acidification
5. Salinity
6. Water logging
7. Shallow soils and rockiness
8. Mass movement

Each hazard is assessed against set criteria tables, as described in the LSC Guideline, with each hazard for the land is ranked from 1 through to 8 with the overall ranking of the land determined by its most significant limitation.

Hazard 1: Water Erosion

The Study Area lies within the Eastern and Central NSW Division, and the appropriate criteria for this division were used in the assessment. Assessment of water erosion hazard is almost solely dependent on the slope percentage of the land, based on each soil landscape unit. The only exception is land which falls within the slope range of 10-20%, which may be designated LSC Class 4 or 5 depending on the presence of gully erosion and/or sodic/dispersible soils.

Hazard 2: Wind Erosion

There are four factors used to assess wind erosion hazard for each soil type. Three criteria were assessed to be consistent for each soil type:

- wind erosive power for the Study Area has been mapped as ‘Moderate’ (NSW Department of Trade and Investment);
- exposure of the land to wind was also determined to be “Moderate” throughout the Study Area; and
- the average rainfall for the region is 644.5 mm (BOM 2013), and therefore the Study Area lies within the “greater than 500 mm rainfall” category.

The determining factor with regard to wind erosion hazard was therefore the erodibility of each soil type as determined by soil texture according the LSC Guideline.

Hazard 3: Soil Structure Decline

Soil structure decline is assessed on soil characteristics, including surface soil texture, sodicity (laboratory tested) and degree of self-mulching (field tested). These parameters assess the soil structure, stability and resilience of the soil.

Hazard 4: Soil Acidification

The soil acidification hazard is assessed using three criteria, being soil buffering capacity, pH and mean annual rainfall. In this assessment, soil buffering capacity was based on soil physical properties; surface soil pH and a regional mean annual rainfall range of greater than 500 mm.

Hazard 5: Salinity

The salinity hazard is determined through a range of data and criteria. The recharge potential for the site was determined based on an average annual rainfall of 644.5 mm, with annual evaporation of 1400-1600 mm (BOM 2013). This would suggest a moderate recharge potential.

Based on the annual rainfall data (644.5 mm) and an average annual evapotranspiration rate of 800-900 mm, a low discharge potential for the site is likely due to a balanced rate of water flow.

According to the Salt Store Map of NSW, the Study Area is located in area of low salt store. However, due the current available scale of this mapping, laboratory tested EC values were used to determine salt store.

Hazard 6: Water Logging

Water logging was determined by the soil drainage characteristics, specifically field sample evidence of mottling, soil texture attributes as well as slope and climate.

Hazard 7: Shallow Soils and Rockiness

The shallow soils and rockiness hazard is determined by an estimated exposure of rocky outcrops and average soil depth.

Hazard 8: Mass Movement

The mass movement hazard is assessed through a combination of three criteria: mean annual rainfall, presence of mass movement and slope class.

4.1.2 Land and Soil Capability Assessment

As listed in **Table 7**, the Study Area has been assessed and classified into the LSC Class of 4.

Table 7 – Land and Soil Capability Assessment

Soil Types		Hazard Criteria								
No.	Name	1	2	3	4	5	6	7	8	Overall
		Water erosion	Wind erosion	Struct -ure	Acidity	Salin- ity	Water- logging	Soil depth	Move- ment	Class
1	Spolic Anthroposol*	3	2	4	1	2	3	1	1	**4**

The limitations associated with land Class 4 are discussed below and the land area of Class 4 is shown in **Table 8**.

Table 8 – Land and Soil Capability Areas

Land and Soil Capability	Study Area	
Class	ha	%
4	160.6	100
Total	**160.6**	**100**

Class 4 Land

Class 4 land is represented by Soil Type 1. This classification indicates that the land is moderately capable for a range of land uses, and specialised practices are necessary to overcome very severe limitations. The primary constraint to this land class is soil alkalinity, topsoil sodicity and likely low fertility. An assumption has been made that the soil depth across the site is 0.80 m, however there is considerable potential for variation on rehabilitated land.

4.2 Agricultural Suitability

4.2.1 Agricultural Suitability Methodology

The Agricultural Suitability system was applied to the Study Area in accordance with the DPI's guideline *Agricultural Suitability Maps – uses and limitations* (NSW Agricultural & Fisheries 1990). The system consists of five classes (Classes 1 to 5), providing a ranking of rural lands according to their productivity for a wide range of agricultural activities with the objective of determining the potential for crop growth within certain limits. A description of each Agricultural Suitability Class is provided in **Table 9**.

Table 9 – Agricultural Suitability Classes

Class	Land Use	Management Options
1	Highly productive land suited to both row and field crops.	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.
2	Highly productive land suited to both row and field crops.	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation.
3	Moderately productive lands suited to improved pasture and to cropping within a pasture rotation.	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture.
4	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.	Land suitable for grazing but not for cultivation. Agriculture is based on native or improved pastures established using minimum tillage.
5	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.	Land unsuitable for agriculture or at best suited only to light grazing.

The main soil properties and other landform characteristics considered significant for the agricultural suitability assessment are topsoil texture, topsoil pH, solum depth, external and internal drainage, topsoil stoniness and slope as well as bio-physical factors such as elevation, rainfall and temperature. The overall suitability classification for each specific soil type is determined by the most severe limitation, or a combination of the varying limitations.

Agricultural Suitability has been assessed and classified into Class 4 for the Study Area. The limitations associated with this Agricultural Suitability Class are discussed below and the land area of each Class is shown in **Table 10**.

Table 10 – Agricultural Suitability Class Areas

Agricultural Suitability	Study Area	
Class	ha	%
4	160.6	100
Total	**160.6**	**100**

Class 4 Land

Class 4 land consists of Soil Type 1. Agricultural activity must be based on improved pastures established using minimum tillage techniques. The land is not suitable for cultivation. The production level is low as a result of constraints such as sodicity and the chemical limitation of strong alkalinity on vegetation growth.

4.3 Biophysical Strategic Agricultural Land

The NSW Government released the Strategic Regional Land Use Policy to assist the development of a long-term strategy for continued progress of the mining industry that also ensures local community sustainability and on-going viability of existing industries. Part of this policy is the development of Strategic Regional Land Use Plans (SRLUPs), which includes the determination of BSAL, defined as areas with unique natural resource characteristics highly suited for agriculture.

There are currently two documents pertaining to the assessment of BSAL, the *Strategic Regional Land Use Plan for the Upper Hunter* (DP&I 2012) and the *Interim Protocol for Site verification and mapping of biophysical strategic agricultural land* (OEH 2012b). Although there is significant overlap between the two documents, there is differing BSAL assessment criteria contained in both, therefore a BSAL assessment has been undertaken using both documents.

4.3.1 BSAL Assessment Using SRLUP for the Upper Hunter

The values and criteria that relate to BSAL are outlined in **Table 11**. This assessment used these criteria to assess BSAL in the Study Area according to the *SRLUP for the Upper Hunter* (DP&I 2012).

Table 11 – BSAL Criteria: SRLUP for the Upper Hunter

Criteria	
•	Land that falls under soil fertility classes “high”, “moderately high” under the Draft Inherent General Fertility of NSW (OEH, 2011a); and
•	Land capability classes I, II or III under the Land and Soil Capability Mapping of NSW (OEH); and
•	Reliable water of suitable quality, characterised by land having rainfall of greater than 350 mm per annum (9 out of 10 years) or land within 150 m of the following surface or groundwater resource: a regulated river; or unregulated rivers where there are flows for at least 95% of the time (i.e. the 95th percentile flow of each month of the year is greater than zero) or 5th order and higher rivers, or groundwater aquifers (excluding miscellaneous alluvial aquifers, also known as small storage aquifers) which have a yield rate greater than 5 L/s and total dissolved solids of less than 1,500 mg/L.
	Or
•	Land that falls under soil fertility classes “moderate” under the Draft Inherent General Fertility of NSW (OEH, 2011a); and
•	Land capability classes I or II under the Land and Soil Capability Mapping of NSW (OEH); and
•	Reliable water of suitable quality, characterised by land having rainfall of greater than 350 mm per annum (9 out of 10 years) or land within 150 m of the following surface or groundwater resource: a regulated river; or unregulated rivers where there are flows for at least 95% of the time (i.e. the 95th percentile flow of each month of the year is greater than zero) or 5th order and higher rivers, or groundwater aquifers (excluding miscellaneous alluvial aquifers, also known as small storage aquifers) which have a yield rate greater than 5 L/s and total dissolved solids of less than 1,500 mg/L.

BSAL Assessment Results

The minimum requirement for rainfall reliability for the region was met for the Study Area (refer **Section 2.1**) and therefore, the LSC and fertility class were further assessed in this section. To do this, this assessment compares the LSC Classes against the soil types fertility attributes to determine if the BSAL criteria, as specified in **Table 11**, are met in the Study Area. The soil fertility and the outcomes of the BSAL assessment are shown below in **Table 12**.

Table 12 – Applied BSAL Criteria: SRLUP for the Upper Hunter

Soil Type		Great Soil Group	LSC Class	Fertility*	BSAL	BSAL Limitation
1	Spolic Anthroposol	N/A	**4**	Low*	No	LSC class & fertility

** No correlation within SRLUP exists for Anthroposols, Assumed 'Low' fertility due to human disturbance and pre-existing soil landscape*

Whilst the Study Area met the minimum rainfall, the fertility class and LSC classifications for Soil Type 1 indicate that the soil resources does not qualify as BSAL. Further, groundwater TDS in the Study Area exceeds 1,500 mg/l (AECOM, 2012).

4.3.2 BSAL Assessment Using Interim Protocol for Site Verification

This methodology used the 12 step site verification criteria listed within the *Interim Protocol for Site Verification*, which are summarised in **Table 13**. If a criterion fails to meet any of the BSAL conditions, the site is rejected as BSAL and the remaining conditions are not assessed.

Table 13 – Twelve Step Site Verification Criteria According to Interim Protocol

Step Number	Criteria	BSAL Definition
1	Reliable Water Supply	Greater than 350 mm annual rainfall (9 out of 10 years), or underlain by ground water aquifer with yield greater than 5L/s and total dissolved solids less than 1,500 mg/L
2	Slope	Slope of less than or equal to 12%
3	Rock Outcrop	Rock outcrop of less than 30%
4	Soil Type	Soil which has naturally high, moderately high or moderate fertility
5	Surface Rockiness	Less than 20% of the area has unattached rock fragments greater than 60 mm diameter
6	Gilgai	Less than 50% of the area has gilgai depression that are deeper than 500 mm
7	Soil Depth	Soil depth greater than 750 mm
8	Drainage	Soil must not be poorly or very poorly drained soils
9	pH	pH within range of 5.0 to 8.9 when measured in water or pH within range of 4.2 to 8.1 when measured in calcium chloride.
10	Soil Salinity	Electrical conductivity in a saturated extract (ECe) less than or equal to 4 dSm/m or if gypsum is present, chlorides less than 800 mg/kg
11	Soil Water Storage	Soil must be able to store more than or equal to 75 mm of water to effective soil depth of 1 m or less
12	Minimum Area	Soil must have a contiguous area of greater or equal to 20 Ha

BSAL Assessment Results

The minimum requirement for Step 1 was met for Soil Type 1 with an average annual rainfall of 644.5 mm for the Study Area (**Section 2.1**), although groundwater TDS exceeded 1,500 mg/s. Soil Type 1 also met the requirement for Step 2 with a slope less than 12% and for Step 3 with less than 30% rock outcrop. However, Soil Type 1 has assumed fertility of 'Low' due to human disturbance, which does not meet the criteria for Step 4.

Therefore Soil Type 1 was rejected as BSAL at Stage 4 of the steps of the *Interim Protocol for Site verification and mapping of biophysical strategic agricultural land* (OEH 2012b) (**Table 13, 14**).

Table 14 – Applied BSAL Criteria: Interim Protocol for Site Verification

Soil Type		Site Verification Step							BSAL
No.	Name	1	2	3	4	5	6	7	
1	Spolic Anthroposol	✓	✓	✓	✗	-	-	-	No

4.3.3 Biophysical Strategic Agricultural Land Summary

As discussed, two BSAL assessments have been completed due to differing BSAL assessment criteria contained in both the *SRLUP for the Upper Hunter* (DP&I 2012) and the *Interim Protocol for Site verification and mapping of biophysical strategic agricultural land* (OEH 2012b). Both assessments determined that no BSAL is present within the Study Area.

4.4 Post-Disturbance Land Assessment

4.4.1 Post-Disturbance Land and Soil Capability Assessment

The post-disturbance LSC classes determined for the Study Area are anticipated to be the same as the pre-disturbance classes (post-rehabilitation). Therefore, the proposed modification will have no impact on the pre-disturbance land and soil capability classes if the disturbance management recommendations listed in **Section 5.0** are implemented.

4.4.2 Post-Disturbance Agricultural Suitability Assessment

As per the findings for the post disturbance soil and land capability, the proposed modification will have no impact on the pre-disturbance Agricultural Suitability classes if the disturbance management recommendations listed in **Section 5.0** are implemented.

5.0 DISTURBANCE MANAGEMENT

This section presents:

- a soil stripping assessment which provides a topsoil stripping strategy indicating recommended stripping depths for topsoil salvage and re-use as topdressing in rehabilitation; and
- soil management recommendations for soil that is stripped, stored and used for rehabilitation (as per recommendations in AECOM, 2012).

5.1 Soil Stripping Assessment

5.1.1 Soil Stripping Methodology

Determination of suitable soil to conserve for later use in rehabilitation has been conducted in accordance with Elliott and Reynolds (2007), which remains the benchmark for land resource assessment in the NSW mining industry. This procedure involves assessing soils based on a range of physical and chemical parameters. **Table 15** lists the key parameters and corresponding desirable selection criteria.

Table 15 – Topsoil Stripping Suitability Criteria

Parameter	Desirable criteria
Structure Grade	>30% peds
Coherence	Coherent (wet and dry)
Mottling	Absent
Macrostructure	>10cm
Force to Disrupt Peds	≤ 3 force
Texture	Finer than a Fine Sandy Loam
Gravel & Sand Content	<60%
pH	4.5 to 8.4
Salt Content	<1.5 dS/m

Gravel and sand content, pH and salinity were determined for all samples using the laboratory test results. Texture was determined in the field and cross referenced with laboratory results, specifically particle size analysis. All other physical parameters outlined in **Table 15** were determined during the field assessment.

Structural grade is significant in terms of the soil's capability to facilitate water relations and aeration. Good permeability and adequate aeration are essential for the germination and establishment of plants. The ability of water to enter soil generally varies with structure grade and depends on the proportion of coarse peds in the soil surface. Better structured soils have higher infiltration rates and better aeration characteristics. Structureless soils, without pores, are considered less suitable as topdressing materials.

The shearing test is used as a measure of the soil's ability to maintain structure grade. Brittle soils are not considered suitable for revegetation where structure grade is weak or moderate because peds are likely to be destroyed and structure is likely to become massive following mechanical work associated with the excavation, transportation and spreading of topdressing material. Consequently, surface sealing and reduced infiltration of water may occur which will restrict the establishment of plants.

The force to disrupt peds, when assessed on soil in a moderately moist state, is an indicator of solidity and the method of ped formation. Deflocculated soils are hard when dry and slake when wet, whereas flocculated soils produce crumbly peds in both the wet and dry state. The deflocculated soils are not suitable for revegetation and may be identified by a strong force required to break aggregates.

The presence of mottling within the soil may indicate reducing conditions and poor soil aeration. These factors are common in soils with low permeability however some soils are mottled due to other reasons, including proximity to high water-tables or inheritance of mottles from previous conditions. Reducing soils and poorly aerated soils are unsuitable for revegetation purposes.

5.1.2 Soil Stripping Recommendation

It is recommended that both the topsoil and subsoil be stripped to a total depth of 0.80 m (0 – 0.30 m topsoil; 0.30 – 0.80 m subsoil). It is important to strip and store the topsoil and subsoil separately and only respread the subsoil for use as an intermediate layer between spoil and topsoil. Approximate stripping depths and resource volumes are shown in **Table 16**.

Table 16 – Recommended Soil Stripping Depths and Resource Volumes

Soil Type		Area	Topsoil Stripping Depth	Subsoil Stripping Depth	Total Resource Volume	
No.	**ASC Name**	**m^2**	**cm**	**cm**	**Topsoil m^3**	**Subsoil m^3**
1	Spolic Anthroposol	1,606,000	0 - 30	30 - 80	481,800	803,000
Total Resource Volume minus 10% (handling loss)					**433,620**	**722,700**
Combined Total Resource Volume minus 10% (handling loss)					**1,156,320**	

5.1.3 Topdressing Management

Where soil stripping and transportation is required, the following handling techniques are recommended to prevent excessive soil deterioration.

- Strip material to the depths stated in **Table 16**, subject to further investigation as required.
- Topsoil should be maintained in a slightly moist condition during stripping. Material should not be stripped in either an excessively dry or wet condition.
- Grading or pushing soil into windrows with graders or dozers for later collection for loading into rear dump trucks by front-end loaders, are examples of preferential less aggressive soil handling systems. This minimises compression effects of the heavy equipment that is often necessary for economical transport of soil material.
- The surface of soil stockpiles should be left in as coarsely structured a condition as possible in order to promote infiltration and minimise erosion until vegetation is established, and to prevent anaerobic zones forming.
- As a general rule, maintain a maximum stockpile height of 3 m. Clayey soils should be stored in lower stockpiles for shorter periods of time compared to sandier soils.
- If long-term stockpiling is planned (ie greater than 3 months), seed and fertilise stockpiles as soon as possible. An annual cover crop species that produce sterile florets or seeds should be sown. A rapid growing and healthy annual pasture sward will provide sufficient competition to minimise the emergence of undesirable weed species. The annual pasture species will not persist in the rehabilitation areas but will provide sufficient competition for emerging weed species and enhance the desirable micro-organism activity in the soil.
- Prior to re-spreading stockpiled topsoil, an assessment of weed infestation on stockpiles should be undertaken to determine if individual stockpiles require herbicide application and / or “scalping” of weed species prior to topsoil spreading.

- An inventory of available soil should be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities.

5.1.4 Soil Re-Spreading and Seedbed Preparation

Soil should be re-spread directly onto stripped areas where practical. Topsoil should be spread, treated with fertiliser and seeded in one consecutive operation, to reduce the potential for topsoil loss to wind and water erosion. Soil should be respread to the approximate depth from which it was stripped, with at least 10 cm of topdressing material before the intermediate subsoil layer.

Thorough seedbed preparation should be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas should be lightly contour ripped (after topsoil spreading) to create a “key” between the soil and the spoil. Ripping should be undertaken on the contour. Best results will be obtained by ripping when soil is moist and when undertaken immediately prior to sowing. The re-spread topsoil surface should be scarified prior to, or during seeding, to reduce run-off and increase infiltration. This can be undertaken by contour tilling with a fine-tyned plough or disc harrow.

6.0 SUMMARY

This Soil and Land Resource Assessment has been conducted based on the findings of a field investigation and a desktop review of reference information. The findings of the study include the following;

- Soil landscapes within the Study Area – two Soil Landscapes would have occurred in the Study Area prior to disturbance – Liddell and Dartbrook.

- Soils type within the Study Area – the entire area has been previously disturbed by mining activity and subsequent rehabilitation. As a result, the soil type covering the entire Study Area is a Spolic Anthroposol.

- Land Assessment – the Study Area was assessed for the LSC and Agricultural Suitability classifications, as well as for its qualification as BSAL.

  The pre-disturbance LSC class was Class 4 (moderately capable land) supporting rehabilitation. Agricultural Suitability was assessed as Class 4 (land suitable for low impact grazing but not cultivation).

  BSAL was assessed to determine if unique natural resource characteristics highly suitable for agriculture occur within the Study Area in accordance with the NSW Government's Strategic Regional Land Use Policy. The Assessment determined that no soils within the Study Area qualified as BSAL.

- Soil stripping assessment - the topsoils within the Study Area are recommended to be stripped prior to any significant surface disturbance, to a depth of 0.30m. Subsoil is recommended to be stripped to a depth of 0.80 m.

- Soil volume assessment – the volume of topsoil suitable for stripping is 481,800 m^3; the volume of subsoil available for stripping is 803,000m^3. Assuming a 10% handling loss, the total resource available for stripping is 1,156,320 m^3.

- Soil amelioration – topsoils stripped from the Study Area would benefit from treatment with the addition of organic material (such as biosolids, mulch or compost) to improve structure and water holding capacity and gypsum to reduce sodicity issues. Subsoils should only be used as an intermediate layer between spoil and topsoil, due to their high clay content (AECOM, 2012).

Management recommendations based on these findings are presented in this assessment, and are a guide to mitigating the impacts of the proposed modification and enhance the success of rehabilitation.

7.0 REFERENCES

AECOM (2012). HVO North – Mining Operations Plan (MOP).

BOM (Bureau of Meteorology) (2012) http://reg.bom.gov.au/climate/data/.

BOM (Bureau of Meteorology) (2008) Bureau of Meteorology, http://www.bom.gov.au/climate/map/evaporation/evap_ann.shtml.

Cunningham G.M., Higginson F.R, Riddler A.M.H and Emery K.A. (1988) Rural Land Capability Mapping, Soil Conservation Service of NSW. Sydney, NSW.

Department of Environment and Climate Change (2008) Managing Urban Stormwater: Soils and Construction Vol. 2E mines and Quarries.

Department of Natural Resources (2005) Land Capability Spatial Data. Resource Information Unit, Hunter Region.

Department of Planning and Infrastructure (2012) Upper Hunter Strategic Regional Land Use Plan (SRLUP).

Elliot, G.L. and Reynolds, K.C. *in* Charman, P.E.V. and Murphy, B.W. (2007) Soils their Properties and Management (Oxford University Press, Australia).

Elliot, G.L. and Veness, R.A. (1981) Selection of Topdressing Material for Rehabilitation of Disturbed Areas in the Hunter Valley, J. Soils Cons. NSW 37 37-40.

Emery, K.A. (1986) Rural Land Capability Mapping. Soil Conservation Service of NSW. Sydney, NSW.

Isbell R. F. (1996) The Australian Soil Classification (CSIRO Publication, Australia).

Kovac, M. and Lawrie, J.L. (1991) Soil landscapes of the Singleton 1:250,000 Sheet. Soil Conservation Service of NSW, Sydney.

Landcom (2004) Managing Urban Stormwater: Soils and Construction Vol. 1.

National Committee on Soil and Terrain (NCST) (2008) Guidelines for Surveying Soil and Land Resources. (CSIRO, Australia).

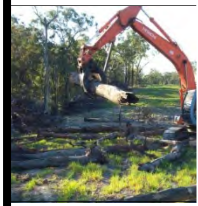
National Committee on Soil and Terrain (NCST) (2009) Australian Soil and Land Survey Field Handbook, 3rd edition (CSIRO, Australia).

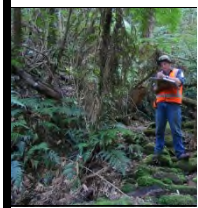
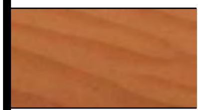
NSW Agriculture & Fisheries (1990) Agricultural Suitability Maps – Uses and Limitations. Agfact AC.9.

Office of Environment and Heritage (2012a) The Land and Soil Capability Assessment Scheme; Second approximation.

Office of Environment and Heritage (2012b) Interim Protocol for Site verification and mapping of biophysical strategic agricultural land.





Certificate of Analysis

APPENDIX 1

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO12/250R1
REPORT TO:	Matt Hemingway GSS Environmental PO Box 907 Hamilton NSW 2303
REPORT ON:	Ten soil samples HVO
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	31 August 2012
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

SR Young
(Laboratory Manager)

SOIL CONSERVATION SERVICE
Scone Research Centre

Report No: SCO12/250R1
Client Reference: Matt Hemingway
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	C1A/4	C2A/3	C2B/3	C5A/4 CEC & exchangeable cations (me/100g)						C6A/2
	Sample Id	EC (dS/m)	pH	pH ($CaCl_2$)	CEC	Na	K	Ca	Mg	Al	OC (%)
1	HVO 2 0-15cm	0.15	8.3	7.4	25.5	1.6	1.2	12.3	10.1	nt	1.07
2	HVO 2 15-60cm	0.51	9.6	8.7	25.9	6.2	0.6	6.4	11.9	nt	0.20
3	HVO 2 60-80cm	0.90	9.2	8.5	27.1	7.3	0.7	5.2	13.0	nt	0.13
4	HVO 3 0-20cm	0.07	7.0	6.3	26.9	0.3	2.8	12.0	10.4	0.2	1.82
5	HVO 3 20-70cm	0.07	7.0	6.2	10.2	0.5	0.9	4.6	4.6	0.1	0.83
6	HVO 3 70-120cm	0.14	7.4	6.5	26.6	2.3	0.9	9.5	12.8	0.2	0.86
7	HVO 4 0-3cm	0.05	8.3	7.4	21.4	0.5	1.2	10.2	9.3	nt	1.60
8	HVO 4 3-30cm	0.07	9.0	8.2	9.0	0.4	0.4	5.9	3.5	nt	0.42
9	HVO 4 30-60cm	0.08	8.8	8.0	15.0	0.6	0.6	10.1	3.9	nt	0.39
10	HVO 4 60-80cm	0.07	8.7	7.8	16.9	0.7	0.6	12.3	3.7	nt	0.37

nt = not tested

S R Young

SOIL CONSERVATION SERVICE
Scone Research Centre

Report No: SCO12/250R1
Client Reference: Matt Hemingway
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P7B/2 Particle Size Analysis (%)					P7C/2 Particle Size Analysis – mech dis (%)					P9B/2
	Sample Id	clay	silt	f sand	c sand	gravel	clay	silt	f sand	c sand	gravel	EAT
1	HVO 2 0-15cm	43	21	24	11	1	36	26	25	12	1	3(1)
2	HVO 2 15-60cm	34	10	32	24	0	29	16	31	24	0	2(1)
3	HVO 2 60-80cm	34	10	27	29	0	30	11	31	28	0	2(2)
4	HVO 3 0-20cm	53	25	14	7	1	40	26	21	12	1	3(2)
5	HVO 3 20-70cm	25	14	27	27	7	22	15	28	28	7	3(2)
6	HVO 3 70-120cm	56	21	14	9	0	42	26	22	10	0	2(1)
7	HVO 4 0-3cm	34	24	15	27	<1	26	26	22	26	<1	5
8	HVO 4 3-30cm	15	7	25	51	2	7	7	30	54	2	5
9	HVO 4 30-60cm	36	16	26	22	0	33	17	29	21	0	3(1)
10	HVO 4 60-80cm	43	16	25	15	1	38	19	27	15	1	3(2)

S R Young

SOIL CONSERVATION SERVICE
Scone Research Centre

Report No: SCO12/250R1
Client Reference: Matt Hemingway
GSS Environmental
PO Box 907
Hamilton NSW 2303

Lab No	Method	P18B/2 AWC		Colour	
	Sample Id	0.3bar (%)	15bar (%)	dry	moist
1	HVO 2 0-15cm	33.5	17.2	10YR 5/4	7.5YR 4/4
2	HVO 2 15-60cm	33.3	15.8	10YR 6/4	10YR 5/4
3	HVO 2 60-80cm	31.6	15.2	7.5YR 6/4	7.5YR 5/6
4	HVO 3 0-20cm	34.8	19.9	7.5YR 5/4	7.5YR 3/4
5	HVO 3 20-70cm	18.6	9.1	10YR 6/3	7.5YR 4/4
6	HVO 3 70-120cm	31.6	17.4	7.5YR 5/3	7.5YR 3/4
7	HVO 4 0-3cm	30.3	14.8	10YR 5/4	10YR 3/3
8	HVO 4 3-30cm	12.6	6.0	7.5YR 6/4	7.5YR 4/6
9	HVO 4 30-60cm	23.4	12.7	7.5YR 6/6	7.5YR 5/6
10	HVO 4 60-80cm	26.0	14.6	7.5YR 6/6	7.5YR 5/8

AWC = moisture content (%) by weight

END OF TEST REPORT

Soil Conservation Service

Experienced people protecting your resources

709 Gundy Road, Scone NSW 2337
PO Box 283, Scone NSW 2337
P: 02 6545 1666
F: 02 6545 2520
M: 0408 446 132

Matt Hemingway
GSS Environmental
PO Box 907
Hamilton NSW 2303

31 August 2012 SCO12/250R1

Dear Matt Hemingway

Analysis of ten soil samples – Soil erodibility factor

The soil erodibility factor (K factor) has been determined for ten HVO soil samples (Soil test report SCO12/250R1) using the particle size analysis-mechanical dispersion and the organic carbon (as described by Rosewell 1993). The surface soil structure was assumed to be medium granular and the profile permeability was assumed to be slow to moderate.

Lab No	Sample Id	Soil erodibility factor	
		K factor	Rating
1	HVO 2 0-15cm	0.031	Moderate
2	HVO 2 15-60cm	0.034	Moderate
3	HVO 2 60-80cm	0.030	Moderate
4	HVO 3 0-20cm	0.025	Moderate
5	HVO 3 20-70cm	0.031	Moderate
6	HVO 3 70-120cm	0.028	Moderate
7	HVO 4 0-3cm	0.032	Moderate
8	HVO 4 3-30cm	0.032	Moderate
9	HVO 4 30-60cm	0.031	Moderate
10	HVO 4 60-80cm	0.029	Moderate

This interpretation was based on the soil samples being representative, and literature guidelines. If you have any queries, please contact me on (02) 6545 1666.

Yours sincerely

SR Young

SR Young, Laboratory Manager

References

Rosewell CJ (1993) Soiloss – A program to assist in the selection of management practices to reduce erosion. Department of Conservation and Land Management.

www.emgamm.com

SYDNEY
Groun oor, Suite 01, 20 Chandos Street
St Leonards, New South Wales, 2065
T 02 9493 9500 F 02 9493 9599

NEWCASTLE
Level 1, 6 Bolton Street
Newcastle, New South Wales, 2300
T 02 4927 0506 F 02 4926 1312

BRISBANE
Suite 1, Level 4, 87 Wickham Terrace
Spring Hill, Queensland, 4000
T 07 3839 1800 F 07 3839 1866

www.emgamm.com