Cadia Valley Operations

Cadia Valley Operations Surface Preconditioning and On-site Warehouse Modification

Environmental Assessment | February 2017

NEWCREST MINING LIMITED

CADIA VALLEY OPERATIONS
SURFACE PRECONDITIONING AND ON-SITE WAREHOUSE MODIFICATION

ENVIRONMENTAL ASSESSMENT

PREPARED BY
CADIA HOLDINGS PTY LIMITED

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Project No. NEC-16-83
Document No. 00820930

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1 INTRODUCTION

The Cadia Valley Operations are located approximately 25 kilometres (km) south-west of Orange, in the Central Tablelands of New South Wales (NSW) (Figure 1). Cadia Holdings Pty Limited (CHPL) is the owner and operator of the Cadia Valley Operations and is a wholly owned subsidiary of Newcrest Mining Limited.

Project Approval (PA) for the Cadia East Project was granted by the NSW Minister for Planning under Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 6 January 2010 (PA 06_0295). The approval includes all components of the mining operations at Cadia Valley Operations (as described in Schedule 1 of the Project Approval PA 06_0295) including the Cadia East underground mine, the Cadia Hill open cut mine, the Ridgeway underground mine, the Concentrate Dewatering Facilities, and ancillary infrastructure. These integrated operations are herein referred to as the Cadia Valley Operations.

1.1 OVERVIEW OF THE EXISTING CADIA VALLEY OPERATIONS

The Cadia Hill open pit, Ridgeway underground mine and Cadia East underground mine are located in the Cadia Valley within Mining Lease (ML) 1405, ML 1472, ML 1481, ML 1449, ML 1689 and ML 1690 (Figure 2). The Concentrate Dewatering Facility is located approximately 25 km to the east of the Cadia Valley in the town of Blayney (Figure 1).

Mining at the Cadia Valley Operations commenced at Cadia Hill in 1998 after a two year construction phase, and was placed on care and maintenance in 2012.

Ore production from the Ridgeway underground mine commenced in 2002 using block caving underground mining methods. Operations at the Ridgeway underground mine ceased in 2016 and was placed on care and maintenance.

Cadia East was approved in 2010 and the panel caving underground mine extraction method is used to extract approximately 450 million tonnes of ore over a period of 21 years. The ore contains gold, copper and some molybdenum. Figure 2 shows the approved General Arrangement at the end of the currently approved mine life.

Cadia East is described in full in the *Cadia East Project Environmental Assessment* (the Cadia East EA) (CHPL, 2009).

At peak operations, approximately 32 million tonnes per annum (Mtpa) of ore will be processed at the Cadia Valley Operations. Mineral concentrate containing gold and copper is pumped approximately 25 km from the Cadia Valley Operations to the nearby town of Blayney, where it is dewatered and loaded onto trains for transport to Port Kembla on the eastern seaboard.

1.2 OVERVIEW OF THE CADIA VALLEY OPERATIONS SURFACE PRECONDITIONING AND ON-SITE WAREHOUSE MODIFICATION

The Cadia Valley Operations Surface Preconditioning and On-Site Warehouse Modification (the Modification) would involve extension of the existing Cadia East surface preconditioning programme and the construction and operation of a new on-site warehouse.

The proposed Cadia East surface preconditioning programme (Figure 2) would build on similar preconditioning which occurred in 2014 and would involve approximately 150 additional diamond drill holes at 50 metre (m) spacing and hydro-fracturing of overburden across the Cadia East orebody to increase the number of cracks and fissures in the host rocks to assist with the propagation of subsidence.

In addition, an on-site warehouse would be constructed and operated to facilitate the receipt, storage and dispatch of consumables on-site.

A description of the Modification is provided in Section 2.

1.3 LEGISLATIVE FRAMEWORK

The Cadia Valley Operations is approved as a 'transitional Part 3A project' under clause 2 of Schedule 6A of the EP&A Act and therefore section 75W of the EP&A Act continues to apply to modifications to the Project Approval PA 06_0295, notwithstanding its repeal.[1] Section 75W of the EP&A Act relevantly provides:

> ***75W Modification of Minister's approval***
>
> *(1) In this section:*
>
> ***Minister's approval** means an approval to carry out a project under this Part, and includes an approval of a concept plan.*
>
> ***modification of approval** means changing the terms of a Minister's approval, including:*
>
> *a) revoking or varying a condition of the approval or imposing an additional condition of the approval, and*
>
> *b) changing the terms of any determination made by the Minister under Division 3 in connection with the approval.*
>
> *(2) The proponent may request the Minister to modify the Minister's approval for a project. The Minister's approval for a modification is not required if the project as modified will be consistent with the existing approval under this Part.*
>
> *(3) The request for the Minister's approval is to be lodged with the Director-General. The Director-General may notify the proponent of environmental assessment requirements with respect to the proposed modification that the proponent must comply with before the matter will be considered by the Minister.*
>
> *(4) The Minister may modify the approval (with or without conditions) or disapprove of the modification.*
>
> *…*

1.4 CONSULTATION FOR THE MODIFICATION

CHPL provided an overview of the Modification to the Department of Planning and Environment on 2 February 2017. In addition, CHPL presented a similar overview to the Community Consultative Committee on 13 February 2017.

In addition, CHPL wrote to the Division of Resources and Energy and the Department of Primary Industries – Water in February 2017 to describe the Modification and inform of the upcoming lodgement of the Modification.

[1] Part 3A of the EP&A Act (as in force immediately before its repeal) continues to apply. The description and quotations of relevant references to clauses of Part 3A in this document are as if Part 3A of the EP&A Act is still in force.

1.5 DOCUMENT STRUCTURE

This Environmental Assessment (EA) is structured as follows:

Section 1	Provides an introduction to the existing/approved Cadia Valley Operations and the Modification, describes the structure of this EA, legislative framework and provides a summary of the consultation undertaken.
Section 2	Describes the approved Cadia East Project and the Modification.
Section 3	Details the environmental assessment for the Modification.
Section 4	Provides a conclusion to this EA.
Section 5	Lists documents and reports referenced in this document.

2 PROJECT DESCRIPTION

2.1 OVERVIEW OF THE APPROVED PRECONDITIONING ACTIVITIES

2.1.1 Panel Cave Mining Method

The Cadia East panel caving operation would be conducted in three lifts (i.e. Lifts 0, 1 and 2). The Cadia East mining method involves inducing caving of the rock mass by undercutting a block of ore. Mining proceeds by progressively advancing an "undercut" level beneath the block of ore. Above the undercut level, the overlying host rocks are preconditioned using blasting and/or hydro-fracturing, resulting in controlled fracturing of the ore block. Figure 3 provides a schematic diagram of the panel caving ore extraction method during the mine life.

Following preconditioning of the overlying host rocks, broken ore is removed through an extraction level developed below the undercut level. The extraction level is connected to the undercut level by draw-bells, through which the ore gravitates to draw-points on the extraction level (Figure 3). The ore would then be removed by a load-haul-dump fleet to underground crushing stations.

2.1.2 Preconditioning Methods

Hydro-Fracturing Technique – Cadia East Environmental Assessment

The Cadia East EA describes how preconditioning using hydro-fracturing would be conducted at Cadia East to improve the fragmentation and caving characteristics of the ore, prior to panel cave mining being initiated.

Hydro-fracturing of ore involves isolating sections of ore via drilling and creating a pressurised zone by pumping water into the system until the tensile strength of the rock is reached and a fracture is created (Section 2.2.1). Once the fracture is created it is extended by pumping water at a rate of up to approximately 300 litres (L) per minute.

The Cadia East EA describes that once the planned fracture extension is achieved, the pressure would be released and up to 60 percent of the total water injected would be recovered via the mine dewatering system. Estimated water consumption for hydro-fracturing would be approximately 0.2 L per tonne of preconditioned ore or up to approximately 5 megalitres (ML) of water per annum. Approximately 3 ML of water per annum would be recovered.

The Cadia East EA did not identify or assess hydro-fracturing of the host rocks above the Cadia East mineralisation (e.g. weakly mineralised and unmineralised Ordovician porphyritic and vocaniclastic rocks and Silurian shales and sandstones).

Hydro-fracturing Technique – Cadia East Preconditioning Program

The *Cadia East Surface Preconditioning Program Environmental Assessment* (CHPL, 2014a) describes a programme of surface preconditioning using hydro-fracturing would be conducted at Cadia East to improve the fragmentation and caving characteristics of the ore, prior to panel cave mining being initiated.

A total of 10 diamond drill holes were developed in 2014 during this programme, which involved filling these holes with a cement-based grout, reaming out the grouted holes before preconditioning the surrounding rock using high-pressure water (i.e. water was pumped into the hole until the tensile strength of the host rock is reached and a fracture is created that radiates approximately 50 m from the drill hole).

The equipment required on the surface to conduct the surface preconditioning programme consisted of a surface drilling rig, or an underground rig bolted to a cement pad. The drill rig was used to pump water into the drill holes and operated 24 hours a day.

Blasting Technique

The *Cadia East Surface Blasthole Preconditioning Program Environmental Assessment* (CHPL, 2014b) also described how preconditioning using drilling and blasting may be used instead of or as well as hydro-fracturing.

The blasting technique involved the development of long, vertical drill holes from the undercut or extraction levels and controlled and precise detonation of explosives. Estimated consumption of bulk emulsion explosive was approximately 0.003 kilograms per tonne of preconditioned ore using up to a Maximum Instantaneous Charge of 1,500 kilograms of explosives per delay.

Subsidence Zone Propagation

Following conduct of the 2014 preconditioning campaign, the Cadia East subsidence zone broke through to the surface as planned in October 2014.

2.2 DESCRIPTION OF THE MODIFICATION

The Modification would include surface preconditioning of the rock mass above Cadia East and the construction and operation of an on-site warehouse.

2.2.1 Surface Preconditioning

The Cadia East Surface Preconditioning Programme Modification, approved in February 2014 (PA 06_0295, Modification 4), proposed to '*increase the number of cracks and fissures in the host rocks so that subsidence above the orebody occurs in a controlled manner'*. This proposal was specific for the program targeting the rock mass above panel cave 1 (Section 2.1.2). It was determined, from this program, that preconditioning by hydro-fracturing proved to be effective in promoting the safe and controlled propagation of the first Cadia East panel cave to the surface and, when necessary, would be used to promote future Cadia East caves to the surface. Accordingly, further preconditioning using hydro-fracturing is proposed.

The Modification would generally involve:

- The use of diamond drill holes, drilled in sequence with the mining operations throughout the life of mine. The minimum spacing is expected to be in a staggered 50 m x 50 m grid array and vary in length between approximately 400 and 650 m (Figures 2 and 4).
- Once drilled, the diamond drill holes would be filled with a cement-based grout which would remain in place until the preconditioning occurs. Grout would be used where necessary to maintain the integrity of the drill hole walls (i.e. prevent collapse or filling by loose rock).

- The first step in the hydro-fracturing process is to drill through (i.e. ream) the grout. The only drilling chemical required for the grout removal is an organic, biodegradable drilling product (i.e. AMC CR-650, Tiger Core), which would be used to help lift the cuttings from the hole. This product would be collected in the drilling sumps along with the drilling water and grout fines (i.e. drilling mud). Once the grout reaming is completed the drilling mud would be pumped to the Cadia East subsidence zone.
- Once the holes have been reamed out and prepared, the hydro-fracturing would be conducted. Water would be pumped into the hole until the tensile strength of the host rock is reached and a fracture is created that radiates approximately 50 m from the drill hole. Fractures would be installed at vertical intervals of approximately 2 m in the target areas of each hole. Approximately 12,000 L of water would be used per hydro-fracture. No additives would be used for the preconditioning (i.e. only water would be used).

2.2.2 On-Site Warehouse

This Modification also incorporates the construction and operation of a new on-site warehouse (Figure 4).

The Cadia East EA (CHPL, 2009) assessed all consumables being transported to the Cadia Valley Operations, where consumables were delivered to on-site workshops and stores. Subsequently, CHPL commenced use of a warehouse in Leewood, South Orange, which provided a 'hub' where consumables were initially delivered for storage prior to being dispatched to the Cadia Valley Operations.

In order to reduce transport and labour costs, CHPL proposes to move all consumable storage to a new and larger warehouse on-site to prepare for increasing the ore processing rate to the approved 32 Mtpa. The on-site warehouse is expected to result in the more efficient storage and distribution of consumables, resulting in operational cost savings.

The proposed warehouse would be constructed on existing/approved surface disturbance areas adjacent to the south waste rock dump and would include a separate building for lubricant storage and car parking.

3 ENVIRONMENTAL REVIEW

3.1 WATER RESOURCES

A Groundwater Assessment for the Cadia East Project was conducted as part of the Cadia East EA by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) (2009) and was peer reviewed by Dr Noel Merrick. The assessment included a comprehensive review of the available hydrogeological information and groundwater monitoring results, and the development and use of regional numerical groundwater model.

The Cadia Valley Operations groundwater model developed as part of AGE (2009) for the Cadia East Project has been updated on two occasions (AGE 2013 and 2017) in accordance with Schedule 3, Condition 34(d) of Project Approval PA 06_0295.

The Cadia East deposit is hosted in Ordovician porphyritic and vocaniclastic rock units, and in parts by 100 to 300 m of Silurian shales and sandstones. A thin Tertiary basalt cap also occurs in the north-eastern section of the approved Cadia East subsidence zone.

AGE (2017) has reviewed groundwater monitoring data collected since operations at the Cadia East mine commenced. Of particular note is that none of the monitoring bores within a cluster of bores on the edge of the approved subsidence zone show any significant response to the breakthrough of the cave zone in October 2014.

The lack of any significant response or drawdown within the monitoring bores both within the Tertiary basalt and Silurian sediments adjacent to the existing cave zone indicates the fracture networks within the major rock units are poorly interconnected, and therefore do not readily facilitate movement of groundwater (AGE, 2016). This conclusion is supported by the low volume of groundwater seepage entering the Cadia East mine, that is currently estimated to be in the order of 0.5 ML per day (AGE, 2017).

Potential Impacts

The Modification could potentially impact local groundwater resources through the pumping of additional water into the Ordovician host rocks and aquifer located above the Cadia East mineralisation and also by the pumping of the drilling sumps (containing drilling muds) into the Cadia East subsidence zone.

AGE (2017) has conducted a review of the potential impacts of the Modification on the groundwater resources in the Cadia Valley (Appendix 1). The review concluded that the proposed preconditioning would not induce additional fracturing beyond that already accounted for by the regional numerical groundwater modelling of the Cadia Valley Operations.

AGE (2017) identified that the proposed preconditioning would cause fracturing that would result in a continuation of the propagation of the subsidence zone, which broke through to the surface in 2014.

Notwithstanding, AGE (2017) identified that seepage from the Tertiary basalt and Silurian sediments has already been accounted for by the groundwater modelling. AGE (2017) therefore concluded that the preconditioning would have no net additional impact on the groundwater regime beyond that predicted by the numerical modelling (i.e. the predicted location and magnitude of the regional groundwater drawdown would remain unchanged).

The proposed preconditioning would not change the amount of water that would drain to and accumulate in the Cadia East underground workings (i.e. no change to groundwater extraction amounts). As a result, the current mine dewatering licences would not require any changes (AGE, 2017).

Groundwater quality impacts would be limited as the sump liquid (drilling mud) from drilling operations would be directed into the subsidence zone, towards the mine workings, which form a groundwater sink (i.e. groundwater flow is towards the mine). Accordingly, no groundwater quality impacts are anticipated (AGE, 2017).

In accordance with Condition 34 of Schedule 3 of Project Approval PA 06_0295, CHPL has prepared a Groundwater Monitoring Program which includes programs to monitor the volume of water seeping into the underground workings, a program to monitor the impacts on the groundwater supply of potentially landowners, and the impacts on springs and groundwater dependent ecosystems. These programs would be sufficient to monitor the effects of the surface preconditioning activities, without the need for additional monitoring sites, parameters or changes to the monitoring frequency.

3.2 NOISE

A comprehensive noise and blasting assessment for the Cadia East Project was undertaken by Wilkinson Murray (2009) as part of the Cadia East EA. The Noise and Blasting Assessment included assessment of:

- potential on-site operational noise impacts from the Cadia Valley Operations (including the Cadia East activities);
- potential noise impacts from the Concentrate Dewatering Facility;
- potential blasting impacts from the Cadia Valley Operations (including the Cadia East activities); and
- potential off-site road traffic noise impacts.

An acoustic model was developed and used to simulate the Cadia Valley Operations components and noise source information (i.e. sound levels and locations). The model also considered meteorological effects, surrounding terrain, distance from source to receiver and noise attenuation. The predicted operational and construction noise levels were generally lower than the Project-specific criteria at each assessed receiver location during daytime, evening and night-time operations for all modelled scenarios.

In accordance with Condition 9 of Schedule 3 of Project Approval PA 06_0295, CHPL has prepared a detailed Noise Monitoring Program for the Cadia Valley Operations. The Noise Monitoring Program describes the unattended and attended monitoring measures that are used, as well as the noise monitoring protocol that has been adopted to evaluate compliance with the noise impact assessment and land acquisition criteria specified in Project Approval PA 06_0295.

3.2.1 Operational Noise

The Modification could potentially affect the local acoustic amenity through the use of the surface drill rig to pump water into the holes used for hydro-fracturing. Wilkinson Murray (2017) (Appendix 2) has conducted a review of the potential noise impacts of the Modification (Attachment 2). The review concluded that the predicted noise levels of the pumps and drill rig alone are at least 13 decibels (dBA) below the relevant noise criteria at all receivers during the worst case night-time noise emission. At receivers closest to the preconditioning location, the noise from the pump and drill rig could increase the overall mine noise level by up to 0.5 dBA, depending on the location of the preconditioning activities. Wilkinson Murray (2017) concluded that this amount of change in noise levels is generally regarded as being imperceptible by the majority of people.

At no location is the minor increase in noise levels predicted to result in the noise impact assessment and land acquisition criteria specified in Project Approval PA 06_0295 being exceeded.

3.2.2 Construction Noise

Wilkinson Murray (2017) also considered noise associated with construction of the on-site warehouse. Construction would be undertaken daytime only (7:00 am to 6:00 pm) Monday to Saturday. Noise levels were predicted by simulating noise associated with the indicative construction fleet list provided by CHPL using the existing environmental noise model.

The resulting noise levels were assessed against both the *Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2009) criteria and the operational noise criteria in Project Approval PA 06_0295. The review concluded that the predicted construction noise levels are at least 10 dBA below the relevant noise criteria at all receivers. Accordingly, no noise impact is predicted due to construction of the warehouse (Wilkinson Murray, 2017).

3.3 TRAFFIC

The principal route used to access the Cadia Valley Operations is from Orange via Forest Road and Cadia Road (Figure 1). The existing Cadia Valley Operations access roads are located on Cadia Road.

Traffic impacts associated with the Cadia Valley Operations were assessed by Traffix (2009). The assessment found that the Cadia East Project would result in a short term increase in existing traffic levels during the Cadia East Project construction period and whilst the existing Cadia Valley Operations are operating. After this period, traffic levels would return to levels generally consistent with average Cadia Valley Operations traffic. The Levels of Service on local roads and intersections would not change as a result of the Cadia East Project (Traffix, 2009).

As described in Section 2.2.2, the Cadia East EA (CHPL, 2009) assessed all consumables being transported to the Cadia Valley Operations, where consumables were delivered to on-site workshops and stores. Subsequently, CHPL commenced use of a warehouse in Leewood, South Orange, which provided a ‘hub’ where consumables were delivered for subsequent dispatch to the Cadia Valley Operations. Under the Modification, all deliveries would be directed to a new warehouse on-site (Figure 2).

Table 1 provides a comparison of forecast traffic movements associated with the Modification with the existing/approved traffic movements.

Table 1
Traffic Movements Comparison

Assessment	Scenario	Project Year	Key Activities	Estimated Employee Trips	Estimated Daily Operation Truck Trips	Estimated Daily Construction Truck Trips
Cadia East Project EA	1	Year 2	• Cadia Hill • Ridgeway • Ridgeway Deeps • Cadia East Project Construction	1,643	132	150
	2	Year 4	• Cadia Hill • Ridgeway Deeps • Cadia East Project	1,191	132	5
Existing/Approved Operations	3	Current (2017) actual movements*	• Cadia East Project • Orange Distribution Centre	990 (Estimated)	102	6
Modification	**4**	**Cadia Valley Operations Warehouse Construction**	• **Cadia East Project** • **Warehouse Construction** • **Orange Distribution Centre**	**1,029**	**102**	**8**
	5	**Cadia Valley Operations Warehouse Operations**	• **Cadia East Project** • **Cadia Distribution Centre**	**994**	**94**	**6**

Source: After Traffix (2009).
* From site access data.
Note: A trip is a one-way vehicular movement.

From review of Table 1, it is noted that the forecast traffic movements associated with the construction and operation of the warehouse is likely to result in traffic movements slightly less than the long term predicted movements in Traffix (2009) (i.e. Scenario 2 in Table 1) and much lower than those during Cadia East Project construction (Scenario 1). As the Levels of Service on local roads and intersections were found not to change as a result of the Cadia East Project (Traffix, 2009); it follows that impacts on local roads and intersections would not change due to the Modification.

3.4 OTHER ASPECTS

The Modification would not require any additional land disturbance as it would use a combination of existing drill pads and access tracks, or the new tracks within approved disturbance areas (including the Cadia East subsidence zone). As indicated previously, the entire area in which the activities would occur is already approved to be disturbed as they would be located within the Cadia East subsidence zone. Notwithstanding, CHPL would adopt its existing land management practices when conducting the surface preconditioning programme (e.g. fire, weed and pest control measures, land and water contamination controls).

Views of the existing mining operations from dwellings and the local public road network (i.e. Cadia Road) to the east are generally screened by a ridgeline and intervening vegetation, including the Canobolas State Forest. Accordingly, neither the warehouse nor the proposed surface preconditioning activities would be visible from public vantage points (e.g. Cadia Road to the east of the Cadia Valley Operations) and no visual impacts are predicted to occur due to the Modification.

The Modification would not involve any activities that could potentially generate significant quantities of dust or adversely affect air quality.

4 CONCLUSION

The existing Project Approval PA 06_0295 for the Cadia Valley Operations authorises preconditioning of the Cadia East orebody using hydro-fracturing or blasting, however it does not currently allow for the ongoing preconditioning of the host rocks above the Cadia East orebody.

CHPL wishes to conduct a life of mine preconditioning program from the surface at Cadia East using hydro-fracturing. The surface preconditioning programme would involve the use of approximately 150 drill holes that extend approximately 400 to 650 m from the surface into the weakly mineralised and unmineralised host rocks above the Cadia East orebody. Water would be pumped into the holes and used to create fractures that radiate out approximately 50 m from each drill hole. The area in which the surface preconditioning programme would be undertaken is located entirely within the approved Cadia East subsidence zone.

A drill rig located on the surface would be used to pump water into the holes and precondition the host rocks, with the water allowed to drain downwards into the underlying Cadia East development and mining areas (where it would be collected and recycled). The surface preconditioning programme would be conducted 24 hours a day over the life of mine.

An on-site warehouse is proposed to be constructed on-site to facilitate the receipt, storage and dispatch of consumables on-site. The original Cadia East EA assessed road transport deliveries under a worst case of combined construction and ongoing operations. Accordingly, no additional deliveries would occur relative to those assessed in the Cadia East EA due to the operation of the on-site warehouse and no additional road transport impacts are anticipated.

Approval for the Modification is being sought via a modification to Project Approval PA 06_0295 under section 75W of the EP&A Act. An environmental assessment has been conducted and is documented in this report. The assessment includes reviews by AGE (groundwater) and Wilkinson Murray (noise), which both conclude that the surface preconditioning program would not result in any significant additional impacts when compared with the Cadia East EA and Project Approval PA 06_0295. No other material impacts on other environmental aspects (e.g. land resources, ecological values, amenity or heritage values) are predicted to occur.

5 REFERENCES

Australasian Groundwater and Environmental Consultants Pty Ltd (2009) *Cadia East Project Groundwater Assessment*. Report prepared for Cadia Holdings Pty Limited.

Australasian Groundwater and Environmental Consultants Pty Ltd (2013) *Cadia East Mine Update to Groundwater Model.* June 2013.

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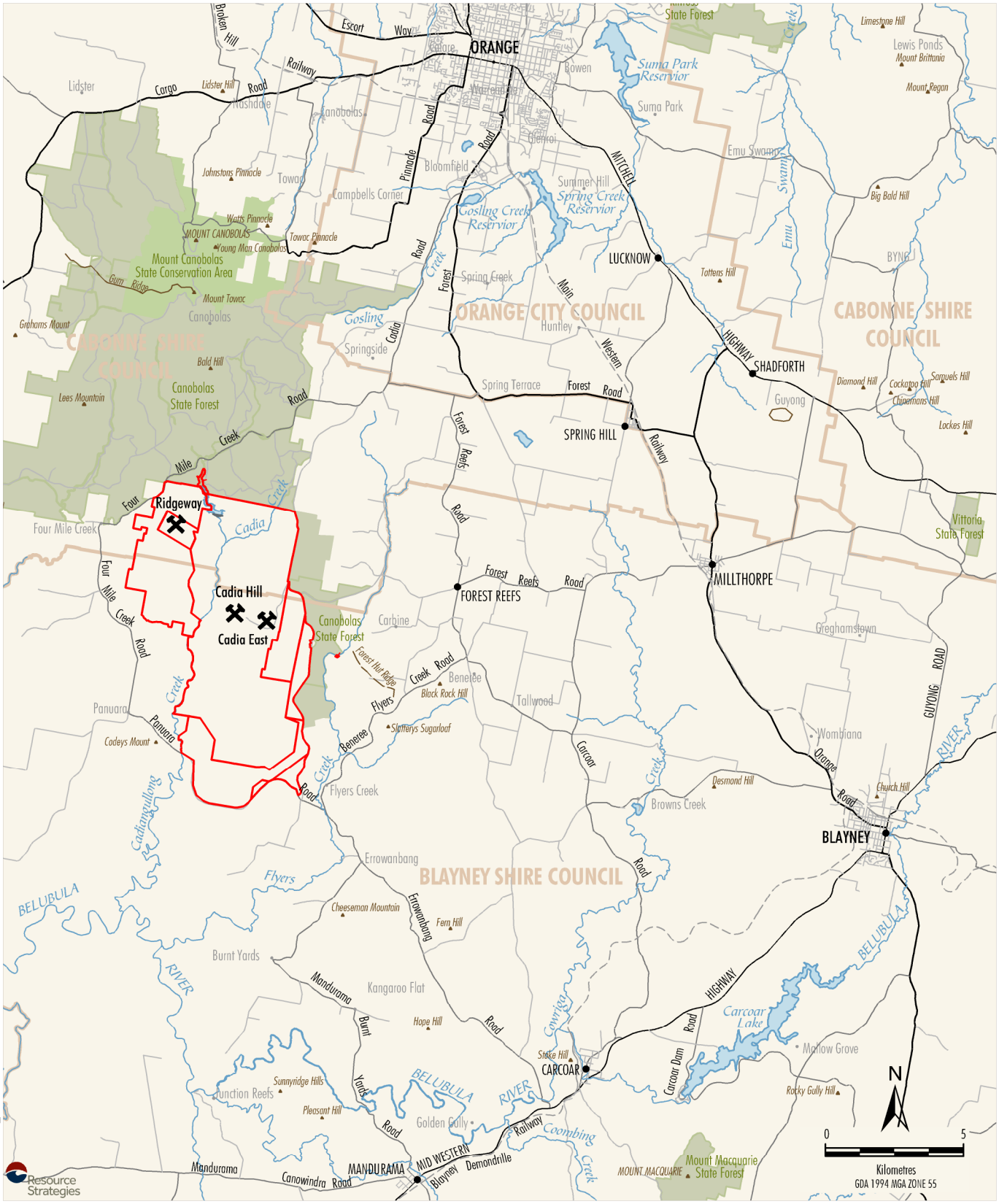
Department of Environment and Climate Change (2009) *Interim Construction Noise Guideline*.

Traffix (2009) *Cadia East Project Road Transport Assessment.*

Wilkinson Murray Pty Ltd (2009) *Cadia East Project Noise and Blasting Impact Assessment*. Report prepared for Cadia Holdings Pty Limited.

Wilkinson Murray Pty Ltd (2017) *Cadia East Surface Preconditioning Program*. Letter report prepared for Cadia Holdings Pty Limited.

FIGURES



LEGEND

- Mining Lease/Mining Lease Application Boundary
- Local Government Area
- Road
- Railway
- NSW State Forest - Forest Commission Land
- NPWS Reserve

Source: Department of Lands NSW (2006); Department of Industry (2017)

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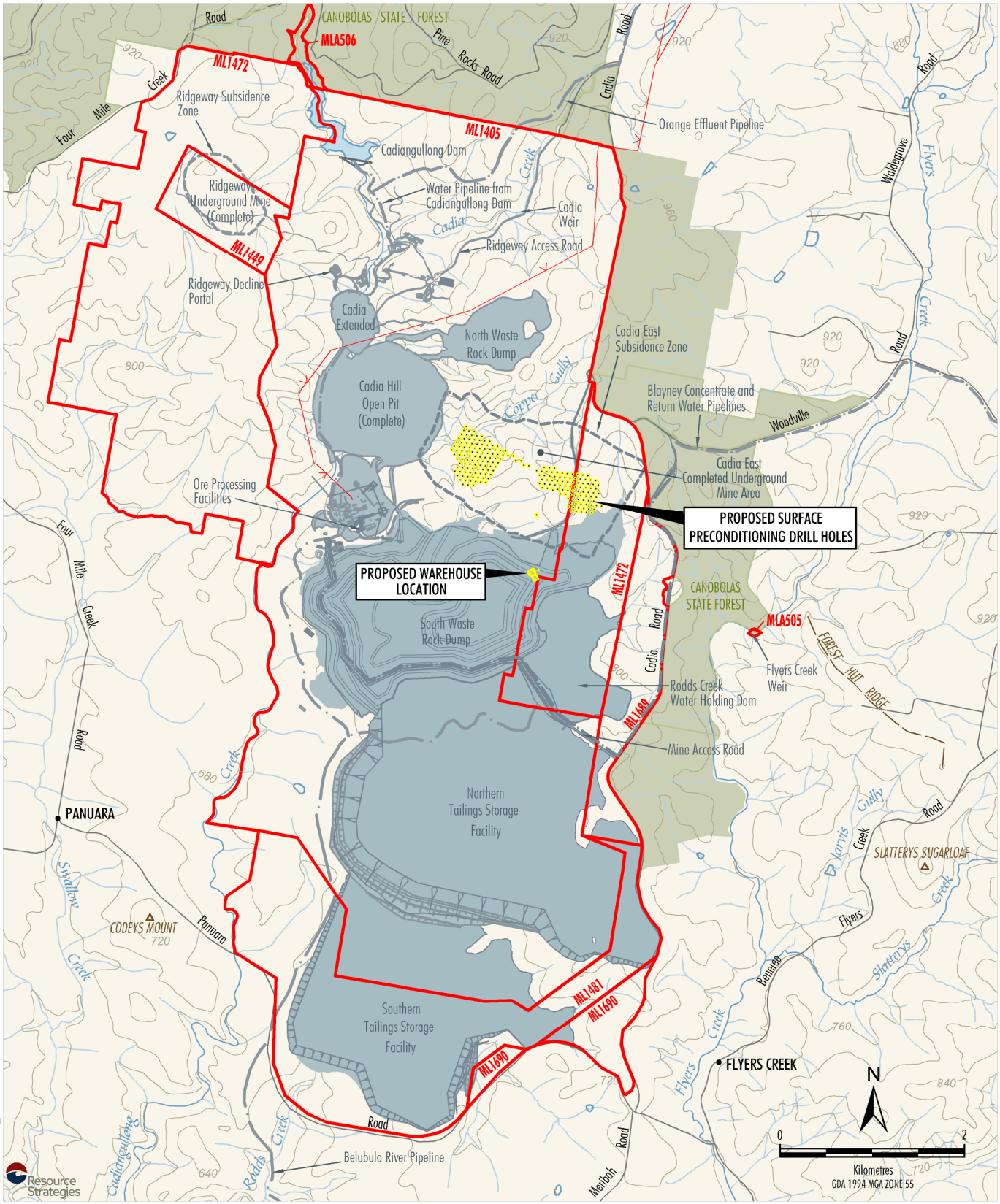
CADIA VALLEY OPERATIONS MODIFICATION 9

Regional Location

Figure 1



LEGEND

- Mining Lease/Mining Lease Application Boundary
- Powerline
- Road
- NSW State Forest - Forest Commission Land
- Existing/Approved Mine Infrastructure and Landforms
- Surface Preconditioning Drill Hole Conceptual Location

Source: CHPL (2009); Department of Industry (2017)

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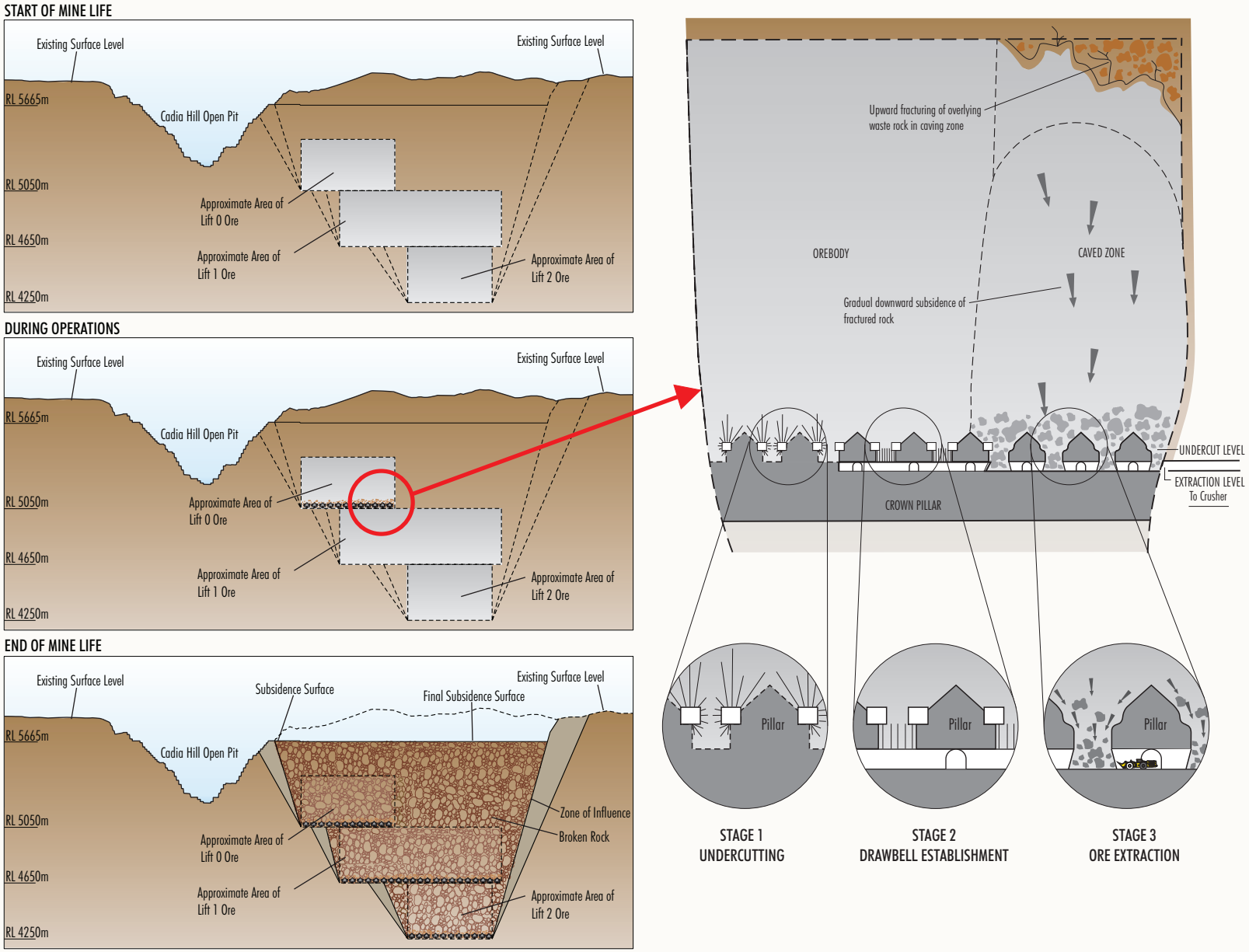
CADIA VALLEY OPERATIONS MODIFICATION 9

Cadia Valley Operations
Modification 9 General Arrangement

Figure 2



Resource Strategies

NEC-16-83 OSW Mod9_001A

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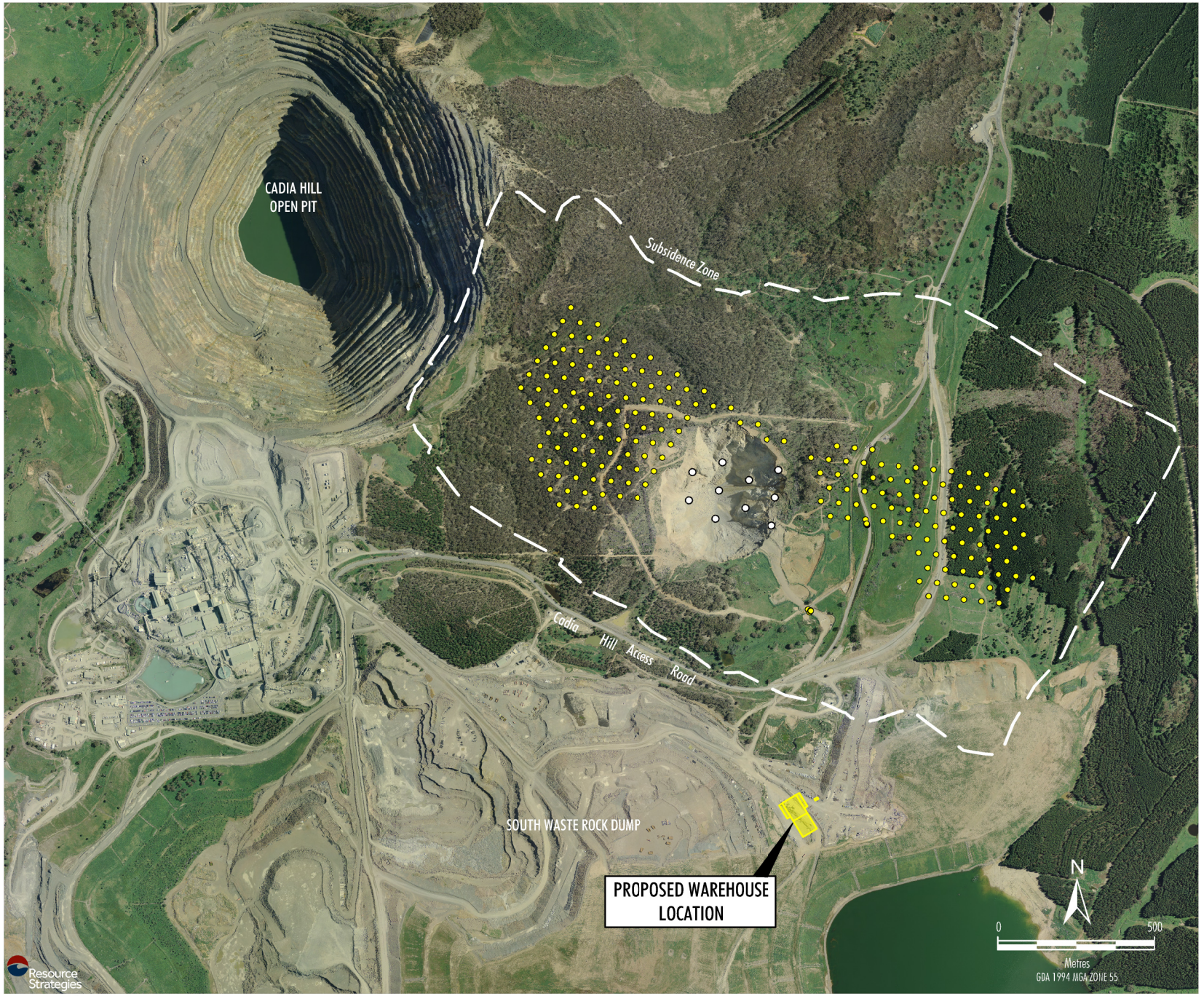
CADIA VALLEY OPERATIONS MODIFICATION 9

Panel Caving Mining Method Schematic

Figure 3



LEGEND

- Existing Drill Hole
- Proposed Drill Hole

Source: Aerial Photograph CHPL (Flown Nov 2016)

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CADIA VALLEY OPERATIONS MODIFICATION 9

Conceptual Surface Location of Drill Holes and Warehouse

Figure 4

NEC-16-83 OSW Mod9_103G

APPENDIX 1

GROUNDWATER REVIEW

Australasian Groundwater
and Environmental Consultants Pty Ltd
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JST:tp(G1383H.CadiaMOD9)
2 February 2017

Mr Andrew Wannan
Manager Environment

Cadia Valley Operations – Newcrest Mining Limited
via email

Dear Andrew,

RE: Cadia East Preconditioning – Groundwater Assessment

1 Introduction and scope of work

The Cadia Valley Operations (CVO) are located approximately 25 kilometres south-west of Orange, in the Central Tablelands of New South Wales (NSW), and comprises one open cut mine (Cadia Hill), and two underground mines (Ridgeway and Cadia East). Cadia Holdings Pty Limited (CHPL) owns and operates the CVO and is a wholly owned subsidiary of Newcrest Mining Limited.

The Cadia East mining method induces controlled caving of the rock mass by undercutting a block of ore. Mining proceeds by advancing an 'undercut' level beneath the block of ore. Above the undercut level, the overlying host rocks are preconditioned by drilling from within the underground mine and blasting and/or hydro-fracturing the ore block. CHPL has also 'preconditioned' the host rocks using hydro-fracturing from the ground surface to improve the controlled caving of the rock mass. The most recent program was conducted in 2014 and preceded the formation of the subsidence zone at the surface in October 2014. CHPL is now proposing additional hydro-fracturing holes from the land surface across the mine footprint so that subsidence continues to occur in a controlled manner. CHPL seeks a modification to the current Project Approval (PA 06_0295) to conduct the surface preconditioning program.

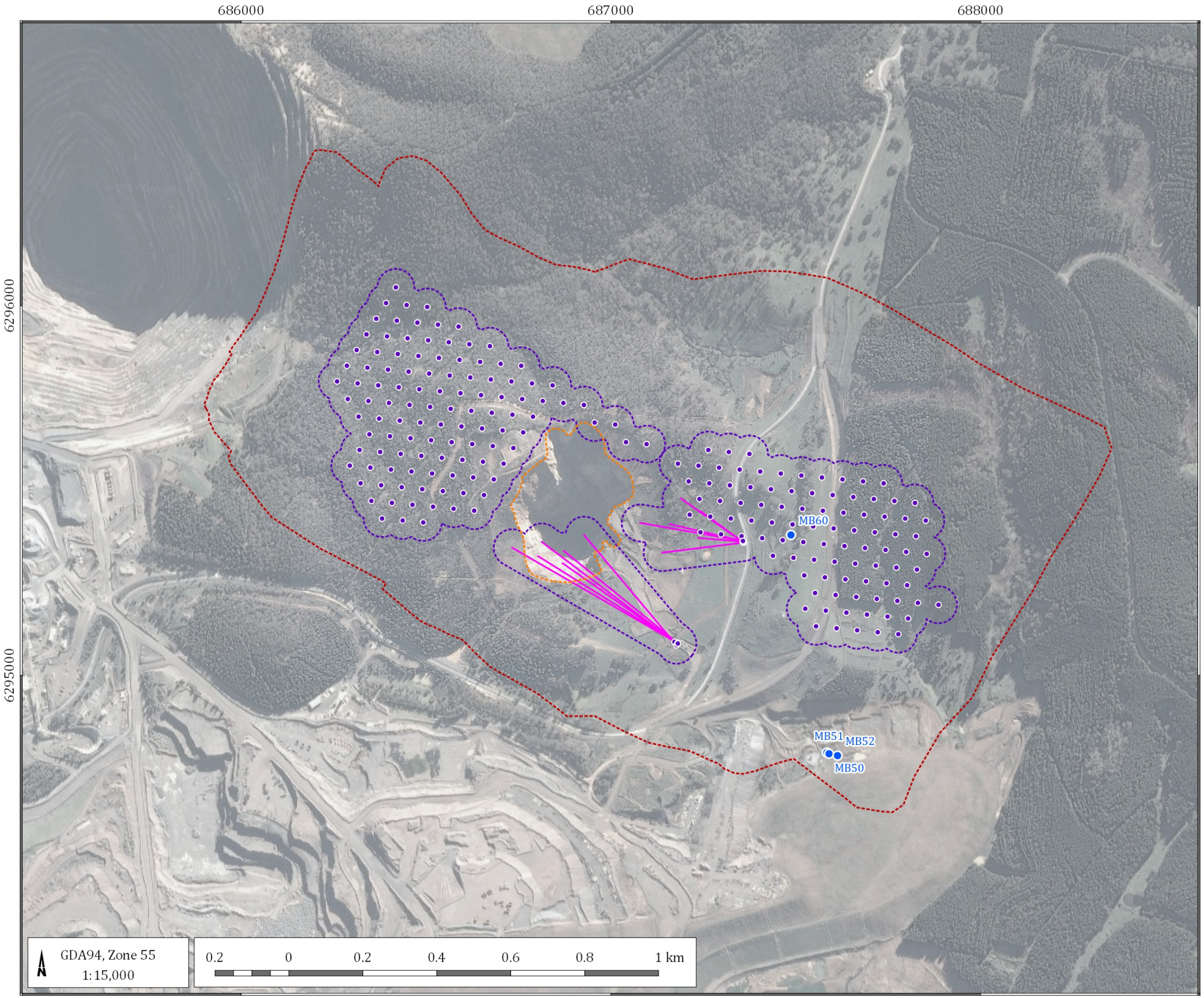
CHPL engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to assess the impacts of the proposed preconditioning program on the groundwater regime. This letter reviews the groundwater regime and discusses the impacts of the proposed preconditioning program. The impacts are also compared with the Minimal Impact Considerations of the *NSW Aquifer Interference Policy* (AIP) (NSW Office of Water [NOW], 2012).

2 Hydro-fracturing program

The modification would generally involve:

- The use of diamond drill holes, drilled in sequence with the mining operations throughout the Life of Mine. The minimum spacing is expected to be in a staggered 50 metre (m) x 50 m grid array and vary in length between approximately 400 m and 650 m.
- Once drilled, the diamond drill holes would be filled with a cement-based grout conducted which would remain in place until the preconditioning occurs. Grout is used where necessary to maintain the integrity of the drill hole walls (i.e. prevent collapse or filling by loose rock).
- The first step in the hydro-fracturing process is to drill through the grout. The only drilling chemical required for the grout removal is an organic, biodegradable drilling product (i.e. AMC CR-650, Tiger Core), which is used to help lift the cuttings from the hole. This product would be collected in the drilling sumps along with the drilling water and grout fines (i.e. drilling mud). Once the grout reaming is completed the drilling mud would be pumped to the Cadia East subsidence zone.
- Once the holes have been reamed out and prepared, the hydro-fracturing would be conducted. Water would be pumped into the hole until the tensile strength of the host rock is reached and a fracture is created that radiates approximately 50 m from the drill hole. Fractures would be installed at vertical intervals of approximately 2 m in the target areas of each hole. Approximately 12,000 litres of water would be used per hydro-fracture. No additives would be used for the preconditioning (i.e. only water would be used).

Figure 1 shows the extent of the fracturing assuming a 50 m influence around each drill hole.



LEGEND

- Vertical hydraulic fracturing hole
- Angled hydraulic fracturing hole
- Selected monitoring bore
- Approved Cadia East Subsidence Zone
- Current Cadia East Subsidence Zone
- 50m buffer around hydraulic holes

Cadia East (G1383H)

Subsidence zone and hydraulic fracturing holes

DATE
25/01/2017

FIGURE No:
1

©2017 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au;
G:/Projects/G1383H.Cadia_MOD9/3_GIS/Workspaces/001_Deliverable1/01_G1383H_Subsidence zone and holes.qgs

3 Groundwater regime of the subsidence zone

There are three major hydrostratigraphic units within the project site and region:

- Tertiary basalt, which forms a productive aquifer utilised by surrounding properties with varying yields from low to high and consistently fresh water suitable for potable use;
- the underlying Silurian sequence which is more variable can form a low yield aquifer from fractured sandstone and siltstones, with locally high yields where fractured limestones are present towards the base of the sequence; and
- the Ordovician volcaniclastic basement rocks which have a widely spaced and poorly interconnected fracture network beyond the major fault zones and form an aquitard with very low yields and slightly brackish water quality.

The Tertiary basalt is discontinuous and occurs only within the eastern portion of the approved subsidence zone. Within the area of the subsidence zone a more continuous sequence of about 200 m of Silurian sediments occurs as a capping layer over the Ordovician volcaniclastic basement rocks. The Cadia East mining workings are in excess of about 1,000 m below the surface.

CVO monitors a large network of groundwater bores that are located around the mining areas, tailings dams and within the wider agricultural region surrounding the mine. Of most interest to the proposed modification are the monitoring bores that are closest to the Cadia East subsidence zone. There are four bores in proximity to the subsidence zone where groundwater levels have been monitored before and after the breakthrough of the current cave zone in October 2014. These bores are of interest as they can be examined to determine how the groundwater systems respond to previous hydro-fracturing programs and the breakthrough of the subsidence zone at the surface. Figure 1 shows the locations of the monitoring bores with Table 1 below summarising the key details for each bore.

Table 1 Groundwater monitoring bores – construction details

Hole ID	Coordinates*		Screened horizon	Ground level* mAHD	Gravel pack mbGL
	mE	mN			
MB50	687,584	6,294,791	Silurian limestone/ forest reef volcanics	808.02	Open hole 197-217
MB51	687,590	6,294,788	Silurian siltstone	808.15	36 - 57
MB52	687,613	6,294,783	Silurian siltstone	807.29	34 - 57
MB60	687,487	6,295,380	Tertiary basalt	901.55	43.3 - 56.8

Notes: *Co-ordinates AGD84, Zone 55*

mE = metres Easting, mN = metres Northing

mAHD = metres above Australian height datum

mbGL = metres below ground level

** surveyed by CVO staff with survey equipment – sub-meter accuracy*

Historically five bores were drilled into Silurian sediments within the predicted Cadia East subsidence zone to investigate the water bearing potential of the Silurian sequence. A further three bores (MB50, MB51, MB52) were installed adjacent to a ventilation shaft (known as Raise Bore VR81) adjacent to the subsidence zone to investigate the potential for seepage from the Silurian into the underground mine when drilling the shaft.

Continuous water level records are available for MB60 and the cluster of bores around the ventilation shaft (MB50, MB51, MB52), which is adjacent to the approved subsidence zone. Other bores within the subsidence zone were found to be dry upon installation and have not been monitored continually.

Figure 2 shows the recorded groundwater levels in each bore before and after the breakthrough of the subsidence zone at the land surface. It also shows the occurrence of rainfall recharge (millimetres [mm]) estimated by AGE (2016).

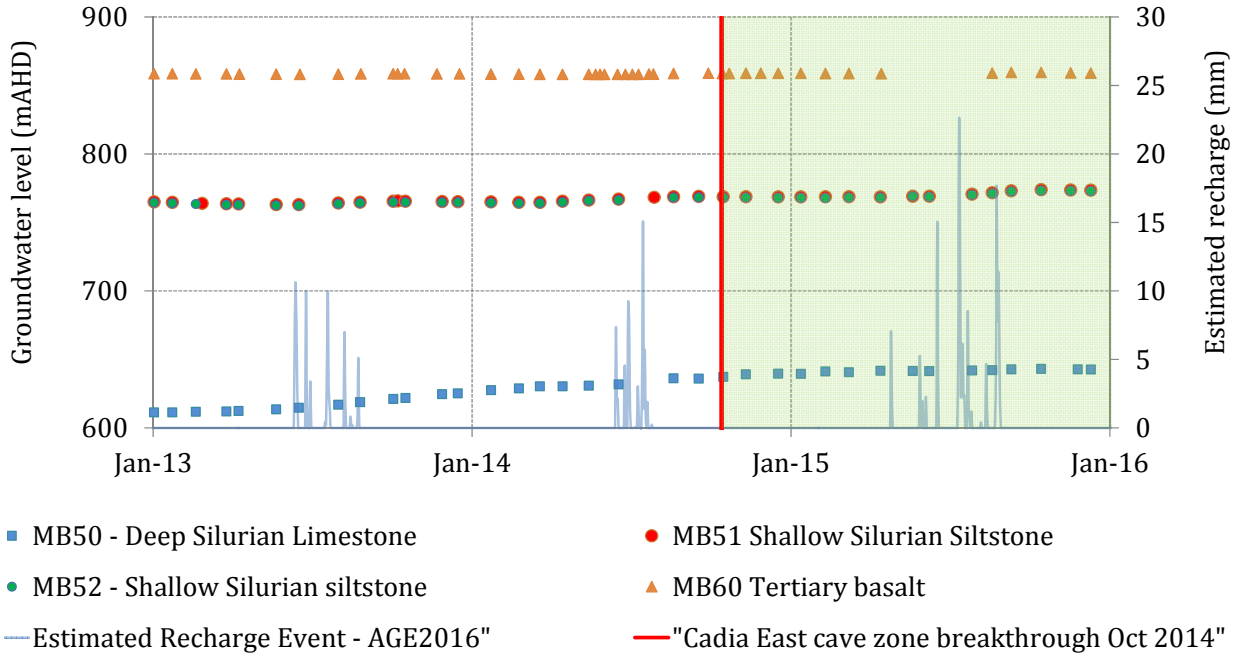


Figure 2 Groundwater levels

The closest monitoring bore to the subsidence zone is MB60, which is screened within Tertiary basalt. Water level records from within this bore have been relatively stable since installation in 2013, and did not react to the previous drilling for hydro-fracturing, or when the cave zone broke through to the surface in October 2014. There is also limited response in water levels to periods of rainfall recharge.

The cluster of bores outside the approved subsidence zone (MB50, MB51, MB52) have all recorded increasing groundwater levels since installation in 2013, and clearly respond to periods of rainfall recharge. There is a notable difference in the groundwater levels within the shallow Silurian siltstone water levels compared with the deeper Silurian limestone. Groundwater levels within the Silurian limestone were significantly depressed during installation of the Raise Bore VR81, and has only recorded a slow recovery since this time. Previous work concluded the Silurian basal limestone unit is highly heterogeneous and does not occur as a uniform layer across the subsidence zone and has a poor ability to store and transmit water due to a low primary porosity, except along fault zones where fracturing creates secondary porosity increasing water storage. The slow recovery of water levels within this unit supports this previous conclusion. Of particular note is that none of the monitoring bores within this cluster show any significant response to the breakthrough of the cave zone in October 2014.

The lack of any significant response or drawdown within the monitoring bores both within the Tertiary basalt and Silurian sediments adjacent to the existing cave zone indicates the fracture networks within the major rock units are poorly interconnected, and therefore do not readily facilitate movement of groundwater. This poor interconnection is common in fractured rock groundwater systems and means flow of groundwater to the subsidence zone as well as resultant drawdown is limited. This conclusion is supported by the low volume of groundwater seepage entering the Cadia East mine, that is currently estimated to be in the order of 0.5 megalitres per day (ML/day).

4 Impact of preconditioning

As noted previously, the groundwater model for the mine has been updated on two occasions (AGE, 2013; 2016) in accordance with Schedule 3, Condition 34(d) of PA 06_0295. On both occasions, the groundwater model has used updated estimates of the extent of subsidence provided by CVO. The estimated extent of the subsidence zone has generally decreased between each model update based on more refined geotechnical modelling of the planned subsidence extent. The less extensive subsidence zone along with recalibration of the model to match the limited drawdown observed in the monitoring network to date has generally resulted in the model predicting less extensive drawdown around the mining areas, and less inflow to the workings. The steady state nature of the 2009 model upon which the approval was based also contributed to the larger zone of drawdown predicted by that model.

The groundwater model developed for the project approval in 2010 simulated mining at Cadia East from 2013 until the end of mining, with the fracturing estimated at that time to first break through to the surface in late 2017/early 2018. Previous preconditioning programs resulted in the subsidence zone break in a relatively small area, occurring on 10 October 2014. The proposed hydro-fracturing remains within the approved subsidence zone and based on the planned commencement in April 2017, it will promote further subsidence and breakthrough in line with the assumption of 2017/2018 in the original numerical model.

The proposed preconditioning would not induce additional fracturing beyond that already accounted for by groundwater modelling. It would however need to be represented within future updates to the groundwater model.

Measurements of groundwater entering the Cadia East underground during operations have been relatively low (0.5 ML/day), which indicates a relatively low permeability rock mass and limited drainage of groundwater from the overlying Tertiary basalt and Silurian sediments due to the poor fracture connectivity within the rock mass. The Cadia East Mine dewatering has already been accounted for by previous modelling. It is therefore concluded that the preconditioning would have no net additional impact on the groundwater regime beyond that predicted by numerical modelling for Cadia East. As a result, the preconditioning modification would not change mine dewatering licences requirements.

Groundwater quality impacts would be limited as the sump liquid (drilling mud) from drilling operations would be directed into the subsidence zone, towards the mine workings, which form a groundwater sink (i.e. groundwater flow is towards the mine). Accordingly, no groundwater quality impacts are anticipated.

5 Aquifer Interference Policy

The Cadia East Project was assessed and approved in 2009 prior to the enactment of the AIP (NOW, 2012). Groundwater extraction licences have been issued for the CVO, and as described above, no net increase to the predicted groundwater take or licenced allocations are required as a result of the modification. Notwithstanding, a comparison of the CVO including proposed modification against the AIP (NOW, 2012) is provided in the tables below. Much of this is based on the updated modelling presented by AGE (2016), and therefore, describes the impacts of the entire CVO, not the preconditioning modification alone.

	AIP requirement	Proponent response
1	Described the water source (s) the activity will take water from?	• Lachlan Fold Belt MDB Groundwater Source • Orange Basalt Groundwater Source
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	• Lachlan Fold Belt MDB Groundwater Source – 792 megalitres per year (ML/yr) • Orange Basalt Groundwater Source – 289 ML/yr average • **No additional take due to preconditioning modification**
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	No more than above
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (page 27)	Numerical model used subjected to 3D transient calibration – refer AGE (2016)
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	• Lachlan Fold Belt MDB Groundwater Source – 792 ML/yr • Orange Basalt Groundwater Source – 289 ML/yr average • **No additional take due to preconditioning modification**
6	Described how any licence exemptions might apply?	N/A
7	Described the characteristics of the water requirements?	Yes – refer AGE (2016)
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	Yes • WAL31702 - Units 371 megalitres (ML), Lachlan Fold Belt MDB Groundwater Source • WAL36229 - Units 931ML, Lachlan Fold Belt MDB Groundwater Source • WAL31062 - Units 196ML, Orange Basalt Groundwater Source • **No additional take due to preconditioning modification**
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	Yes
10	Determined how it will obtain the required water?	Yes

	AIP requirement	Proponent response
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	N/A
12	Considered actions required both during and post-closure to minimize the risk of inflows to a mine void as a result of flooding?	Yes surge pumping system installed to mitigate risk during mining. Post mining voids will flood and lake will form in the subsidence void **No additional flow due to preconditioning modification**
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Surrendering of water licenses post mining if required
	Will uncertainty in the predicted inflows have a significant impact on the environment or other authorized water users? *Items 14-16 must be addressed if so.*	**No additional inflow predicted due to preconditioning modification**
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?	Purpose of hydro-fracturing is to reduce rock strength within the subsidence zone which will enhance hydraulic connections. The extent of enhancement will remain within the approved subsidence zone.
15	Quantified any other uncertainties in the groundwater or surface water impact modeling conducted for the activity?	Yes sensitivity analysis undertaken by AGE (2016)
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	Yes ongoing monitoring and routine updates to groundwater model in accordance with Schedule 3, Condition 34(d) of PA 06_0295

Determining water predictions in accordance with Section 3.2.3

	AIP requirement	Proponent response
1	Addressed the minimum requirements found on page 27 of the AIP for the estimation of water quantities both during and following cessation of the proposed activity?	Yes

Other requirements to be reported on under Section 3.2.3

	AIP requirement	Proponent response
1	Establishment of baseline groundwater conditions?	Yes
2	A strategy for complying with any water access rules?	Yes
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	Yes
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	Yes
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	N/A
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	N/A
7	Potential to cause or enhance hydraulic connection between aquifers?	Yes
8	Potential for river bank instability, or high wall instability or failure to occur?	N/A
9	Details of the method for disposing of extracted activities (for CSG activities)?	N/A

Addressing the minimal impact considerations

Aquifer	Fractured Rock - Orange Basalt
Category	Highly productive

Level 1 minimal impact consideration	Assessment
Water Table 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 water table decline cumulatively at any water supply work.	**Acceptable** • No high priority groundwater dependent ecosystems or culturally significant sites have been identified within the predicted zone of depressurisation. • Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m.
Water pressure A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.	**Acceptable** • Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	**Acceptable** • During mining groundwater flow is towards the mine. Sump liquid from drilling operations would also be directed into the subsidence zone, towards the mine workings. Therefore, there will be no change in the beneficial use category of the basalt. • Post mining the subsidence void will remain a permanent sink to groundwater and therefore the flow will still be into the void and there will be no change in the beneficial use category of the basalt

Aquifer	Porous rock or fractured rock – Silurian and Ordovician Bedrock - Lachlan Fold Belt MDB Groundwater Source
Category	Less productive

Level 1 Minimal impact consideration	Assessment
Water Table 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 water table decline cumulatively at any water supply work.	**Acceptable** • No high priority groundwater dependent ecosystems or culturally significant sites have been identified within the predicted zone of depressurisation. • Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m.
Water pressure A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.	**Acceptable** • Updated model indicates no private water supply bores predicted to be impacted by drawdown in excess of 2 m
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	**Acceptable** • During mining groundwater flow is towards the mine. Sump liquid from drilling operations would also be directed into the subsidence zone, towards the mine workings. Therefore, there will be no change in the beneficial use category. • Post mining the subsidence void will remain a permanent sink to groundwater and therefore the flow will still be into the void and there will be no change in the beneficial use category

6 Conclusion

It is concluded that the proposed preconditioning would not change the amount of water that would drain to and accumulate in the Cadia East underground workings (i.e. no change to groundwater extraction amounts). As a result, the preconditioning modification would not change mine dewatering licences requirements. Groundwater quality impacts would be limited as the sump liquid from drilling operations would be directed into the subsidence zone, towards the mine workings, which form a groundwater sink. Accordingly, no groundwater quality impacts are anticipated. A review of impacts associated with the modification against the AIP's Minimal Impact Considerations indicates that the modification is acceptable.

7 References

Australasian Groundwater and Environmental Consultants Pty Ltd, (2013), *"Cadia East Mine Update to Groundwater Model"*, June 2013, Project Number G1383A.

Australasian Groundwater and Environmental Consultants Pty Ltd, (2016), *"Cadia Mine Update to Groundwater Model"*, August 2016, Project Number G1383C.

New South Wales Office of Water, (2012), *"Aquifer Interference Policy".*

Please contact the undersigned should you have any queries or require clarification.

Yours faithfully,

JAMES S. TOMLIN
Principal Hydrogeologist/Director
Australasian Groundwater and Environmental Consultants Pty Ltd

APPENDIX 2

NOISE REVIEW

3 February 2017

WM Project Number: 14060-C
Our Ref: chpl030217gj

Mr Andrew Wannan
Cadia Holdings Pty Ltd
1460 Cadia Road
ORANGE NSW 2800

Dear Andrew

Re: Cadia Modification 9 - Noise Assessment

Cadia Holdings Pty Limited (CHPL), a wholly owned subsidiary of Newcrest Mining Limited, owns and operates the Cadia Valley Operations (CVO), which are situated some 25 kilometres south-west of Orange, in the Central Tablelands of New South Wales (NSW).

Project Approval for the Cadia East Project was granted by the NSW Minister for Planning under Part 3A of the *Environmental Planning and Assessment Act, 1979* on 6 January 2010 (PA 06_0295). The approval includes all components of the CVO (as described in Schedule 1 of PA 06_0295) including the Cadia East underground mine, the Cadia Hill open cut mine, the Ridgeway underground mine, the Concentrate Dewatering Facilities, and ancillary infrastructure.

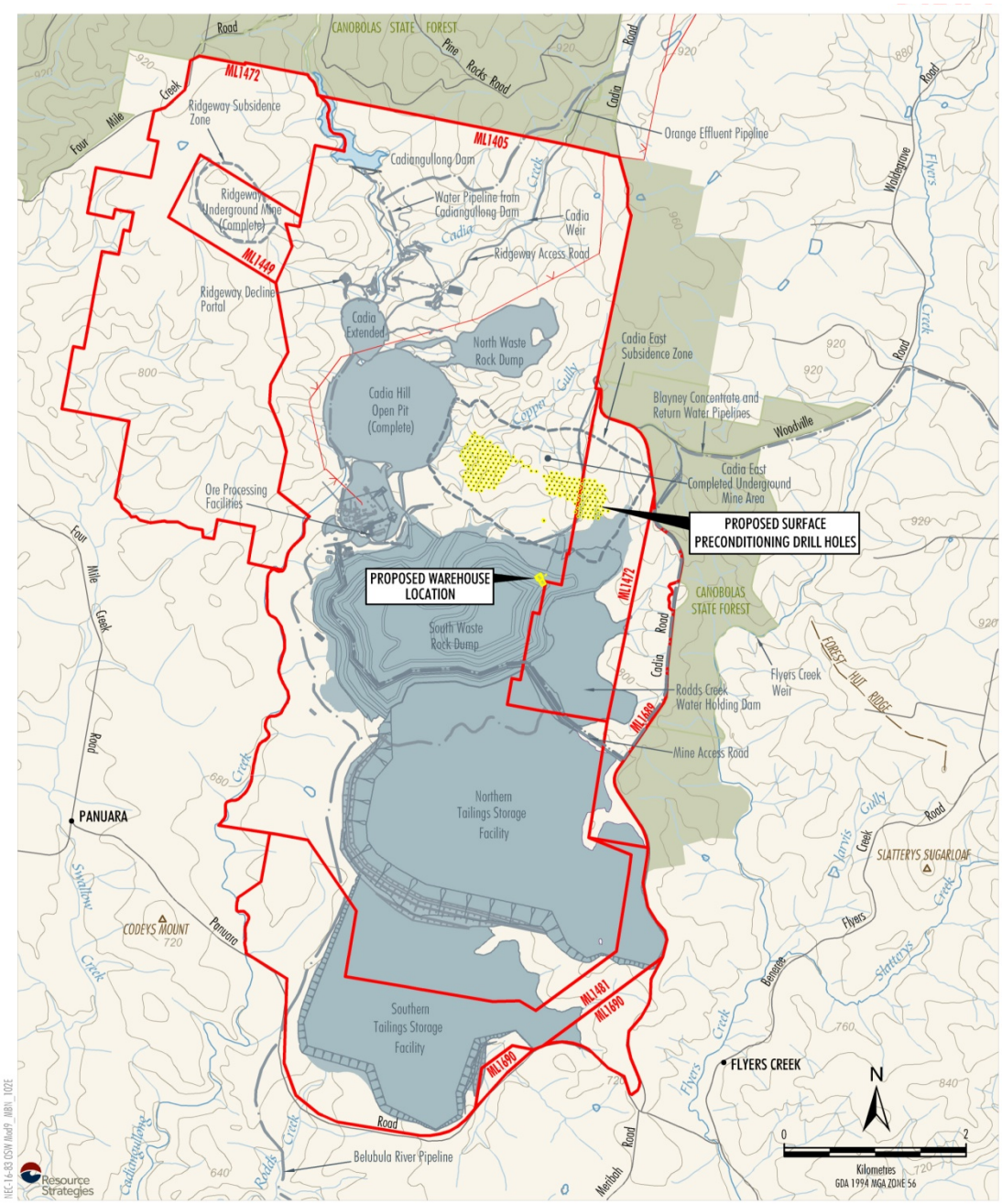
A modification to the Project Approval (PA 06_0295) is now sought to allow "preconditioning activities" (Modification 9). The modification involves hydro-fracturing of rock above the Cadia East orebody. The preconditioning process includes a pump and drill rig at surface level and therefore has the potential to cause noise impacts. The location of the preconditioning area is shown on Figure 1.

Noise from preconditioning activities associated with Modification 4 were assessed by Wilkinson Murray in 2014 (Wilkinson Murray Ref: RS070214 of 3 February 2014).

It is also proposed to construct a new on-site warehouse as shown on Figure 1. This report also assesses noise from construction of the warehouse.

The proposed modification does not affect operational blasting, traffic noise or noise levels at the CVO Dewatering Facility, therefore no consideration of these aspects is provided in this report.

Figure 1 Location of Drilling and Warehouse



SUMMARY OF PREVIOUS NOISE ASSESSMENTS

Noise Assessment for the Cadia East Project Environmental Assessment

Wilkinson Murray conducted a Noise and Blasting Assessment of the Cadia East Project in 2009, with the report being included as Appendix D of the Environmental Impact Statement of that project.

Noise level criteria were developed in accordance with the procedures of the *NSW Industrial Noise Policy (INP)*.

Noise levels from existing approved and proposed operations at the CVO were assessed cumulatively with proposed construction activities.

The Wilkinson Murray (2009) Cadia East Project Noise and Blasting Assessment report concluded that:

- Operational noise impacts would be greatest during the early part of the Project when Cadia Hill and Ridgeway would be still active and construction activities associated with Cadia East would be undertaken (i.e. from 2010 to 2012). Noise levels were expected to increase marginally from 2007 levels (1-2 'A' weighted decibels [dBA]) at night in Year 1 of the Project (2010). Noise levels would however comply with the project-specific criteria at all but one of the sensitive receivers, which would experience a minor (1 dBA) exceedance[1]. This receiver would be in the noise management zone.
- Noise levels would steadily decrease over the following years as Cadia Hill and Ridgeway are completed. It was anticipated that noise levels in Year 4 would decrease by around 2 dBA on average, relative to the Year 1 noise levels. By Year 17 of the Cadia East mine life a further reduction of 2-3 dBA was predicted during Cadia East-only operations.

In summary, the 2009 assessment predicted that while there would be a short-term marginal increase in operational noise during Year 1, noise would subsequently reduce over the life of the Cadia East mine.

Noise Assessment for Modification 4

Noise from preconditioning activities associated with Modification 4 were modelled (Wilkinson Murray Ref: RS070214 of 3 February 2014). The predicted noise levels were well under the noise limits at the nearest noise-sensitive receivers.

Processing Rate Modification

Wilkinson Murray Report 06325-M (March 2015) was a noise assessment of the Processing Rate Modification. The Modification included changes to the ore processing facilities such as additional crushing, grinding and flotation capacity.

The assessment predicted continued compliance with key noise criteria, and recommended that noise monitoring continues to be conducted in accordance with the Noise Monitoring Program (CHPL, 2014a) to confirm the modelling results.

---

1 Receiver now owned by CHPL.

NOISE MONITORING

Attended noise monitoring is conducted bi-annually at the CVO as required by Project Approval PA 06_0295.

Previous hydro-fracturing activities for Modification 4 were undertaken in 2014.

Wilkinson Murray Report 06325-M included a review of noise monitoring from July 2012 to June 2014 which indicated that operational noise complied with the relevant Project Approval (PA 06_0295) criteria at privately-owned residences (CHPL, 2013; 2014b).

The CVO Annual Environmental Management Report 2014/1015 includes a summary monitoring results for July 2014 to June 2015. A review of the monitoring results indicates that hydro-fracturing activities were not audible at any time. No exceedances were recorded by attended monitoring methods during this period.

NOISE CRITERIA

The noise impact assessment criteria for the CVO are set out in Condition 2 of Schedule 3 of Project Approval (PA 06_0295), and are repeated below.

The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 2-1 at any residence on privately owned land or on more than 25 per cent of any privately owned land.

Table 2-1(PA 06-0295) Noise Impact Assessment Criteria – dBA

Location	Operational Noise Criteria, $L_{Aeq,15min}$			Sleep Disturbance Criterion, $L_{A1,1min}$
	Day	Evening	Night	
Mining Operations				
41-CW Knox ('Meribah', 43-CJ Healey ('Triangle Park'), 138-AC & A Bailey ('Mayburies', 45-CC Colman ('Mirrabooka'), 246-CK Channell and KP & DV Donlan ('Eastburn'), 209-JI McLennan ('Northwest'), 171-GA Knox ('South Log')	43	38	38	45
1-GT & JA Christou ('Coorabin'), 137-MP & LA Ellis ('Argyle'), 169-RL & SL Chamberlain ('Weemalla')	43	38	37	45
44-AR Colman ('Triangle Flat'), 105-KA Hughes ('Barton Park'), 133-LC & LR Baker ('Bonnie Glen')	43	38	36	45
Other privately owned land	43	38	35	45

Notes:

- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*
- *The noise limits do not apply if the Proponent has an agreement with the relevant owner/s of these residences/land to generate higher noise levels, and the Proponent has advised the Department in writing of the terms of this agreement.*

The $L_{A1,1min}$ sleep disturbance criteria for the various sites apply between 10.00pm-7.00am. Considering that $L_{A1,1min}$ and L_{Amax} descriptors are similar, the L_{Amax} noise levels have been used for the purpose of this assessment.

The Proponent shall implement all reasonable and feasible measures to ensure that the noise generated by the project combined with the noise generated by other mines and industries does not exceed the amenity criteria in Table 2-2 at any residence on privately owned land or on more than 25 per cent of any privately owned land, to the satisfaction of the Director-General.

Table 2-2(PA 06-0295) Cumulative $L_{Aeq(period)}$ Noise Criteria – dBA

Location	Day	Evening	Night
Mining Operations			
All privately owned land	*50*	*45*	*40*

Note: Cumulative noise is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.

NOISE LEVELS ASSOCIATED WITH THE PROPOSED PRECONDITIONING

Source of Noise

The source of noise from the preconditioning works would be a pumps and a drill rig. The pump and drill rig would be used to pump water underground via existing/approved drill holes to induce the hydro-fracturing.

Two of the pumps and a diamond drill rig will operate in unison. The pumps sit adjacent to each other, the diamond drill rig is between 50 metres (m) and 400m away from the pumps depending on collar location. Based on manufacturer's data, the assumed sound power level of the equipment is:

- Pumps (450 kilowatts) – L_{Aw} 97dBA; and
- Drill (DR950 Drilling Rig) – L_{Aw} 108dBA.

There are approximately 150 drill hole locations that would be constructed and operated across eight stages. Operations were assumed to occur on a 24 hour per day basis.

Noise Prediction

The noise model used for the Wilkinson Murray (2009) Cadia East Noise and Blasting Assessment was used to predict noise from the proposed preconditioning activities. As was the case in the 2009 assessment, the noise model predicts the equivalent continuous noise level over a 15-minute period ($L_{Aeq,15min}$) as the 10^{th} percentile exceedance value, based on the probability of occurrence of the meteorological conditions.

As the proposed preconditioning activities would be conducted at various drill pad locations on the surface, the noise was predicted with the noise source at four locations, located to indicate worst case noise levels, around the periphery of the drilling area. The worst case noise from those four scenarios was taken as the potential impact at any residence.

The assessment was based on the CVO night time criteria as these are the lowest, and atmospheric conditions that enhance noise propagation are most prevalent during the night time. Hence compliance at night leads to compliance during daytime and evening periods.

Table 1 shows the predicted noise levels generated by the pumps and drill rig during the night time period. The results are given for the receivers where specific noise criteria are conditioned. The predicted levels of the pump and drill rig alone are at least 13dBA below the noise criteria at all receivers during the worst case night time noise emission. At receivers closest to the preconditioning location, the noise from the pump and drill rig could increase the overall mine noise level by less than 0.5dBA, depending on the location of the drilling. This amount of change in noise levels is generally regarded as being imperceptible by the majority of people.

At no location is the minor increase in noise levels predicted to result in non-compliance of the Project Approval (PA 06_0295) noise limits.

Cumulative Noise & Sleep Disturbance

Based on the findings of this review the proposed modification would not lead to non-compliances of the cumulative noise and sleep disturbance criteria at the CVO.

WAREHOUSE CONSTRUCTION NOISE ASSESSMENT

Construction of the onsite warehouse is anticipated to take up to 12 months and would take place from 7.00 am to 6.00 pm Monday to Saturday. The equipment required for construction is listed in Table 2, along with the assumed sound power level of the equipment.

As there are different discrete construction phases (bulk earthworks, fill and compaction, detailed earthworks and concreting), there would be varying levels of activity and associated noise from the proposed site during this time. However, in order to conservatively assess noise impacts at sensitive receivers, plant items with an asterisk listed in Table 2 were assumed to be active at the same time during the fill and compaction phase of construction, which is considered to be worst-case.

Table 1 Predicted Night Time Noise Levels

Location	Worst Case Winter / Autumn Night Time Noise, $L_{Aeq,15min}$	
	Criterion	Predicted Noise Level
41-CW Knox ('Meribah')	38	11
43-CJ Healey ('Triangle Park')		11
138-AC & A Bailey ('Mayburies')		11
45-CC Colman ('Mirrabooka')		16
246-CK Channell and KP & DV Donlan ('Eastburn')		10
209-JI McLennan ('Northwest')		20
171-GA Knox ('South Log')		8
1-GT & JA Christou ('Coorabin')	37	7
137-MP & LA Ellis ('Argyle')		9
169-RL & SL Chamberlain ('Weemalla')		14
44-AR Colman ('Triangle Flat')	36	15
105-KA Hughes ('Barton Park')		8
133-LC & LR Baker ('Bonnie Glen')		8
26–T & E Sharp	35	10
17–P Hicks		19
27–Contago Agricultural Company		5
176–CL Suttie		10
177–SW & KA Munro		22

Table 2 Warehouse Construction Fleet

Item	Sound Power Level (dBA)
1 x CAT 980 FEL*	110
1 x 30 t Water Cart*	110
2 x 15 t Tip Trucks*	100
1 x CAT 320 Excavator	110
1 x CAT D9 Dozer*	113
1 x CAT 825 Compactor*	110
1 x Grader*	109
2 x Scrapers	111
1 x Tamping Machine	115
1 x Franna Crane (20-30 t)	103
1 x 50 t Crane	105
3 x Concrete Trucks	108

* Indicates modelled during the fill and compaction construction phase.

Construction Noise Management Levels

The NSW EPA *Interim Construction Noise Guideline* (ICNG) recommends the following objectives:

Recommended standard hours of work

- Monday to Friday 7.00am to 6.00pm
- Saturday 8.00am to 1.00pm
- No work on Sundays or Public Holiday

Management Noise Goals

The recommendations of the ICNG are used to set construction Noise Management Levels (NML) at noise-sensitive receivers. Table 3 outlines the procedure for setting NMLs.

Table 3 Noise at Residences using Quantitative Assessment

Time of Day	Management Level $L_{Aeq,(15min)}$ *	How to Apply
Recommended Standard Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dB(A)	• The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	• The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. • If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.

Note: RBL = Rating Background Noise

The daytime RBL is generally 30dBA at all receivers, leading to a NML of 40dBA for standard hours. Construction is also proposed for Saturday from 7.00am to 6.00pm. The Saturday hours from 7.00am to 8.00am and 1.00pm to 6.00pm are outside the recommended standard hours, hence the appropriate criterion is background +5dBA as per the INP. Therefore the NML for those Saturday periods is 35dBA.

Predicted Construction Noise Levels and Assessment

For worst-case daytime noise prediction it was assumed that there would be a light wind blowing from the construction site in the direction of the receiver. The predicted noise levels from the compaction phases are given in Table 4. The predicted levels are significantly less than the lowest noise criterion of 40dBA at all receivers. In addition, given the low predicted levels, no cumulative impacts with operational noise are predicted and no exceedances of the operational noise criteria (i.e. Condition 2 of Schedule 3 of Project Approval [PA 06_0295]) would be expected. Accordingly, no noise impact is predicted due to construction of the warehouse.

Table 4 Predicted Construction Noise Levels

Location	Worst Case Daytime Construction Noise, $L_{Aeq,15min}$	
	Management Level	**Predicted Noise Level**
41-CW Knox ('Meribah')	40 dBA standard hours	9
43-CJ Healey ('Triangle Park')		9
138-AC & A Bailey ('Mayburies')		5
45-CC Colman ('Mirrabooka')		14
246-CK Channell and KP & DV Donlan ('Eastburn')		0
209-JI McLennan ('Northwest')		19
171-GA Knox ('South Log')		5
1-GT & JA Christou ('Coorabin')		8
137-MP & LA Ellis ('Argyle')		4
169-RL & SL Chamberlain ('Weemalla')		3
44-AR Colman ('Triangle Flat')	35 dBA Saturday non-standard hours	15
105-KA Hughes ('Barton Park')		8
133-LC & LR Baker ('Bonnie Glen')		3
26–T & E Sharp		18
17–P Hicks		14
27–Contago Agricultural Company		19
176–CL Suttie		21
177–SW & KA Munro		25

We trust this information is sufficient. Please contact us if you have any further queries.

Yours faithfully
WILKINSON MURRAY

George Jenner
Associate

REFERENCES

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