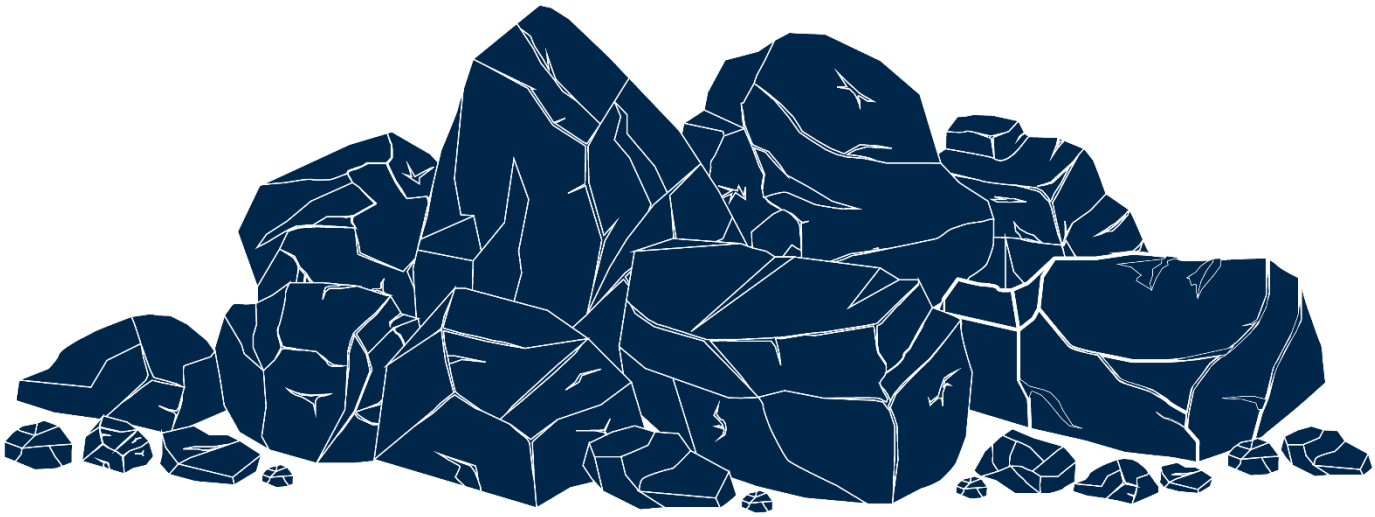
Karuah Hard Rock Quarry
ABN: 15 093 914 937
Hunter Quarries Pty Ltd
Andersite Road, Karuah NSW 2324

W: www.hunterquarries.com.au
E: admin@hunterquarries.com.au
T: 02 4050 0304
P: PO Box 3284, Thornton NSW 2322

Karuah Hard Rock Quarry

Rehabilitation and Closure Plan

March 2025



Revision History

Version	Date Reviewed	Author	Status	Amendment Details
1A	June 2018	SLR	Draft for Consultation	Consolidated Rehabilitation and Closure Plan developed to satisfy Schedule 3, Condition 39 and Condition 44 of the Development Consent. Refer to previous Rehabilitation Management Plan and Quarry Closure Plan for previous versions.
1B	December 2018	SLR	Approved	Updated for DPE comments.
2A	August 2019	SLR	Draft for Consultation	Comprehensive periodic review.
2B	December 2019	SLR	Draft for Consultation	Update for MCC and DPIE comments.
2C	February 2020	SLR	Approved	Update following DPIE comments.
3A	May 2021	SLR	Approved	Update following DPIE meeting on 06 May 2021.
4A	January 2024	IEMA	Draft for Review	Comprehensive periodic review. Update for new Karuah East Quarry document template and extension of licence agreement to access Lot 11 to 06 May 2026.
4B	February 2024	IEMA	Draft for Consultation	Minor updates following internal review by HQPL. Document submitted to MidCoast Council for consultation.
4C	April 2024	IEMA	Approved	Document submitted to NSW Planning for approval following no response from MidCoast Council (PAE-68035706).
5A	March 2025	IEMA	Approved	Comprehensive review following acquisition of Lot 11 from Wedgerock Pty Ltd. Revision of rehabilitation schedule to align with Development Consent rather than Licence Agreement to access Lot 11.

Contents

Revision History **2**
Contents **3**
Terms, Definitions and Abbreviations **4**
1.0 Introduction **5**
1.1 Background and Site Overview 5
1.2 RCP Objectives 7
1.3 Rehabilitation Objectives 8
2.0 Requirements of the Development Consent **9**
3.0 Key Rehabilitation and Closure Processes **11**
4.0 Site Domains **12**
4.1 Current Domains 12
4.2 Final Landform Domains 12
5.0 Mitigation and Management Measures **15**
5.1 Short Term Rehabilitation 15
5.2 Medium to Long-Term Rehabilitation 16
5.3 Schedule of Works 19
6.0 Final Landuse **20**
6.1 Woodland Rehabilitation 20
6.2 Site Dams 20
6.3 Final Quarry Void 20
6.4 Quarry Benches and Highwalls 21
7.0 Rehabilitation and Closure Criteria **24**
8.0 Rehabilitation Monitoring **26**
8.1 Annual Rehabilitation Inspection 26
8.2 Monitoring Post-Closure 26
8.3 Progress Reviews and Reporting 27
8.4 Rehabilitation Bond **27**
9.0 Roles and Responsibilities **28**
10.0 References **29**
Appendix A: Correspondence with MidCoast Council **30**
Appendix B: Correspondence with NSW Planning **33**
Appendix C: Final Void Water Balance **35**

Terms, Definitions and Abbreviations

Abbreviation / Term	Meaning
AR / AMER	Annual Review / Annual Environmental Management Report
EIS	Environmental Impact Statement
EPL	NSW Environment Protection Licence
Ha	Hectare
HQPL	Hunter Quarries Pty Ltd
KEQ	Karuah East Quarry
KEQPL	Karuah East Quarry Pty Limited
KHRQ	Karuah Hard Rock Quarry
km	Kilometre
L	Litre
LDP	Licenced Discharge Point
MCC	MidCoast Council
NSW Planning	NSW Department of Planning, Housing and Infrastructrue
NTU	Nephelometric Turbidity Unit
POEO Act	NSW *Protection of the Environment Operations Act 1997*
RCP	Rehabilitation and Closure Plan
RFS	NSW Rural Fire Service
tpa	tonnes per annum

1.0 Introduction

1.1 Background and Site Overview

Mountain Industries obtained approval to operate the Karuah Hard Rock Quarry in 1997, with the site subsequently purchased by Hunter Quarries Pty Ltd (HQPL) in 2002. In October 2004, HQPL applied to the then Department of Infrastructure, Planning and Natural Resources (now known as the Department of Planning, Housing and Infrastructure – NSW Planning) for approval to expand the quarry into adjoining lands (the Stage 2 area) to allow the extraction of further hard rock resources.

Development Consent was granted by the Minister for Infrastructure, Planning and Natural Resources on 03 June 2005 (DA 265-10-2004), with the approved development including:

- Implementing the remainder of the approved Stage 1 Quarry Operation Area;
- Extending the quarry operations into the Stage 2 Extraction Area;
- Upgrading and using existing infrastructure on site;
- Rehabilitating the site by re-contouring and revegetating exposed surfaces; and
- Producing up to 500,000 tonnes of andesite product a year over the next 22 years.

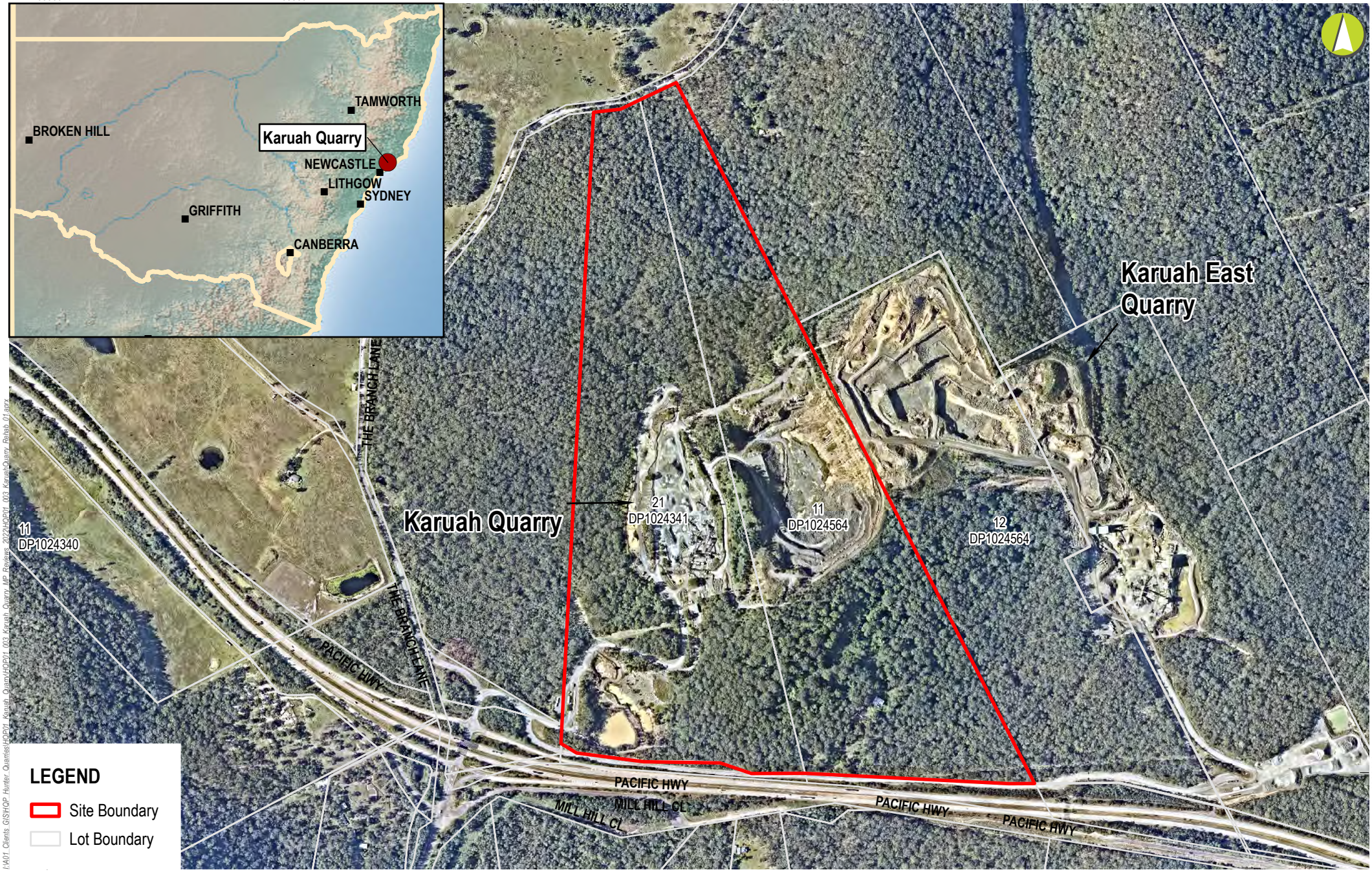
HQPL contributes quarry products to support the construction, infrastructure and land development industries across the Greater Newcastle, Hunter Valley and Mid-North Coast regions. The site is located approximately five kilometres north-east of the village of Karuah, NSW. The overall site covers an area of approximately 78.5 Ha across the following properties as outlined by **Figure 1**:

- Lot 21 DP 1024564 consisting of material processing and product stockpiling;
- Lot 11 DP 1024564 consisting of the Stage 2 extraction area; and
- Part Lot 12 DP 1024564 consisting of the Conservation Offset Area.

HQPL holds and maintains an Environment Protection Licence 11569 (EPL 11569) with the fee-based licence comprising of:

- Crushing, grinding, or separating works (>100,000-500,000 t annual processing capacity); and
- Extractive activities (>100,000-500,000 t annually extracted or processed).

This Rehabilitation and Closure Plan (RCP) addresses the relevant conditions of the Development Consent and consolidates the former Rehabilitation Management Plan (Schedule 3, Condition 39) and the Quarry Closure Plan (Schedule 3, Condition 44).



Karuah Hard Rock Quarry

Rehabilitation and Closure Plan

FIGURE 1 - Regional and Local Context

1.2 RCP Objectives

The key objectives of this Rehabilitation and Closure Plan (RCP) are to:

- Provide an overall framework for Conceptual Quarry closure – including rehabilitation and decommissioning strategies.
- Reducing or eliminating adverse environmental effects once the site ceases operations.
- Ensuring rehabilitation and closure is completed to the satisfaction of NSW Planning.
- Ensuring that the site, and any nominated infrastructure, can be put to a suitable beneficial use post closure.
- Ensuring that the needs of HQPL and the local community are appropriately considered and addressed in the closure planning process, with an emphasis on generating minimal negative impacts.
- Re-establish a similar native forest vegetation cover at final rehabilitation, including native shrubs and ground cover, to that which currently exists over remnant vegetation surrounding the site.
- Rehabilitation of the final void as per **Section 7**.
- Establish stable drainage lines on the rehabilitated areas and implement appropriate erosion controls to ensure the potential for erosion is limited, particularly during the establishment of vegetation.
- Ensure disturbed areas are rehabilitated progressively and as soon as practical after they are disturbed, and quarrying operations cease. This is to reduce the potential for erosion, and to ensure vegetation is re-established as soon as possible.
- Creating a stable post-disturbance area for long-term beneficial uses, as well as for native vegetation propagation. Ensuring surface water dams to be retained will be safe, self-sustaining, and acceptable for the post-quarrying land uses.
- Preserving downstream water quality – the quality of surface water that leaves the site will be adequate to maintain, or improve, environmental values and beneficial uses downstream of the current disturbance area.

1.3 Rehabilitation Objectives

Rehabilitation objectives for the site were discussed with NSW Planning in 2017 as summarised by **Table 1**.

Table 1 Summary of Discussed Rehabilitation Objectives with the Department in 2017.

Feature	Rehabilitation Objectives (NSW Planning)	HQPL Response
All areas of the site affected by the development	▪ Safe. ▪ Hydraulically and geotechnically stable. ▪ Non-polluting. ▪ Fit for the intended post-mining land uses. ▪ Final landform integrated with surrounding natural landforms as far as is reasonable, and minimising visual impacts when viewed from surrounding land.	▪ The post closure land use will meet these requirements. As discussed in this document, the benches will however remain at closure. ▪ An appropriately qualified Geotechnical Engineer will be consulted on final highwall design to ensure the landform is hydraulically and geotechnically stable.
Surface Infrastructure	▪ Decommissioned and removed, unless otherwise agreed by the Planning Secretary.	▪ All surface infrastructure will be removed at closure (unless otherwise agreed with the NSW Planning).
Quarry benches and pit floor	▪ Landscaped and vegetated using native tree and understory species	▪ Refer to **Section 7.7** for details on the rehabilitation of benches. This included side casting of overburden material from Karuah East Quarry.
Final Void	▪ Minimise the size, depth and slope of the batters of the final void. ▪ Minimise the drainage catchment of the final void.	▪ There is no further significant disturbance proposed at the KHRQ site. ▪ Sediment Dam 2 will remain at closure.

2.0 Requirements of the Development Consent

The requirements of the Development Consent are summarised by **Table 2**.

Table 2 Summary of Relevant Conditions of the Development Consent.

No.	Requirements	Section
Schedule 3 – Specific Environmental Conditions		
Condition 29	*The Applicant shall* *a) Implement all practical measures to minimise the visual impacts of the development;* *b) Retain, re-vegetate and subsequently maintain a visual bund within the Stage 1 works area (in accordance with Figures 13 and 14 of the EIS) to minimise the visual impacts of the development;* *c) Include a progress report on the re-vegetation and maintenance of the visual bund in the AEMR.*	**Section 5.2**
Condition 38	*The Applicant shall progressively rehabilitate the site to the satisfaction of the Director-General.*	**Section 5.3**
Condition 39	***Rehabilitation Management Plan*** *Within 6 months of the date of this consent, the Applicant shall prepare, and subsequently implement, a Rehabilitation Management Plan for the site, which integrates rehabilitation works for both Stage 1 and Stage 2 areas, to the satisfaction of the Director-General. This Plan must:*	**Whole Document**
	a) Identify the disturbed area at the site (both Stage 1 and Stage 2);	**Figure 2**
	b) describe in general the short, medium, and long term measures that would be implemented to rehabilitate the site;	**Sections 5 & 6**
	c) describe in detail the measures that would be implemented over the next 5 years to rehabilitate the site; and	**Sections 5 & 6**
	d) describe in detail how rehabilitation measures will be integrated with: ▪ *erosion and sediment control works on the site;* ▪ *remnant vegetation and habitat enhancement and conservation works; and,* ▪ *visual screening works.*	**Section 5**
	e) describe how the performance of these measures would be monitored over time.	**Section 8**
Condition 40	*Within 5 years of providing the Rehabilitation Management Plan to the Director-General, and every 5-years thereafter, the Applicant shall review and update the plan to the satisfaction of the Director-General.*	**Section 8.3**
Condition 41	*The Applicant shall include a progress report on the Rehabilitation Management Plan in the AEMR.*	**Section 8.3**

No.	Requirements	Section
Schedule 3 – Specific Environmental Conditions		
Condition 42	***Rehabilitation Bond*** *Within 6 months of the date of this consent, the Applicant shall lodge a suitable conservation and rehabilitation bond for the development with the Director-General. The sum of the bond shall be calculated at $2.50/m^2, or as otherwise agreed to with the Director-General, for the area of disturbance at the development.* *Notes:* ▪ *If the rehabilitation is completed to the satisfaction of the Director-General, the Director-General will release the rehabilitation bond.* ▪ *If the rehabilitation is not completed to the satisfaction of the Director-General, the Director-General will call in all, or part of, the rehabilitation bond, and arrange for the satisfactory completion of these works.*	**Section 8.4**
Condition 43	*Within 3 years of lodging the rehabilitation bond with the Director-General, and every 5 years thereafter, unless the Director-General directs otherwise, the Applicant shall review, and if necessary revise, the sum of the rehabilitation bond to the satisfaction of the Director-General. This review must consider:* *a) the effects of inflation;* *b) any changes to the area of disturbance; and* *c) the performance of any progressive rehabilitation which has been undertaken at the site.*	**Section 8.4**
Condition 44	***Quarry Closure Plan*** *At least 3 years prior to the cessation of quarrying, the Applicant shall prepare a Quarry Closure Plan for the development, in consultation with the Council, and to the satisfaction of the Director-General. The plan must:*	**Whole Document**
	a) define the objectives and criteria for quarry closure;	**Sections 1.3, 1.4 & 7.0**
	b) investigate options for the future use of the site, including any final void(s);	**Section 6.3**
	c) describe the measures that would be implemented to minimise or manage the ongoing environmental effects of the development; and	**Section 5.1**
	d) describe how the performance of these measures would be monitored over time.	**Section 8.0**

3.0 Key Rehabilitation and Closure Processes

Rehabilitation of disturbed areas is an integral component of the quarry operation, and as such will be undertaken as soon as reasonably practicable after disturbance occurs. Due to the area required for quarrying (Stage 2) and processing (Stage 1), there are few opportunities to complete any progressive rehabilitation until closure.

The proposed progressive rehabilitation techniques for vegetative stabilisation on the site will include, but are not limited to, the following:

- Major and minor landform shaping;
- Re-spreading of available topsoil and subsoil in rehabilitation areas;
- Reshaping of post-quarry land surface to ensure suitable drainage and surface stability;
- Scarification of the surface;
- Use of direct seeding using a woodland seed mix;
- Targeted tube stock planting to increase diversity and address any gaps as necessary; and
- Deep ripping of any compacted areas associated with regular heavy vehicle use.

4.0 Site Domains

4.1 Current Domains

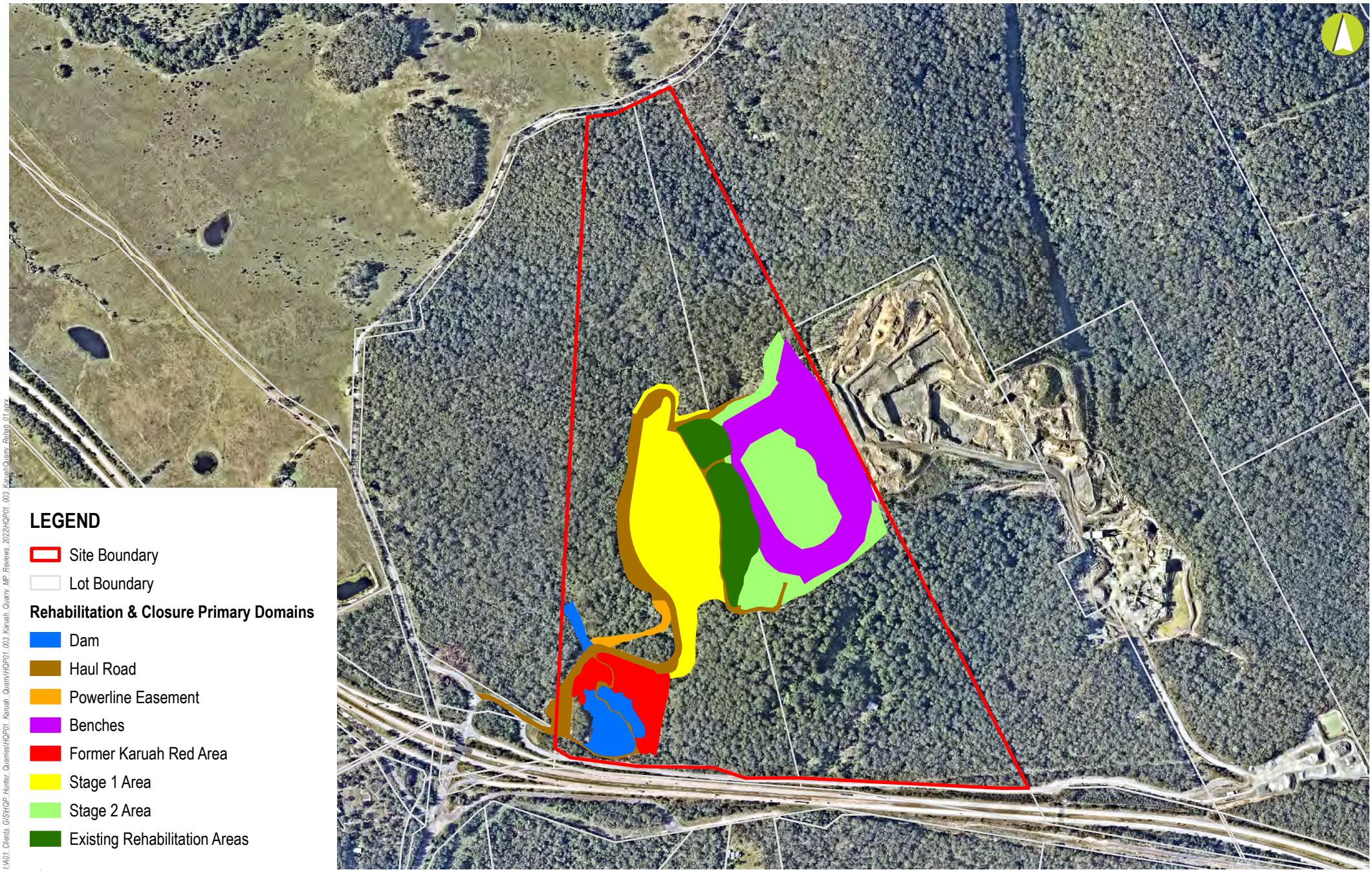
The current site land-use domains are illustrated by **Figure 2** for the purposes of rehabilitation and closure management. Site domains are defined land management units with unique operational and functional purpose and similar geophysical characteristics. Current land-use domains include the following units:

- **Buildings and Infrastructure** – which include the main workshop, portable administrative building, screener and crusher, fuel storage, and quarrying equipment and the site weighbridge.
- **Haul Roads** – which connect the different areas of the site.
- **Stage 1 Quarry Operations Area** – this area is used for the stockpiling and processing of rock from the quarry.
- **Stage 2 Extraction Area** – this area is the current location of the quarry extraction area.
- **KHRQ/KEQ Highwall** – rehabilitation within in this area commenced in 2022 consisting of side-casting material down the eastern highwall of the extraction pit. This has continued throughout 2023 along the northern highwall face of the KHRQ pit.
- **Sediment Dam 2** – which is the main sediment dam for the site, and associated drainage infrastructure.
- **Karuah Red Quarry** – the former area of the original 'Karuah Red' quarry which has since been converted to Sediment Dam 2.
- **Existing Rehabilitation Areas** – consisting of the visual bund located between the Stage 1 Quarry Operations Area and the Stage 2 Extraction Area.

4.2 Final Landform Domains

Final closure land-use domains are illustrated by **Figure 3** and include the following units:

- **Woodland Rehabilitation** – woodland rehabilitation will be undertaken across the existing building and infrastructure area, Stage 1 Quarry Operations Area, Stage 2 Extraction Area (excluding final void and perimeter benches), and the Karuah Red Quarry (excluding Sediment Dam 2).
- **Benches** – side-casting will be undertaken across the perimeter of the quarry void.
- **Final Void** – final land-use of the void will be a water storage.
- **Haul Roads** – haul roads to remain for firefighting access and monitoring inspections.
- **Dam** – Sediment Dams that are to remain after quarry operations cease will be reviewed and if necessary reshaped prior to quarry decommissioning to ensure they are safe, stable, and non – polluting and that they also provide safe access for native fauna and to satisfy public safety requirements.



LEGEND

- Site Boundary
- Lot Boundary

Rehabilitation & Closure Primary Domains

- Dam
- Haul Road
- Powerline Easement
- Benches
- Former Karuah Red Area
- Stage 1 Area
- Stage 2 Area
- Existing Rehabilitation Areas

0 70 140 210 280 m

Scale: 1:10,000

Sheet Size : A4

INTEGRATED ENVIRONMENTAL MANAGEMENT AUSTRALIA
www.iema.com.au

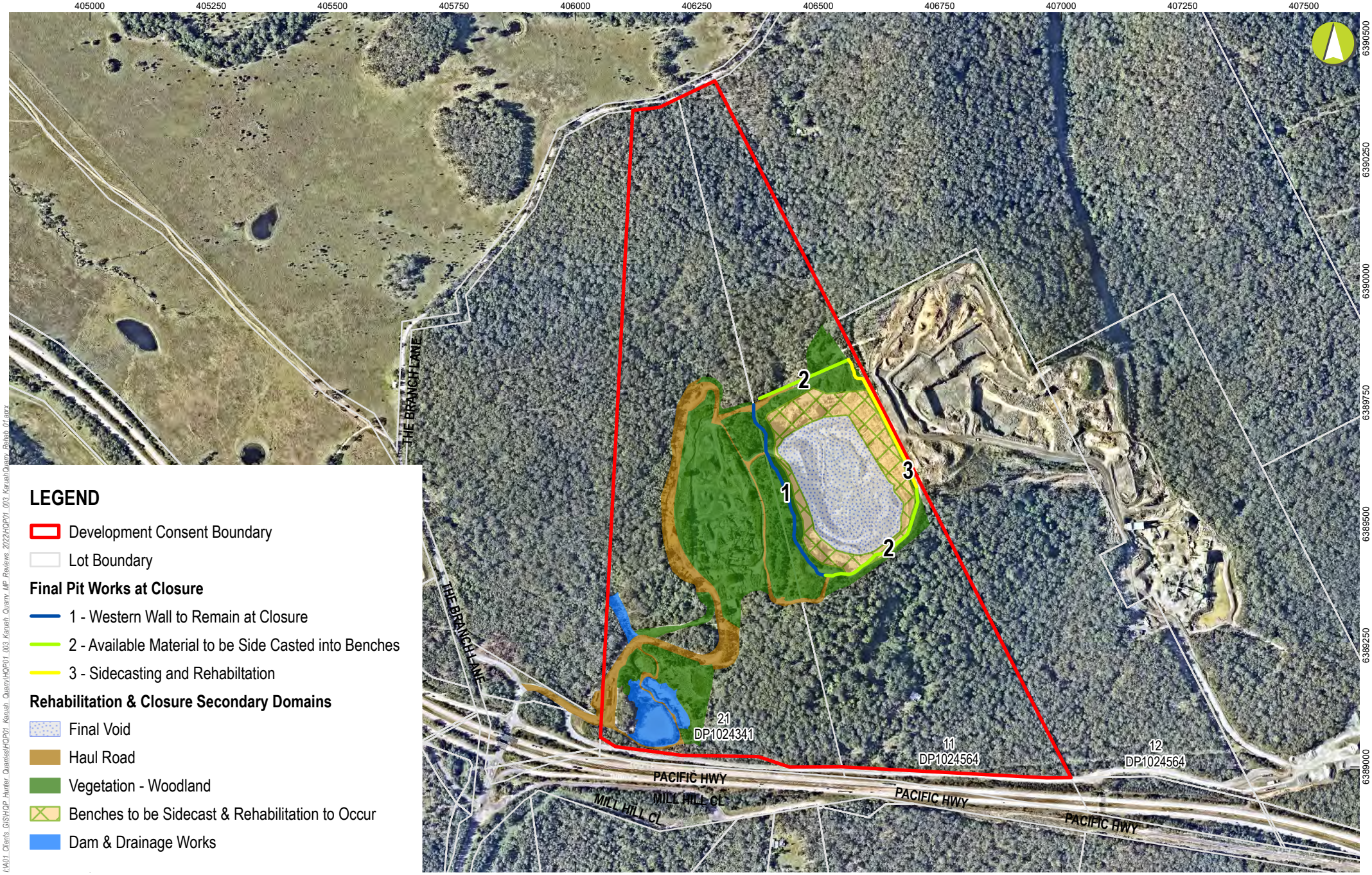
GDA 1994 MGA Zone 56
13/02/2024

I:\A01_Clients_GIS\HQP_Hunter_Quarries\HQP01_Karuah_Quarry\HQP01_003_Karuah_Quarry_MP_Reviews_2022\HQP01_003_KaruahQuarry_Rehab_01.aprx

Karuah Hard Rock Quarry

Rehabilitation and Closure Plan

FIGURE 2 - Current Site Domains



LEGEND

- Development Consent Boundary
- Lot Boundary

Final Pit Works at Closure

- 1 - Western Wall to Remain at Closure
- 2 - Available Material to be Side Casted into Benches
- 3 - Sidecasting and Rehabiltation

Rehabilitation & Closure Secondary Domains

- Final Void
- Haul Road
- Vegetation - Woodland
- Benches to be Sidecast & Rehabilitation to Occur
- Dam & Drainage Works

0 70 140 210 280 m

Scale: 1:10,000

Sheet Size : A4

INTEGRATED ENVIRONMENTAL MANAGEMENT AUSTRALIA
www.iema.com.au

GDA 1994 MGA Zone 56
15/02/2024

I:\A01_Clients_GIS\HQP_Hunter_Quarries\HQP01_Karuah_Quarry\HQP01_003_Karuah_Quarry_MP_Reviews_2022\HQP01_003_KaruahQuarry_Rehab_01.aprx

Karuah Hard Rock Quarry

Rehabilitation and Closure Plan

FIGURE 3 - Final Rehabilitation

5.0 Mitigation and Management Measures

In accordance with the Development Consent, the following sections describe the proposed rehabilitation of the site. Where revegetation works have been progressively undertaken, these areas will be reviewed on a regular basis to determine the success of the progressive rehabilitation program. All rehabilitation findings will be included as part of the progress report on the Plan in the Annual Review.

5.1 Short Term Rehabilitation

Short term rehabilitation techniques can be used to temporarily stabilise areas, including benches or steep batters and bunds prior to final closure and may include hydro mulching and straw mulching.

Hydro Mulching

Hydromulching is a one-step process where seed, fertiliser, mulch and a binder/tackifier are combined together in water. The resulting slurry is sprayed onto the soil surface providing a wood fibre interlocking mat that retains moisture for seed germination.

Almost any seed including native species, trees and shrubs can be used when hydro mulching. The seed mix will include native grass seeds. The mulch is dyed green with a non-toxic chemical to help identify areas requiring ongoing treatment.

Application rates vary between contractors and depending upon site conditions; however a general rule for the application of hydro mulch is summarised in **Table 3** below.

Table 3 Typical Hydromulching Application Rates.

Product	Application Rate
Seed	100 kg/Ha of pasture mix made up of annual crops. Must include at least 20 kg/Ha of cover crop.
Fertiliser	200 kg/Ha (Granulock 15)
Mulch	3,500 – 5,000 kg/Ha (dry weight)
Binder and emulsion	Anionic bitumen emulsion 50/50 bitument to water at 1,500 – 3,500 L/Ha. Polymer binder maximum 350 L/Ha.

It is likely that hydro mulching will be used for seeding of areas of the benches which have had the side casting shaping treatment.

Straw Mulching

Straw mulching is the process of blowing a stream of straw to areas covered with seed at a depth of 20 to 30 mm. The cost of straw mulching can be higher than other hydroseeding methods but will assist with temporary stabilisation.

Straw mulching involves the following steps:

- Seed and fertiliser are applied to an area through a hydroseeding machine. Lime or Gypsum is sometimes required depending on soil conditions. For less steep slopes, seed can be applied by broadcasting or hand sowing.

- Straw shall be applied through a straw mulching machine. There are two approaches:

    1. Both the Straw and Bitumen Emulsion can be applied at the same time through the straw mulching machine; or

    2. Straw can be applied as a separate operation followed by an overspray of bitumen emulsion.

Application rates vary between contractors and depending upon site conditions. A general rule for the application of straw mulch is summarised in **Table 4** below.

Table 4 Typical Hydromulching Application Rates.

Product	Application Rate
Seed	100 kg/Ha of pasture mix made up of annual crops. Must include at least 20 kg/Ha of cover crop.
Fertiliser	200 kg/Ha (Granulock 15)
Mulch	3,500 – 5,000 kg/Ha (dry weight)
Binder and emulsion	Anionic bitumen emulsion 50/50 bitument to water at 1,500 – 3,500 L/Ha. Polymer binder maximum 350 L/Ha.

5.2 Medium to Long-Term Rehabilitation

Material Shaping and Handling

Bulk earthworks will be required to achieve the proposed final landform for the site with available material. The bulk shaping requirements will differ across the two lots, with the Lot 11 shaping consisting of side-casting waste material sourced from Karuah East Quarry; and for Lot 21 the shaping will be undertaken to minimise steep slopes prior to final trim and rehabilitation.

Water Infrastructure and Erosion & Sediment Control

All erosion and sediment control measures will be maintained in a functioning condition until individual areas have been deemed “successfully” rehabilitated. Structural soil conservation works will be inspected after high intensity rainfall so that de-silting and prompt repairs and/or replacement of damaged works can be initiated as required in accordance with the Site Water Management Plan.

Any excess flows would leave the void via a spillway to be constructed in the north-western corner of the site. Further details of water management within the final void are outlined in **Section 7.4**.

Sediment Dam 2 will remain after the cessation of quarrying and if required will be reshaped prior to quarry decommissioning to provide safe access for native fauna and to satisfy public safety requirements. This water can be used by the Rural Fire Service for firefighting. Key drainage lines will remain in place following closure, with surface water from Lot 21 reporting to Sediment Dam 2.

Further erosion and sediment control works will be required post closure, with these to be completed in accordance with the Blue Book.

Haul Road and Associated Infrastructure Areas

During the final rehabilitation phase the main road and smaller access roads will remain for ongoing land management purposes, including providing beneficial access for the Rural Fire Service in the event of bushfires occurring in the surrounding bushland.

All surface infrastructure and remnant stockpiles will be removed at closure unless otherwise agreed with NSW Planning or other development applications for adaptive re-use have commenced by the lapse date of the Development Consent on 03 June 2027.

Conservation and Re-spreading of Soil & Overburden

There is limited available topsoil at Karuah Hard Rock Quarry for final rehabilitation and therefore other ameliorants and bio-solids will be used. Overburden and soil material will be imported from the Karuah East Quarry, with this to assist in landform shaping of the remnant benches by side-casting areas. The material will be transported via truck through internal roads to ensure public roads are not impacted by additional traffic.

Visual Screening

Schedule 3, Condition 29 includes the requirement to maintain a visual bund between the Stage 1 and Stage 2 Extraction Areas, which is subject to established rehabilitation and this will be integrated into the final landform.

Surface Preparation in Lot 21

Once the appropriate landform is achieved, thorough site preparation will be undertaken to ensure rapid establishment and growth of seedlings. It is proposed that seeding areas will be ripped to an indicative depth of 400 – 500 mm with care being taken not to pull subsoil materials through the spread topsoil, subsoil and ameliorants.

Targeted gypsum and/or lime may be applied to the final surface using broadcasting machinery immediately prior to sowing if it is determined to be necessary to achieve the best rehabilitation outcome. The ameliorants will be incorporated to a nominal depth of 300 mm.

In order to optimise seedbed condition during final rehabilitation, scarification will be conducted when the soil is moist to produce a loose and friable seed bed which is essential for good plant establishment from seed. All proposed seeding areas will be deep ripped where safe and practical.

Cultivating on the contour will be conducted to assist in delaying runoff, increasing infiltration and controlling erosion of the seed bed until an effective vegetative cover is established. As a minimum treatment, steep batters (>2:1) will be scarified using a tined bucket on an excavator to achieve surface roughness prior to sowing.

Where available, topsoil will be spread along the contour of re-graded spoil to minimise erosion by dumping at the top of slopes and grading downwards and across the contour. Once topsoil is spread, vehicle traffic will be prevented from entering the area. Re-spread topsoil/ameliorants will be levelled to achieve an even surface, avoiding a compacted or over-smooth finish. As previously stated there is limited supply of topsoil and subsoil at site, hence ameliorants will be required for rehabilitation.

Direct Seeding

Native forest vegetation previously covered most of the Stage 1 and 2 Extraction Areas and it is proposed to reestablish a similar cover to the majority of the post-quarrying landform. Direct seeding is preferred over tube stock as it enables a far greater success rate, limits the need for ongoing maintenance (e.g. watering) and is a more economical method in achieving a successful rehabilitation outcome.

A mixture of native trees and shrubs will be sown onto the majority of the reshaped and benched pit area following topdressing and site preparation. Tree seeding will complement natural regeneration from seed contained within the soil seed bank. The proposed seed mix will include many of the major tree and shrub species shown in **Table 5**, subject to their availability from the nearby area.

Table 5 Proposed Tree Seed Mix.

Genus	Species	Typical Application Rate (kg/Ha)
Acacia	falcata	0.4
	longifolia	0.6
	terminalis	0.4
	irrorata	0.3
	decurrens	0.4
Eucalyptus	globoidea	0.4
	resinifera	0.2
	paniculata	0.4
	tereticornis	0.6
	punctata/propinqua	0.5
	moluccana	0.5
	crebra	0.3
	microcorys	0.3
Angophora	costata	0.1
Allocasuria	torulosa	0.1
Corymbia	maculata	0.8
	gummifera	0.3

Supplementary native pasture seeding will be undertaken where specific species combinations are required. Native pasture species including, but not limited to, Imperata cylindrica (Blady Grass) and Themeda australis (Kangaroo Grass) will be encouraged.

Seed will be appropriately pre-treated in order to break dormancy restrictions. Subject to sufficient follow up rain, high initial tree densities can be expected. These high densities will quickly help stabilise and screen the site and will result in healthy mature tree stands over time. It is intended to create, over time, a mosaic of variable species and plant densities representative of that currently occurring in the area. Growth rates of greater than 1 m per year (Acacia species) can be initially expected for many of the more dominant trees and shrubs. Eucalyptus growth rates will be considerably slower than Acacias.

The native tree and shrub seed mix will be sown at a total combined rate of approximately 6.6 kg/Ha. Seed will be mixed with fertiliser at 100 kg/Ha. Tree seed and fertiliser will be broadcast evenly onto top-dressed areas. It will not be buried. Where practical, seeding will be conducted in late spring and early autumn giving superior results due to higher ground temperatures. Seeding is generally completed by hand for the site.

Weed & Pest Control

Weed control will be undertaken on a quarterly basis for the first year of rehabilitation and then at six-monthly intervals for in Years 2 and 3.

Fauna pest control will be undertaken on all rehabilitation areas according to relevant state and local legislation and policy.

5.3 Schedule of Works

As noted previously, minimal rehabilitation can be completed at the quarry until the operation ceases, as the current disturbed areas are required for safe and efficient operation, until the lapse of the Development Consent on 03 June 2027.

A summary of the scheduled rehabilitation activities within the site are summarised by **Table 6**.

Table 6 Rehabilitation Activities Schedule for the Karuah Hard Rock Quarry.

Timing (year)	2025	2026	2027	2028	2029	2030	2031
Closure Activities							
Decommissioning			After 03 Jun 2027				
Landform Establishment			After 03 Jun 2027				
Growth Media Establishment			After 03 Jun 2027				
Ecosystem & Landuse Establishment			After 03 Jun 2027				
Ecosystem & Landuse Development							
Development Consent Expires			03 Jun 2027				
Post-Closure Activities							
Maintenance					3-year monitoring period		
Monitoring					3-year monitoring period		
Relinquishment							

6.0 Final Landuse

6.1 Woodland Rehabilitation

HQPL has committed to rehabilitating the landform with a seed mix detailed in in **Table 5** and will be applied to the Stage 1 Quarry Operations Area, Stage 2 Quarry Extraction Area (excluding benches and void components), the Karuah Red Quarry (excluding water infrastructure components), Buildings and Infrastructure and non-essential haul roads. This seed mix contains species found in the area and will conform to the surrounding vegetation.

6.2 Site Dams

On cessation of quarrying activities, dams that are to remain will be reviewed and if necessary reshaped prior to quarry decommissioning to ensure they are safe, stable, and non-polluting and that they also provide safe access for native fauna and to satisfy public safety requirements. There are two dams and a drainage system that are to remain upon closure. **Table 7** summarises key water quality parameters of the Karuah Red Quarry (Sediment Dam 2) sampled as of December 2022. Water quality is generally suitable for discharge; however, it should be noted that high turbidity values were associated with the sedimentation function of the dam during current active quarrying operations during high rainfall conditions associated with La Nina weather patterns from 2020 to 2022.

Table 7 Summary of Water Quality Parameters at Sediment Dam 2.

Parameter	Low	Average	High
pH	7.3	7.5	7.9
EC (µS/cm)	220	307	439
Turbidity (NTU)	94	373	680

6.3 Final Quarry Void

SLR previously examined the water balance for the final void, to allow an approximation of the equilibrium water level and the amount of water that will discharge to the downstream. Further details are provided in **Appendix A**.

The water balance analysis indicates that water will accumulate in the void until it reaches the spillway level. The present analysis assumed that the spillway is 11 m above the floor of the quarry. With a storage depth of 11 m (RL76 – RL65) the storage will take approximately 55 years to fill, at an average annual filling rate of 13.5 ML/year.

The average rate of water storage filling reduces as the water level gets higher, since the water surface area increases and losses from evaporation also increase.

Once filled, water will spill to the downstream environment. This would occur intermittently but typically only during rainfall events with a substantial depth of rainfall. In between discharge events, the water level would gradually reduce below the spillway level through evaporation. On average the water storage would discharge approximately once per year, and the estimated average annual overflow volume would be 5.85 ML.

Once the spillway level is reached, water levels will fluctuate depending on rainfall. Fluctuation is likely to be less than 0.5 m on average rainfall years but could be up to 1.2 m during very dry years.

Selection of a final spillway level will be subject to detailed design. The level at which the spillway is placed will dictate the time taken for the quarry void to fill up.

The location of the spillway will be located at the north-western corner of the void, subject to detailed engineering design, so discharge from spill events will be received by the existing watercourse and avoid impacts to existing operational areas to the west.

Peak discharges to the downstream environment may be attenuated by use of a low flow weir that discharges water slowly and maintains a water level which is about 0.3 m below the spillway level. This maintains some 'air space' to store runoff during heavy rainfall and then release it slowly to the downstream environment.

It should also be noted that since the average filling rate of the water storage is low, the filling outcome is very sensitive to groundwater leakage. The average filling rate of 13.5 ML/year equates to an average net inflow rate of 0.4 L/s. If the groundwater leakage is greater than this rate, the void may never be subject to spill events.

6.4 Quarry Benches and Highwalls

Design Considerations

For the purposes of this Rehabilitation and Closure Plan, the quarry benches and highwalls are assumed to be composed of remnant andesite consistent with the approved pit shell.

A stability assessment will be undertaken on the benched highwall section once quarrying ceases, prior to the expiry of the Development Consent on 03 June 2027, which may consider the following matters as deemed geotechnically appropriate:

- Geotechnical stabilisation techniques;
- Review of stability of benches;
- Screening to minimise visual impacts;
- Long term groundwater levels;
- Long term final void water levels
- Height and inclination of slope and number and spacing of intermediate benches;
- Shear strength of the highwall soils and rocks;
  Density and orientation of fractures, faults, bedding planes, and any other discontinuities, and the strength along them; and
- The effects of the external factors such as surface runoff.

To ensure the safety of the final void, the surrounding final slopes should be left to reduce the risk of slope failure as far as reasonably practicable.

Landform Design

The quarry benches and highwalls will remain at closure as summarised by the following components as illustrated in **Figure 4**:

- **Area 1 (Western Highwall & Visual Bund):** comprises the western elevation of the Stage 2 Extraction Area and the rehabilitated overburden dump constructed to form the visual bund. There is no proposed further works to the exposed face of the highwall beyond pushing up any available residual material against the western wall.

- **Area 2 (Northern Benches):** comprises the area above the highwall which will be subject to reshaping to form the spillway. There is no proposed further works to the benches and exposed face beyond the side-casting of any available spare material (commenced in 2023).

- **Area 3 (Southern Benches):** comprises the area above the southern highwall and will be subject to minor shaping with available material and rehabilitated with woodland vegetation. There is no proposed further works to the benches and exposed face beyond the side-casting of any available spare material.

- **Area 4 (Eastern Highwall):** comprises the dividing highwall between the Karuah Hard Rock Quarry and the Karuah East Quarry. Side-casting of material down the exposed face of the highwall has been completed to reduce the extent of the exposed face. All possible means will be made to rehabilitate this area, however due to unsafe access, the level of success may vary.

Risk & Safety Management

At closure, one of the main priorities for the final void will be to render it safe in terms of access by humans, wildlife, and livestock. In order to achieve this, the following key activities will be considered:

- Instability of the highwall can also induce failures and mass movement. To ensure the stability of the highwalls that are to be retained post closure, a suitably qualified geotechnical engineer will be consulted on final highwall design prior to ceasing operations;

- A physical barrier will be constructed at a safe distance from the perimeter of the void to prevent human access. A fence is proposed to be constructed at the northern and southern terminus of the eastern highwall eliminating access. The remaining highwalls will be secured by the construction of a trench and a safety berm at the top of the highwall. The trench and berms are to be constructed in such a way to provide an engineered barrier between the pit and the surrounding area that will physically stop most vehicles. Based on a risk assessment further safety controls may be required;

- Suitable signs, clearly stating the risk to public safety and prohibiting public access will be erected at suitable intervals; and

- Surface water runoff from land surrounding the void will be diverted so as to prevent any potential development of instability of the void walls.

At the conclusion of extraction, a geotechnical risk assessment will be conducted to review the risk to life and property the final landform in accordance with the Australian Geomechanics Society Landslide Taskforce “Practice Note Guidelines for Landslide Risk Management 2007”.

0 70 140 210 280 m

Scale: 1:10,000

Sheet Size : A4

INTEGRATED ENVIRONMENTAL MANAGEMENT AUSTRALIA
www.iema.com.au

GDA 1994 MGA Zone 56
13/02/2024

Karuah Hard Rock Quarry

Rehabilitation and Closure Plan

FIGURE 4 - Final Void Works at Closure

7.0 Rehabilitation and Closure Criteria

The rehabilitation and closure criteria for Karuah Hard Rock Quarry are summarised by **Table 8**.

Table 8 Rehabilitation and Closure Success Criteria.

ID	Phase	Description
1	Decommissioning	▪ Remediation of hydrocarbon contamination; ▪ Remove all nominated infrastructure; ▪ Make safe any remaining footings; ▪ Remove all remaining rubbish and debris; ▪ Removal of all mobile machinery from the site; ▪ Removal of all petroleum, chemicals and explosive products from the site; and ▪ Access to members of the public is restricted.
2	Landform Establishment	▪ Create a stable land form; ▪ Final landform is consistent with surrounding landforms; ▪ Establish drainage systems as part of batter formation to ensure stability.
3	Growth Medium Development	▪ Areas designated for woodland rehabilitation will be deep ripped and then direct seeded with a mix of native tree and shrub species which is blended with an appropriate application of fertiliser or other ameliorant as determined by soil testing; and ▪ Undertake follow-up soil testing as considered necessary.
4	Ecosystem and Landform Establishment	▪ The introduction and spread of weeds and pests should be prevented and an active program in place to minimise their presence; ▪ Undertake vegetation monitoring as required to determine target community structure and floristics; and ▪ Sow initial coloniser species with follow-up sowing and/or tube stock planting as required.
5	Ecosystem and Land-use Development	▪ Evidence of active use of habitat provided during rehabilitation such as logs and signs of natural generation of shelter sources including leaf litter; ▪ Presence of representatives of a broad range of functional indicator groups involved in different ecological processes; ▪ Typical food and water sources required by the majority of vertebrate and invertebrate inhabitants of that ecosystem type are present; ▪ Water quality of the receiving waters is not affected by surface water runoff from the site and discharge water meets the contaminant limits (EC, pH, TSS and oil and grease) of the EPL conditions; ▪ Nutrient cycling and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or other micro-symbionts; ▪ Representation of a range of species characteristic from each fauna assemblage (e.g. reptiles, birds, mammals) based on analogue rehabilitation monitoring reference sites; ▪ Continue monitoring until self-sustaining levels are confirmed; and ▪ Undertake maintenance work as required – including soil treatment, erosion control, weed spraying and re-sowing.

ID	Phase	Description
6	Land Relinquishment	▪ Meets the criteria in the 'Ecosystem and Land Use Development' rehabilitation phase. ▪ Establishment of a self-sustaining vegetation community compatible with the chosen land use. ▪ The quality of water leaving the site should be such as not to cause significant deterioration of water quality to the downstream beneficial use(s) or water quality objectives of the receiving waters declared under the Water Management Act 2000. ▪ Additionally, the quality of water leaving the site will meet the relevant water quality standards, in particular that the Protection of the Environment Operation Act 1997 which requires that there should be no pollution of waters as defined in that Act, unless an Environment Protection Licence (EPL) allows otherwise, in accordance with the EPL.

8.0 Rehabilitation Monitoring

8.1 Annual Rehabilitation Inspection

Upon completion of significant areas of rehabilitation, areas will be reviewed annually during operation of the site and during the 3-year rehabilitation monitoring period. This inspection will include monitoring of:

- Ground cover;
- Erosion;
- Overstorey, mid storey and lower storey;
- Leaf litter;
- Presence of mortality or die back; and
- Presence of weeds and feral animals.

Based on the results of rehabilitation monitoring, changes to maintenance may be required including weed and feral animal management.

8.2 Monitoring Post-Closure

Rehabilitation monitoring will be completed once rehabilitation has reached the ecosystem establishment phase. Analogue rehabilitation sites will be chosen to determine suitable final rehabilitation quality for the area and when rehabilitation monitoring commences at the site it will include:

- Revegetated and landscaped areas to be monitored for a 3-year period; and
- All rehabilitation works (i.e. fencing, weed control, erosion & sediment control) for the quarry's disturbed areas will be monitored as part of the site's monthly internal environmental inspections.

The rehabilitation monitoring transect will be established as a 100 x 5 m straight-line approximately along the contour (i.e. across the slope), attempting to avoid edge effects where possible. The transect may have to be shorter if the total rehabilitation area doesn't allow for full 100 m length. Each end will be marked with steel picket and permanent tags. The monitoring program will include the following parameters outlined in **Table 9** below.

Table 9 Monitoring Program Parameters.

Parameter	Description
Surface Erosion	General surface erosion observations made over entire transect. Evidence of rill, gully or sheet erosion, areas of sedimentation/deposition, surface flow paths, and exposed surface soil texture (sandy, rocky, etc.) recorded. If rill or gully erosion observed, representative erosion pins will be established along the gully and re-measured each monitoring visit to indicate erosion activity.
Groundcover	Depending on vegetation community type and accessibility, either stratified observations of groundcover percentage/type over 20 1m x 1m quadrats, or 200 Point Intercept Observations, or both. Calculations will be made for proportion cover of native groundcover, weed groundcover, litter, deadfall, rock and exposed soil (per hectare).

Parameter	Description
Vegetation (tree & shrubs)	Tree and shrub presence recorded for 100m x 5m transect (2.5m either side of transect tape). Tree/shrub species, height and location recorded. Calculations made for native species stems per hectare and species richness. Mortality and premature senescence rates will be recorded in subsequent years. Observations will be noted on the development of community structure (canopy, understory, groundcover, etc.) will be observed as rehabilitation matures.
Weed Presence	Significant weed infestations will be noted and managed during the next round of weed management. This includes implementing a weed spraying program. Significant weed infestation includes: ▪ the presence of any declared weeds or weeds of national significance (WONS); ▪ infestations that appear to be interfering with the development of rehabilitated vegetation; or ▪ weeds established near creeks or drainage lines that run offsite.
Feral Animals	Noting the presence of feral animals at site.
Comparisons with Analogue Site	Observations and trends noted for rehabilitation monitoring transect will be compared to information supplied from native vegetation monitoring.

8.3 Progress Reviews and Reporting

In accordance with Schedule 3, Condition 40 of the Development Consent this RCP document will be reviewed every five years. In the context that the site will be ceasing within the next five-year period, it is proposed to complete the statutory comprehensive reviews every two years.

A progress report will be included in the Annual Review in accordance with Schedule 3, Condition 41 of the Development Consent. All monitoring results will be included as part of the information presented in the progress report. The RCP will be revised to increase its effectiveness where any changes are recommended based on feedback from NSW Planning.

8.4 Rehabilitation Bond

In accordance with Schedule 3, Condition 42 and 43 of the Development Consent, the rehabilitation bond will be reviewed and updated every five years accounting for the effects of inflation, current disturbance and the performance of completed rehabilitation to-date. The current bond has been updated to reflect current circumstances as of 30 June 2023 as approved by NSW Planning on 09 January 2024.

9.0 Roles and Responsibilities

Table 10 outlines the responsible positions and accountable tasks.

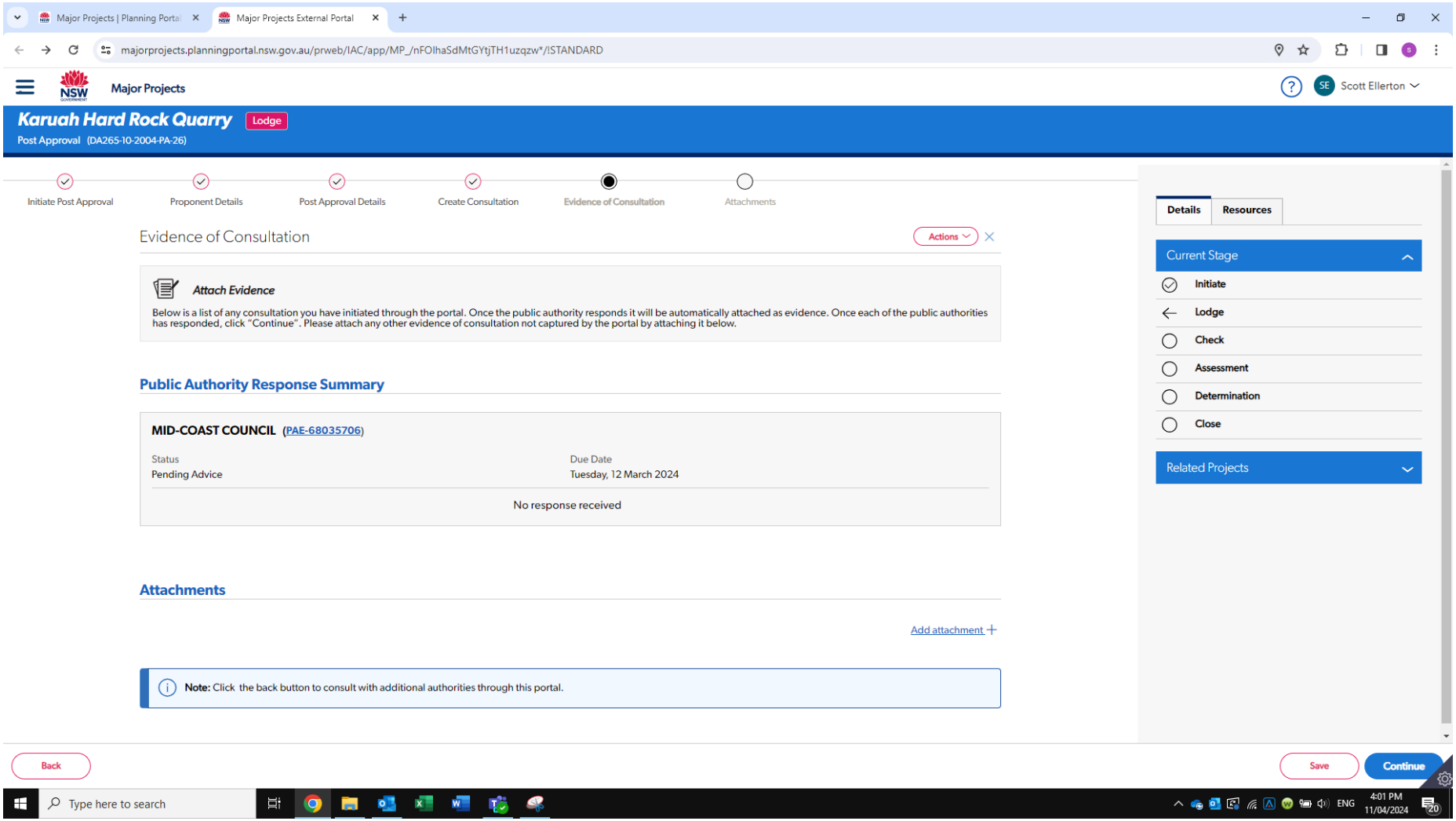
Table 10 Roles & Responsibilities.

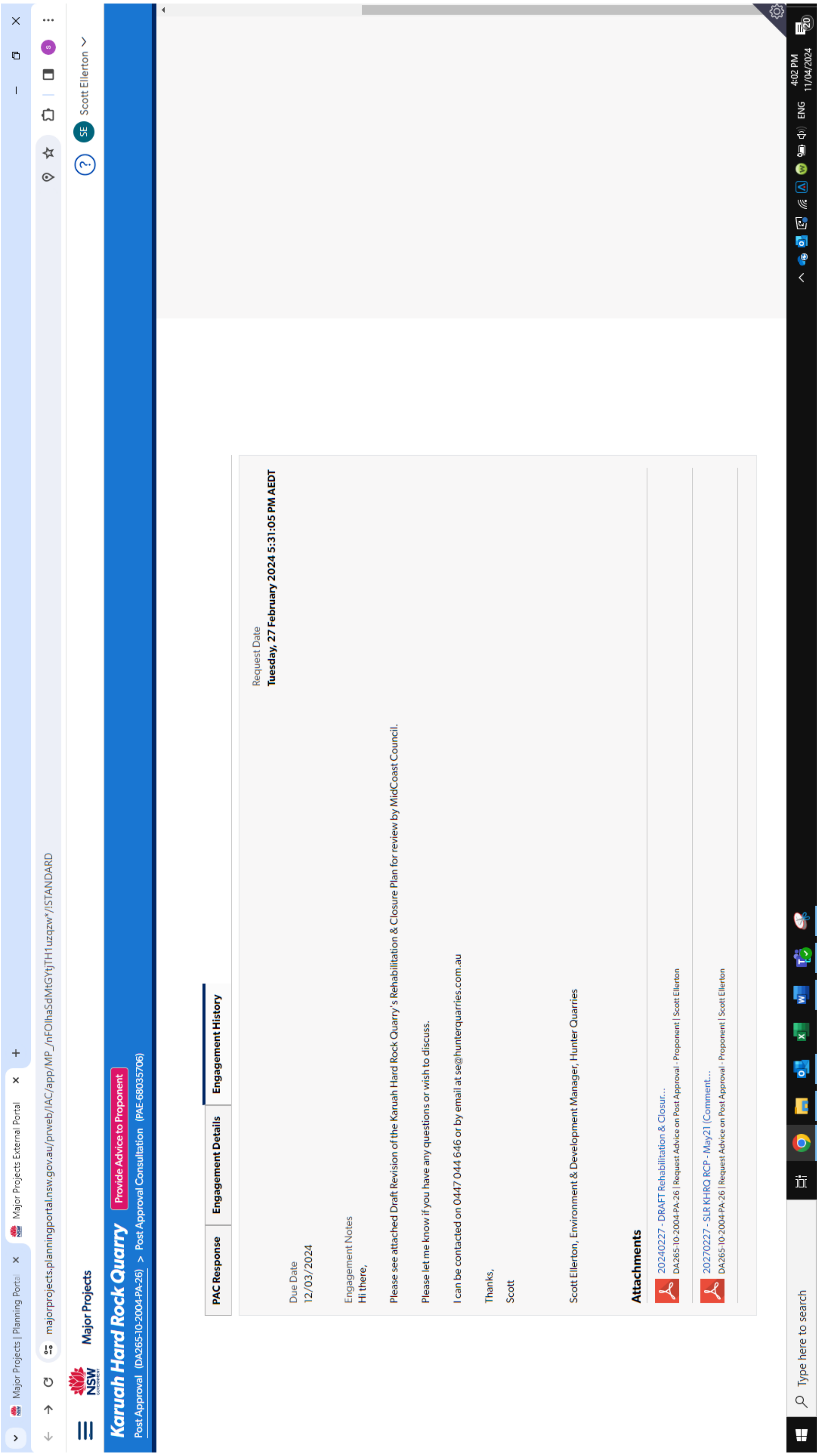
Position	Responsibility
Quarry Manager	▪ Ensure all relevant personnel are aware of rehabilitation procedures. ▪ Ensure all rehabilitation procedures are followed. ▪ Ensure sufficient resources are available to meet rehabilitation criteria and schedule.
Environment & Development Manager (or suitable delegate)	▪ Coordinate rehabilitation activities. ▪ Provide advice and support for the Quarry Manager in relation to this Plan. ▪ Ensure all rehabilitation is undertaken in accordance with the rehabilitation procedures presented in this Plan. ▪ Review and analyse rehabilitation monitoring and advise on rehabilitation maintenance. ▪ Conduct regular review of this Plan.
Quarry Supervisors & Quarry Operators	▪ Ensure clearing remains within the area nominated by the Manager and identified on plans. ▪ Vehicles to remain on established roads and tracks unless otherwise authorised. ▪ Notify Quarry Manager of any disturbance in native vegetation or rehabilitated sites.

10.0 References

- Department of Housing, Managing Urban Stormwater: Soils and Construction' – Volume 1, 4th Edition (2004) manual.
- Department of Resources and Geosciences, Mining Operations Plan Guidelines (2013).
- Former NSW Department of Land and Water Conservation (DLWC), Guidelines for Designing Stable Drainage Lines on Rehabilitated Mine Sites (1999).
- GSS Environmental, Karuah East Soil Survey and Land Resource Assessment (2011).
- Karuah Hard Rock Quarry, Flora and Fauna Management Plan (Reviewed 2023).
- Karuah Hard Rock Quarry, Site Water Management Plan, (Reviewed 2023).
- Karuah Hard Rock Quarry, Environmental Management Strategy, (Reviewed 2023).
- 2021-2022 Karuah Quarry Annual Reviews

Appendix A: Correspondence with MidCoast Council


Major Projects | Planning Portal
Major Projects External Portal
majorprojects.planningportal.nsw.gov.au/prweb/IAC/app/MP_/nFOIhaSdMtGYtjTH1uzqzw*/!STANDARD
Major Projects
Scott Ellerton
Karuah Hard Rock Quarry
Lodge
Post Approval (DA265-10-2004-PA-26)
Initiate Post Approval
Proponent Details
Post Approval Details
Create Consultation
Evidence of Consultation
Attachments
Evidence of Consultation
Actions
Attach Evidence
Below is a list of any consultation you have initiated through the portal. Once the public authority responds it will be automatically attached as evidence. Once each of the public authorities has responded, click "Continue". Please attach any other evidence of consultation not captured by the portal by attaching it below.
Public Authority Response Summary
MID-COAST COUNCIL (PAE-68035706)
Status
Pending Advice
Due Date
Tuesday, 12 March 2024
No response received
Attachments
Add attachment
Note: Click the back button to consult with additional authorities through this portal.
Details
Resources
Current Stage
Initiate
Lodge
Check
Assessment
Determination
Close
Related Projects
Back
Save
Continue
Type here to search
ENG
4:01 PM
11/04/2024


Major Projects | Planning Portal
Major Projects External Portal
majorprojects.planningportal.nsw.gov.au/prweb/IAC/app/MP_/nFOlhaSdMtGYtjTH1uzqzw*/!STANDARD
Major Projects
Scott Ellerton
Karuah Hard Rock Quarry
Provide Advice to Proponent
Post Approval (DA265-10-2004-PA-26) > Post Approval Consultation (PAE-68035706)
PAC Response
Engagement Details
Engagement History
Request Date
Tuesday, 27 February 2024 5:31:05 PM AEDT
Due Date
12/03/2024
Engagement Notes
Hi there,
Please see attached Draft Revision of the Karuah Hard Rock Quarry's Rehabilitation & Closure Plan for review by MidCoast Council.
Please let me know if you have any questions or wish to discuss.
I can be contacted on 0447 044 646 or by email at se@hunterquarries.com.au
Thanks,
Scott
Scott Ellerton, Environment & Development Manager, Hunter Quarries
Attachments
20240227 - DRAFT Rehabilitation & Closur...
DA265-10-2004-PA-26 | Request Advice on Post Approval - Proponent | Scott Ellerton
20270227 - SLR KHRQ RCP - May21 (Comment...
DA265-10-2004-PA-26 | Request Advice on Post Approval - Proponent | Scott Ellerton
Type here to search
4:02 PM
11/04/2024
ENG

Appendix B: Correspondence with NSW Planning

Department of Planning, Housing and Infrastructure

Our ref: DA265-10-2004-PA-38

Scott Ellerton
Environment & Development Manager
Hunter Quarries Pty Ltd
PO Box 23
Karuah, NSW, 2324

14/05/2025

Subject: Rehabilitation and Closure Plan

Dear Mr Ellerton

I refer to the Rehabilitation and Closure Plan submitted in accordance with condition 39 of Schedule 3 of the approval for the Karuah Hard Rock Quarry Project (DA265-10-2004).

The Department has carefully reviewed the document and is satisfied that it meets the requirements of the relevant conditions in consent.

Accordingly, as nominee of the Planning Secretary, I approve the Rehabilitation and Closure Plan (version 5A , dated March 2025).

You are reminded that if there are any inconsistencies between the plan and the conditions of approval, the conditions prevail.

Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Kristina Robinson on 02 9860 1543 or at Kristina.Robinson@dpie.nsw.gov.au.

Yours sincerely

Jarrod Blane
A/Team Leader
Resource Assessments

As nominee of the Planning Secretary

Appendix C: Final Void Water Balance

9 December 2019

630.12963-L01-v1.2 Final 20191209.docx

Hunter Quarries Pty Ltd
Karuah

Attention: **Greg Dressler**

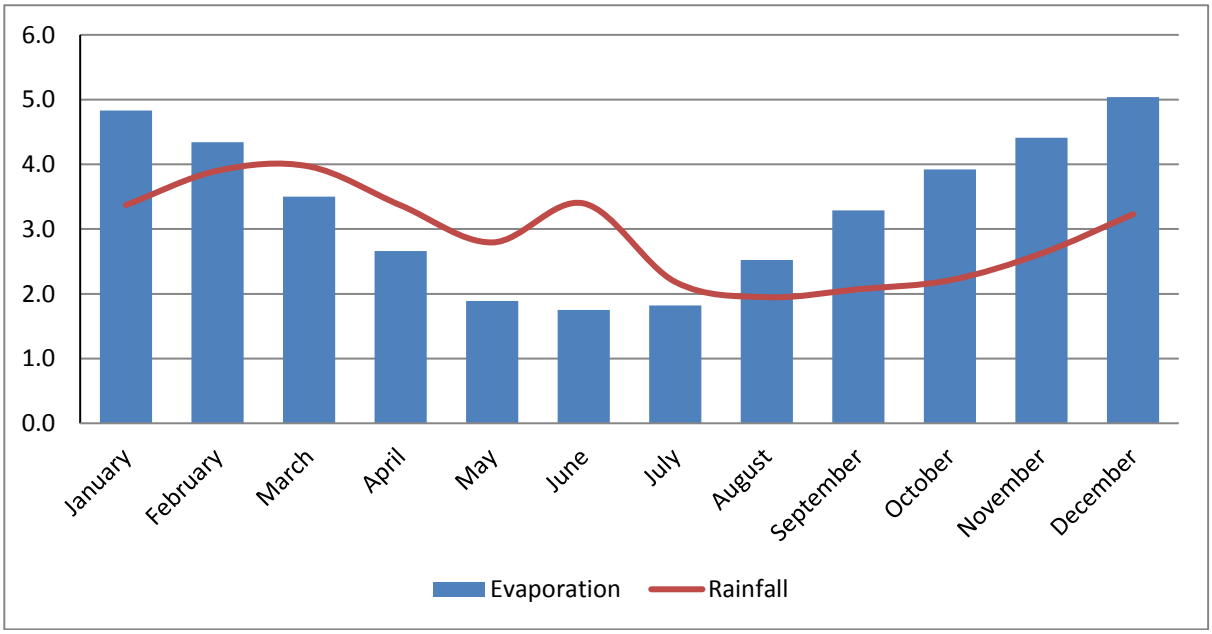
Dear Greg,

Karuah Quarry
Final Void Water Balance

SLR has examined the water balance for the Karuah Quarry final void, to allow an approximation of the equilibrium water level and the amount of water that will discharge to the downstream. We understand that this information will be used to inform final landform designs, rather than be a final determination of precise water levels.

Climate Data

Monthly climate data at the Clarence Town BOM Weather Station is indicated below:



The average annual rainfall is 1067mm. Average annual evaporation is 1753mm. Using a pan coefficient of 0.7 the annual evaporation is reduced to 1217mm.

SLR Consulting Australia Pty Ltd 10 Kings Road New Lambton NSW 2305 Australia (PO Box 447 New Lambton NSW 2305 Australia)
T: +61 2 4037 3200 **E:** newcastleau@slrconsulting.com
www.slrconsulting.com ABN 29 001 584 612

Water Balance Methodology

Water balance modelling was carried out using the GOLDSIM software, which allows historical daily rainfall depths to be applied to a catchment, and by subtracting evaporation (or other losses), simulate the water storage volumes and levels.

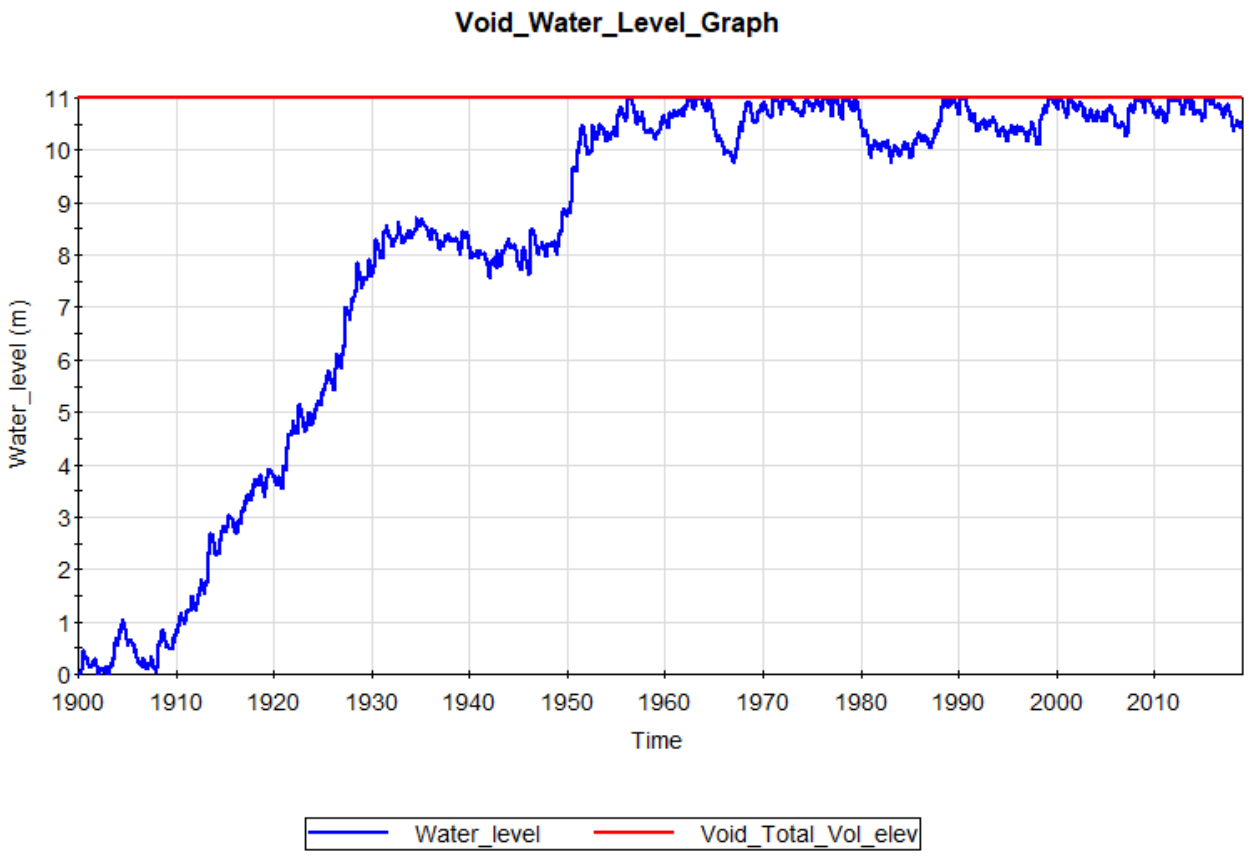
Modelling has been carried out with the following parameters:

- Historical rainfall records – 118 years of rainfall records from the Bureau of Meteorology station at Prince St, Clarence Town (Station 061010) weather station were applied to the catchment. This station was selected because of its proximity to the site, and length of rainfall records.
- Catchment area has been based on survey data supplied by Hunter Quarries dated 23rd of October 2019. The catchment area used was 1.99ha on batters plus a void area of 8.97ha.
- Volumetric runoff coefficient of 1.0 based on hard rock surfaces and subgrades
- Groundwater inflow – Net inflow (water in minus out) was assumed as nil. Whilst on site there was some evidence of seepage into the existing pit. However, when a permanent water body is established, there will also be flows out, which may exceed the flows in. It is also noted that if there is a net leakage then it would be possible to seal the void. In the absence of a quantitative assessment of groundwater the net groundwater inflow was assumed as zero.
- Stage Storage – areas within contours above RL65 were taken from available survey and current contours for the final quarry. Linear interpolation was used to determine areas between available contour data.
- Spillway level – Water balance modelling was carried out with a spillway level at RL76. It is noted that selection of the final spillway level will be subject to detailed design.

Water Balance Modelling Results

The results of water balance modelling are shown in the graphs below, with the first indicating water depth, and the second indicating storage volume. The level of the spillway is indicated by the horizontal red line.

The x-axis values reflect the period of historical rainfall used in the water balance modelling. Actual rates of water storage filling will of course depend on future rainfall.


Void_Water_Level_Graph
Water_level (m)
Time
Water_level
Void_Total_Vol_elev

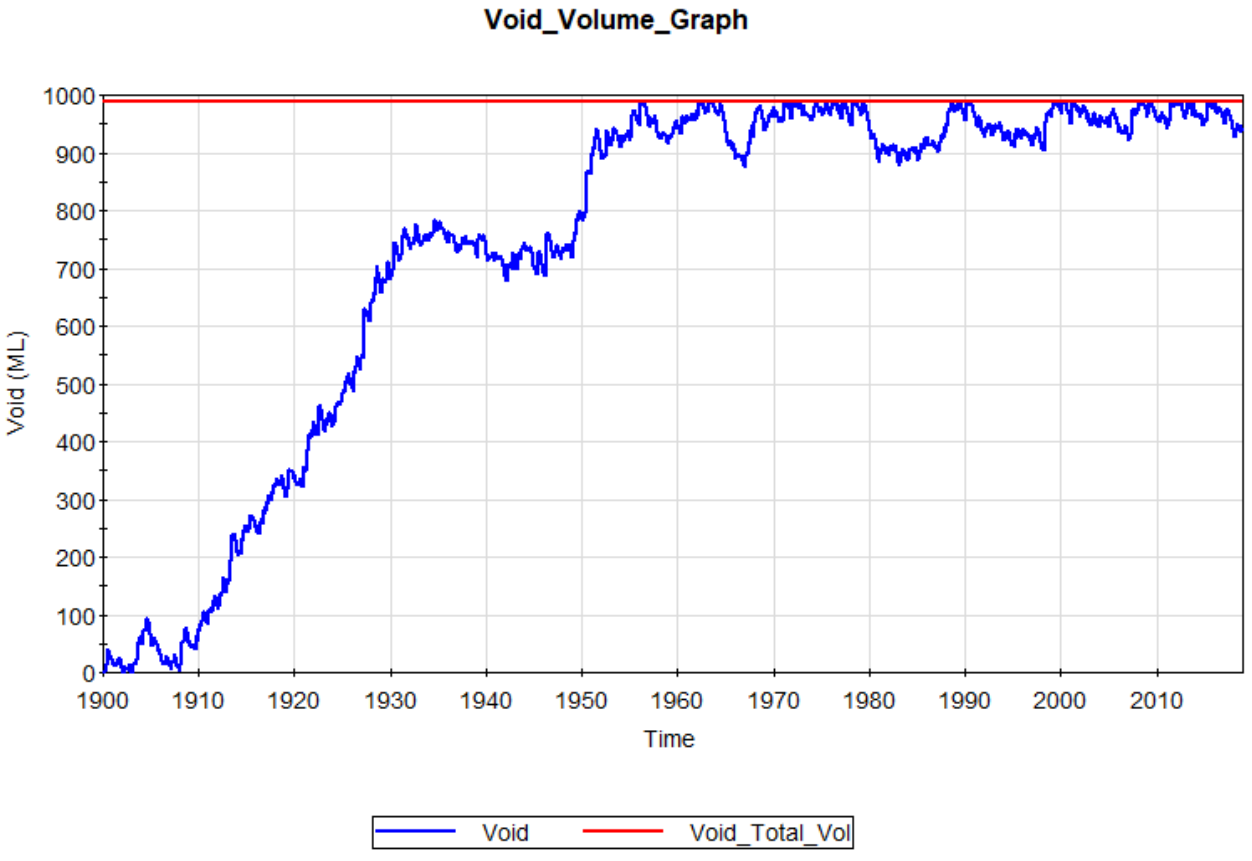

Void_Volume_Graph
Void (ML)
Time
Void
Void_Total_Vol

Table 1 - Average Annual Water Balance

	Description	Average Per year from 1900 to 2018 (ML/year)
Water Source (Inputs)	Catchment runoff	117.7
Water Losses (Outputs)	Evaporation (from water storage)	104.2
Off-site Discharge (once filled)	Void Overflow	5.85

The water balance analysis indicates that water will accumulate in the void until it reaches the spillway level. The present analysis assumed that the spillway is 11m above the floor of the quarry. With a storage depth of 11m (RL76 - RL65) the storage will take approximately 55 years to fill, at an average annual filling rate of 13.5ML/year.

The average rate of water storage filling reduces as the water level gets higher, since the water surface area increases and losses from evaporation also increase.

Once filled, water will spill to the downstream environment. This would occur intermittently but typically only during rainfall events with a substantial depth of rainfall. In between discharge events, the water level would gradually reduce below the spillway level through evaporation. On average the water storage would discharge approximately once per year, and the estimated average annual overflow volume would be 5.85ML.

Once the spillway level is reached, water levels will fluctuate depending on rainfall. Fluctuation is likely to be less that 0.5m on average rainfall years, but could be up to 1.2m during very dry years.

Discussion

The analysis above assumes a spillway level at RL 76. Selection of a final spillway level will be subject to detailed design. The level at which the spillway is placed will dictate the time taken for the quarry void to fill up.

It may be practical to locate the spillway level along the north-western edge of the void so that water will overflow to an existing watercourse and avoid directing discharge into existing operational areas to the west. This would require filling of the existing quarry road entry which is below RL76.

Peak discharges to the downstream environment may be attenuated by use of a low flow weir that discharges water slowly and maintains a water level which is about 0.3m below the spillway level. This maintains some 'air space' to store runoff during heavy rainfall, and then release it slowly to the downstream environment.

It should also be noted that since the average filling rate of the water storage is low, the filling outcome is very sensitive to groundwater leakage. The average filling rate of 13.5ML/year is in the order of 0.4L/s. This means that if the water storage leaks water at an average rate greater than 0.4L/s then it may never fully fill to spillway level.

In terms of the environmental impact of future water quality of discharges from the water storage to the downstream environment, no present water quality monitoring data is available. It could be expected that water quality will improve markedly once operations cease, the landform is stabilised, and water ponded for long periods.

The information in this letter is intended as an approximation of water storage behaviour intended for use in planning closure activities for this void. Let me know if you require refinement of this modelling during detailed design of the final landform and closure activities.

Yours sincerely,

PAUL DELANEY
Manager - Civil Discipline

Checked/ Authorised by:	PD