ROCGLEN LANDFORM ANALYSIS BRIEFING PAPER

Closure MOP V3 Proposed Post Mining Landform

Prepared for:

Whitehaven Coal Mining Limited
PO Box 600
GUNNEDAH NSW 2380

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Whitehaven Coal Mining Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.12887-R01-v2.0	26 November 2019	Nathan Archer	Tony Dwyer	Nathan Archer
630.12887-R01-v1.0	8 October 2019	Nathan Archer	Renae Gifford/Tony Dwyer/Daniel Cherry	Nathan Archer

EXECUTIVE SUMMARY

This *Landform Analysis Briefing Paper* (Briefing Paper) has been prepared by SLR Consulting Australia (SLR) in conjunction with Whitehaven Coal Limited (Whitehaven) for the Rocglen Coal Mine (Rocglen) in the Gunnedah Basin of northern New South Wales (NSW). A previous Briefing Paper dated 17 May 2017 was prepared in response to questions and issues raised by the Department of Planning and Environment (DPE)[1] and the Division of Resources and Energy (DRE)[2] with regard to the post mining landform presented in the *Rocglen Mine Closure Mining Operations Plan* (Closure MOP) submitted in November 2016.

Since the preparation of the previous Briefing Paper, Whitehaven have submitted the *Rocglen Closure MOP V3* (Closure MOP V3) dated 22 February 2019 which details a revised post mining landform for Rocglen. The landform proposed in the Closure MOP V3 was designed to address matters raised by DPIE-RR in correspondence dated 28 November 2017 (Ref: OUT17/47234). The DPIE-RR specifically required that the following requirements be met by the revised landform:

1. No increase to the extent of open cut mining (refer **Section 3**);
2. A reduction in final pit depth from 220 m AHD to 244 m AHD (refer **Section 4.2.3**);
3. Reduction in final void catchment from 156 hectares (ha) to 130 ha (refer **Section 4.2.4**); and
4. Establishment of 213.3 ha of woodland revegetation (refer **Section 4.2.5**).

Following review of the Closure MOP V3, DPIE-RR have requested a revised copy of the Briefing Paper be prepared to confirm the above commitments have been met.

In addition, following review of the Briefing Paper, DPIE-RR requested the following additional information be included:

- *explain why the void footprint has increase from 68ha to 130ha* (refer **Section 4.2.5**); and
- *provide details on the approved and proposed final void water levels and area of void water* (refer **Section 4.2.6**).

Based on analysis of the spatial data provided by Whitehaven for the post mining landform shown in Plan 4 of the Closure MOP V3, SLR conclude the following:

- The approved extent of open cut mining is 160.2 ha while the extent of open cut mining presented in the Closure MOP V3 is 151.7 ha. Therefore the extent of open cut mining is approximately 8.5 ha less than approved;
- Based on the landform contours presented in Plan 4 of the Closure MOP V3, the depth of the final depression is generally no less than 245 m AHD. The maximum contour depth presented is 240 m AHD associated with the two water management areas within the final depression;
- The total final void/depression surface area is 130 ha. SLR are advised that the catchment area will be managed to ensure that no runoff from the Western Emplacement Area will report to the final depression and to limit the catchment area to 130 ha; and
- Based on the secondary domains presented in Plan 4 of the Closure MOP V3, the final land use comprises of approximately 158 ha and 220 ha of rehabilitated pasture and bushland, respectively.

[1] now Department of Planning Industry and Environment (DPIE)

[2] now Department of Planning Industry and Environment – Resources Regulator (DPIE-RR)

- The final void footprint was modified due to changes in the mine plan and material balance meaning that EIS landform design, in particular the final void size and location, could not be achieved. The footprint of the final depression has been assumed to be the same as the overall catchment area. This is due to the flattening of the lowwalls to the north and the reduction in depth of the final depression in the Closure MOP V3 landform; resulting in a less defined final void boundary as the slopes blend into the surrounding topography.
- Assuming pit lake recovery levels consistent with those determined for the EIS and previous landform, the backfilling of the void and reduction in the depth of the overall landform is likely to reduce the area of a final void lake in comparison with previous landforms.

In addition, the Closure MOP V3 post mining landform has significantly reduced the area with slopes greater than 14 degrees by 44 ha from 50.6 ha to 6.6 ha and eliminated the highwall from the final open cut void, hence minimising the area with slopes greater than 18 degrees.

CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

1 Introduction

This *Landform Analysis Briefing Paper* (Briefing Paper) has been prepared by SLR Consulting Australia (SLR) in conjunction with Whitehaven Coal Limited (Whitehaven) for the Rocglen Coal Mine (Rocglen) in the Gunnedah Basin of northern New South Wales (NSW). A previous Briefing Paper dated 17 May 2017 was prepared in response to questions and issues raised by the Department of Planning and Environment (DPE)[3] and the Division of Resources and Energy (DRE)[4] with regard to the post mining landform presented in the *Rocglen Mine Closure Mining Operations Plan* (Closure MOP) submitted in November 2016.

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1. No increase to the extent of open cut mining (refer **Section 3**);
2. A reduction in final pit depth from 220 m AHD to 244 m AHD (refer **Section 4**);
3. Reduction in final void catchment from 156 hectares (ha) to 130 ha (refer **Section 4**); and
4. Establishment of 213.3 ha of woodland revegetation (refer **Section 5**).

Following review of the Closure MOP V3, DPIE-RR have requested a revised copy of the Briefing Paper be prepared to confirm the above commitments have been met.

The Briefing Paper has been updated and revised specifically to address the points above and has been based upon the post mining landform shown in Plan 4 of the Closure MOP V3.

In addition, following review of the Briefing Paper, DPIE-RR requested the following additional information be included:

- *explain why the void footprint has increase from 68ha to 130ha* (refer **Section 4.2.5**); and
- *provide details on the approved and proposed final void water levels and area of void water* (refer **Section 4.2.6**).

[3] now Department of Planning Industry and Environment (DPIE)

[4] now Department of Planning Industry and Environment – Resources Regulator (DPIE-RR)

2 Background

2.1 History of Operations

Rocglen (previously known as the Belmont Coal Project) was originally granted Project Approval (PA) 06_0198 on 15 April 2008 under Part 3A (now repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Mining Lease (ML) 1620 was subsequently issued for the Rocglen operation in June 2008 and coal production commenced in late 2008. Approximately 1.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal is approved to be mined within the open cut pit using truck and excavator method. The coal is transported approximately 30 kilometres by road to the Whitehaven Coal Handling and Preparation Plant (CHPP) for selective washing and subsequent transport by rail to the Port of Newcastle or by road to domestic customers.

On 27 May 2010, an approval was issued under Section 75W of Part 3A of the EP&A Act to modify PA 06_0198 (PA 06_0198 MOD 1). This modification permitted Whitehaven to undertake unplanned emergency earthworks to stabilise the eastern highwall following slipping adjacent to a fault structure in the north eastern portion of the approved open cut pit. It was determined that stabilisation works were required to ensure the long-term stability and safety of the highwall, which would in turn enable on-going extraction efforts at the northern end of the approved open cut.

Following further drilling and definition of the local geological features, as well as additional reviews of the mine plan, Whitehaven proposed to expand operations at Rocglen in order to maximise resource recovery and allow for improved mine progression. Whitehaven received PA 10_0015 on 27 September 2011 for the Rocglen Coal Mine Extension Project. Approval was issued for a modification to PA 10_0015 (MOD 1) on 10 November 2014 relating to coal haulage. A further modification (MOD 2) was approved in 2015 relating to a change to type of rejects permitted to be received. Modification 3 (MOD 3) was approved on 10 February 2017 for the temporary increase in road haulage from 3.5 Mtpa to 4 Mtpa along the southern section of the Approved Road Transport Route for the calendar years 2016 and 2017; Modification 4 (MOD 4) was approved on 1 November 2018 to continue this temporary road haulage.

ML 1662 was issued on 9 January 2012 to cover the Rocglen Coal Mine Extension Project, specifically the water management and overburden emplacement activities proposed to occur outside the bounds of ML 1620.

2.2 MOP History and Scope

Operations at Rocglen have been undertaken in accordance with the Mining Operations Plans (MOPs) outlined in **Table 1**.

Table 1 Rocglen History of MOP

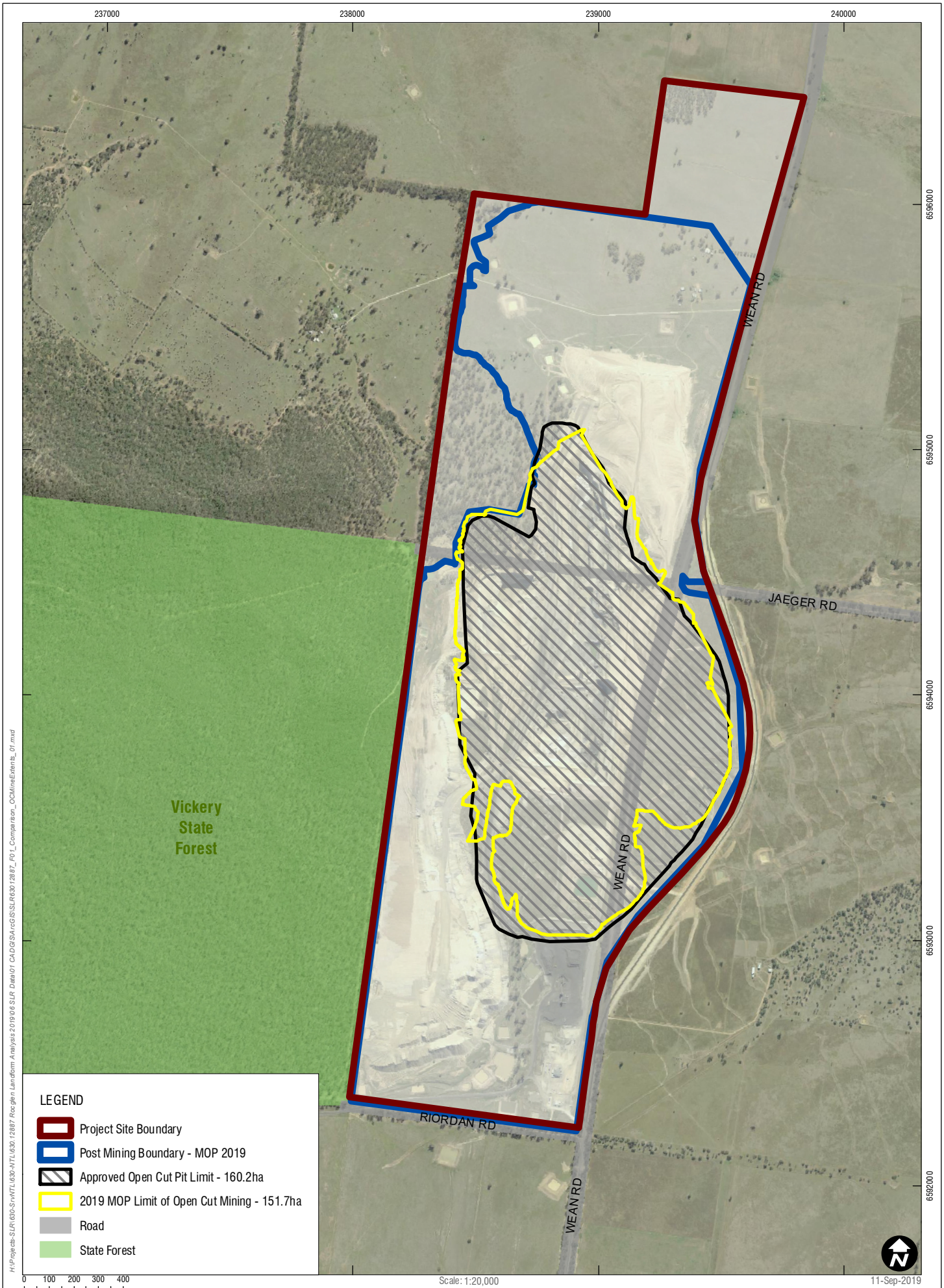
Mining Operations Plan	Date Granted	Expiry	Status
Rocglen Closure MOP V3	Not yet approved	-	Submitted to DPIE-RR on 22 February 2019.
Rocglen Closure MOP	Withdrawn from assessment	-	Submitted to DRE in November 2016. Withdrawn from assessment on 16 October 2017.
Rocglen MOP Amendment A	21 November 2016	30 October 2020	Current
Rocglen MOP	30 October 2015	30 October 2020	Superseded
Rocglen Extension MOP (as amended)	21 October 2011	30 October 2015	Superseded
Rocglen MOP (as amended)	12 June 2008	1 October 2012	Superseded

3 Extent of Open Cut Mining

As outlined in **Section 1**, the DPIE have requested confirmation that there has been no increase to the open cut mining extent proposed by the Closure MOP V3.

A comparison of the 2011 EIS Approved open cut mining extent and the Closure MOP V3 mining extent is presented in **Figure 1.**

As shown in **Figure 1**, the approved extent of open cut mining is 160.2 ha while the extent of open cut mining presented in the Closure MOP V3 is 151.7 ha. Therefore, the extent of open cut mining is approximately 8.5 ha less than approved.



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Comparison of Open Cut Mining Extents

FIGURE 1

4 Post Mining Landform and Land Use Analysis

4.1 Approved Post Mining Landform and Land Use

4.1.1 Approved Post Mining Landform (2011 EIS)

The approved EIS post mining landform is presented in **Figure 2**. As detailed in the EIS, the Conceptual Post Mining Rehabilitated Landform was designed to include the following:

- An elevated landform to the north of the final void (Northern Emplacement Area). The maximum design height of this knoll will be approximately 50 m above the pre-mining landform, which is the approximate height of the adjacent ridge to the west of the Project Site at around 340 m AHD. Reshaping will ensure that final slopes around the margin of the knoll will not exceed 10 degrees (18%).
- Coal extraction will leave an open pit void (final void) at mine closure covering an area of close to 60 ha in the eastern and southern extents of the open cut pit. It will have a maximum depth of around 220 m AHD. The northern, western and southern slopes of the final void will be shaped to achieve between 10 and a maximum of 18 degree batter angles (18 to 32%) depending on the location of the slope within the extent of the void. The highwall on the eastern margin of the final void will be battered to approximately 45 degrees through blasting.
- An elevated ridgeline extending southwards adjacent to the Vickery State Forest along with western boundary of the Project Site, being the approved Western Emplacement Area. The maximum design height of this ridgeline will, again, be approximately 50 m above pre-mining landform, which is the approximate height of the adjacent ridge immediately to the west at 340 m AHD. Reshaping will ensure that final slopes will generally be 10 degrees (18%). In the northern section the eastern batters of this ridgeline will graduate to the gently sloping landform north of the final void, while in the middle section the ridgeline batters will blend with those of the final void. In the section extent, the eastward and south facing batters of the ridgeline will blend into the undisturbed landform.
- A north-south drainage depression extending from just north of the final void passing to the west of the final void through the centre of the Project Site down to the southern boundary where it will flow into an existing drainage line that eventually drains into the Namoi River approximately 10 km from the Project Site.

4.1.2 Approved Post Mining Land Use (2011 EIS)

As shown in **Figure 2**, the EIS approved post mining land use comprises of a mixture of rehabilitated bushland and rehabilitated pasture. Rehabilitated bushland areas will be commensurate with surrounding areas of undisturbed native bushland and will provide linkages to maintain a corridor for wildlife movement across the site from west to east (refer **Section 4.2**). Rehabilitated pasture areas will tie in with the existing surrounding modified grassland areas of the locality and will provide areas of grazing consistent with pre-mining conditions. The EIS (and previous MOPs) also included an area associated with the retained final void highwall. As stated in the EIS:

> *"Of the total anticipated disturbance area of approximately 358 hectares, it is proposed to restore approximately 206 hectares as rehabilitated bushland (58 percent), 147 hectares as rehabilitated pasture (41 percent), with the remaining 5 hectares comprising the retained highwall of the final void (1 percent). Furthermore, there will be retained areas of existing remnant vegetation within the Project Site."*

4.2 Closure MOP V3 Post Mining Landform and Land Use

4.2.1 Development of the Closure MOP V3 Post Mining Landform

The Closure MOP V3 proposed post mining landform has been developed to address the matters raised by DPIE-RR (refer **Section 1**) and has considered refinements in the material balance and movement schedule which have been identified since the preparation of the previous Briefing Paper. The Closure MOP V3 post mining landform is shown in **Figure 2**. In addition, the various iterations to the proposed landform are presented in **Figure 3** for comparison.

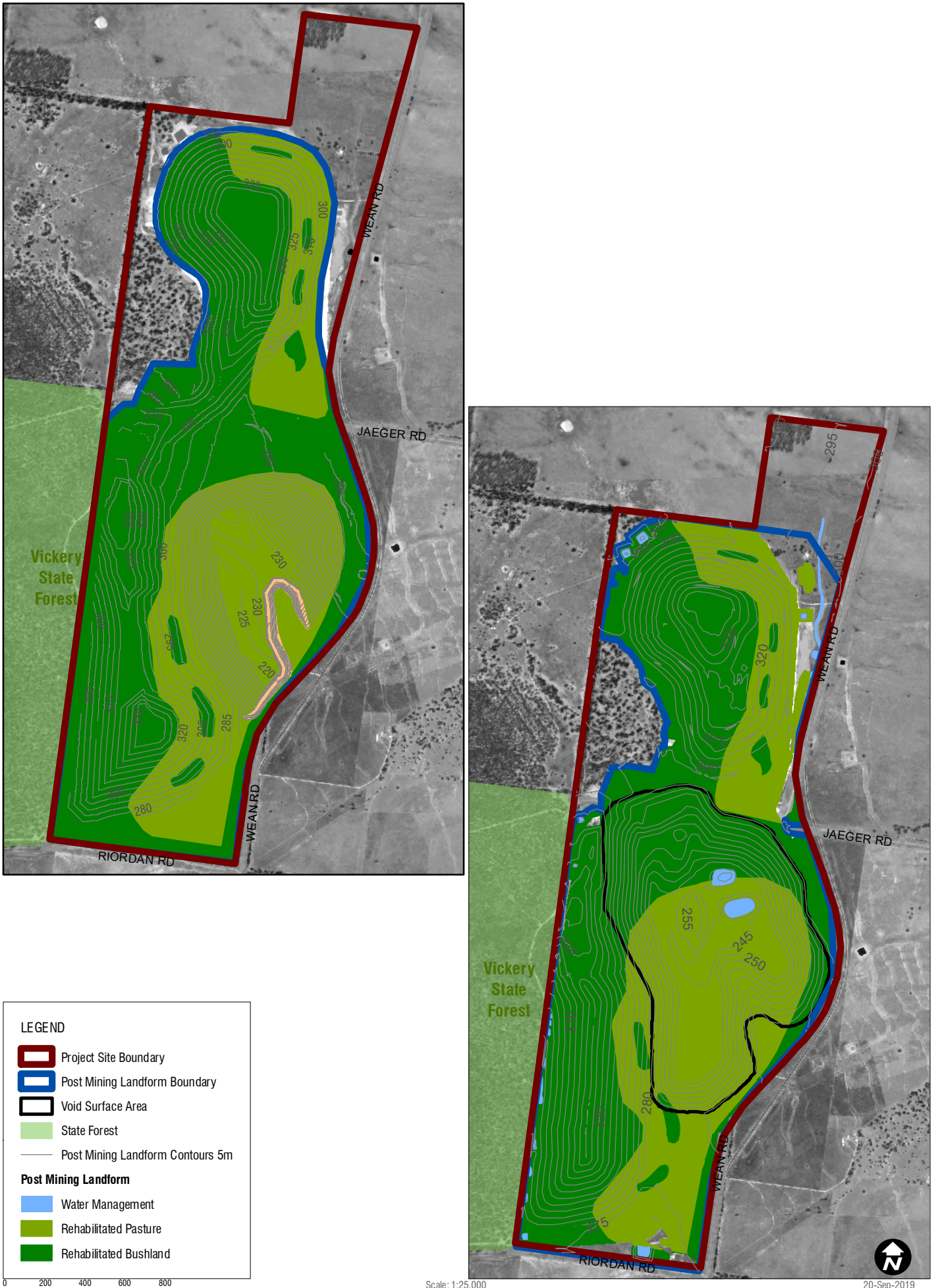
4.2.2 Closure MOP V3 Post Mining Landform Design

The Closure MOP V3 post-mining landform has been designed to achieve a stable topography with consideration to financial feasibility, environmental outcomes and potential future agricultural production.

The major features of the landform include the following:

- Following the cessation of mining, the open cut void will be partially backfilled to leave a final depression.
- The final depression will have a maximum depth of 244 m AHD. The lowwalls, being the northern, western and part of the eastern slopes of the final open cut, will be shaped to achieve between 10 and a maximum of 18 degree batter angles depending on the location of the slope within the extent of the void.
- Material from the Western Emplacement Area will be rehandled into the final open cut void to partially backfill the mining area. The rehandling and backfilling of material will be undertaken such that no highwall remains on the southern and western margin of the final open cut void. Backfilled material will be shaped to be generally less than 14 degrees depending on the location of the slope within the extent of the void.
- An elevated landform to the north, being the Northern Emplacement Area consistent with the EIS. The Northern Emplacement Area has been reshaped with water management structures already designed and constructed and the majority of the disturbed areas revegetated.
- An elevated ridgeline extending southwards adjacent to the Vickery State Forest along the western boundary of Rocglen, being the Western Emplacement Area. The maximum design height of this ridgeline will be approximately 330 m AHD. Reshaping will ensure that final slopes will generally be less than 10 degrees.
- Surface water management will be designed to ensure water from the Western Emplacement Area does not report to the final depression and to reduce the final void catchment area to 130 ha.

The post-mining landform has been developed and refined in order to ensure that a low maintenance, stable and safe landform remains that blends in with the surrounding topography and can support a mixture of rehabilitated bushland with areas of pasture.



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EIS and Closure MOP V3
Post Mining Landforms

FIGURE 2

EIS 2011 Post Mining Landform

MOP 2013 Post Mining Landform

Landform Design Review November 2016

Landform Design Review September 2019

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LEGEND

- Project Site Boundary
- Post Mining Landform Boundary
- Void Surface Area
- Post Mining Landform Contours 10m
- State Forest
- **Post Mining Landform**
- Water Management
- Rehabilitated Pasture
- Rehabilitated Bushland

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Alternative Post Mining Landform Designs Considered

FIGURE 3

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4.2.3 Closure MOP V3 Final Void/Depression Depth

Based on the landform contours presented in Plan 4 of the Closure MOP V3, the depth of the final depression is generally no less than 245 m AHD. The maximum contour depth presented is 240 m AHD associated with the two water management areas within the final depression.

4.2.4 Closure MOP V3 Final Void/Depression Catchment Area

The surface area of the final void/depression is presented in **Figure 2** and measures 130 ha. SLR are advised that the surface water management will be designed to ensure water from the Western Emplacement Area does not report to the final depression and will limit the final catchment area to 130 ha.

4.2.5 Closure MOP V3 Final Void/Depression Footprint

As detailed in the 2017 Briefing Paper, the footprint of the final void was refined due to the following factors:

Modified Mine Plan

- *Exploration drilling completed since the development of the EIS 2011 final landform has redefined the western and southern limit of open-cut mining, extending the economic mining limit further west and south than the 2011 pit shell. This new pit configuration and subsequent mine plan has materially altered the final pit design such that the EIS landform design, in particular the final void size and location, cannot now be achieved.*

Material Balance

- *A detailed material balance of remaining in-situ waste material has determined there is insufficient overburden in the areas still to be mined to deliver the EIS final landform design. A combination of a change in final pit shell and mining sequence over the past few years driven primarily by changing economic conditions, have materially altered the excavation and dumping balance resulting in a redesign of the final landform.*

The footprint of the Closure MOP V3 final depression has been assumed to be the same as the overall catchment area presented above (being 130 ha). This is due to the flattening of the lowwalls to the north and the reduction in depth of the final depression in the Closure MOP V3 landform; resulting in a less defined final void boundary as the slopes blend into the surrounding topography, particularly to the northwest. The lowwall slopes in the EIS final void were approved to be greater than 18 degrees and provided a clearly defined final void. This is illustrated in **Figure 5** and slopes are discussed in **Section 4.3**.

4.2.6 Closure MOP V3 Final Void Water Levels and Area of Void Water

The *Rocglen Extension Project EA – Appendix R – Hydrogeological Assessment* (Douglas Partners, 2010) predicted that the that the equilibrium water levels in EIS approval final void would be in the range of 220 to 245 m AHD. Further detailed hydrological modelling was undertaken in 2017 which predicted that the final equilibrium water level of the 2017 Briefing Paper landform would also be approximately 245 m AHD.

In both cases, the storage level within the final void never reaches the overflow level (RL280 m AHD), therefore indicating that the void is not expected to spill. The calculated void lake elevations in both scenarios are at least 20 m below the pre-mining groundwater elevation of 269 m AHD and therefore there will be an inwards hydraulic gradient from the groundwater system to the void that results in the final void being a permanent groundwater sink (i.e. permanent evaporative-driven groundwater discharge to the pit).

No detailed water balance has been prepared for the Closure MOP V3 final landform; however, it is unlikely that the backfilling of the void will materially affect the previously determined pit lake recovery level. Further, given that the backfilled level of 245m AHD remains at least 20 m below the pre-mining groundwater elevation of 269 m AHD, the final void will remain a permanent groundwater sink. Further, the area of potential inundation below 245m AHD is restricted to two designated dams shown in the void floor in Closure MOP V3 with the remainder of the landform being at or above 245m AHD.

Assuming pit lake recovery levels consistent with those determined for the EIS and previous landform, a summary of the calculated relationship between pit lake elevation and associated lake volume in the Closure MOP V3 Landform is presented in **Table 2**.

Table 2 Predicted Pit Lake Area

Lake Elevation (m AHD)	Approved EIS Landform Lake Area (ha)	Previous Briefing Paper Landform Lake Area (ha)	Estimated Closure MOP V3 Landform Lake Area (ha)
245	35.3	16	8.7

As shown in **Table 2**, the backfilling of the void and reduction in the depth of the overall landform is likely to reduce the area of a final void lake in comparison with previous landforms.

4.2.7 Closure MOP V3 Post Mining Land Use

Table 3 presents the final land use domains as presented in Plan 4 of the Closure MOP V3. In addition, **Table 3** presents the areas shown in Table 24 of the Closure MOP V3 document and the EIS approved post mining land use areas for comparison.

Table 3 Closure MOP V3 Post Mining Land Use

Secondary Domain	EIS Approved Area (ha)	Area in table 24 of Closure MOP V3 Document (ha)	Domain areas provided in Plan 4 GIS data (ha)
Native Vegetation	206	213.3	220.0
Pasture	147	149.2	158.0
Undisturbed	-	0.3	13.2
Water management	-	9.4	4.5
Final Void Highwall	5	-	-
Total area	**358**	**372.2**	**395.7**

It is noted that the areas in Table 24 of the Closure MOP V3 were calculated by Whitehaven based on GIS areas of disturbance and proposed rehabilitation at the end of the MOP term (not the completion of the final landform). The Plan 4 domain areas have been determined by SLR based on the areas of the secondary domain provided in the GIS layers for Plan 4. The total area of 395.7 ha from Plan 4 shown in **Table 3** comprises the entire area within the post mining landform boundary presented in **Figure 2** and **Figure 3.**

As presented in **Table 3**, the post mining land use is proposed to restore at least 213 ha of native vegetation which exceeds the 206 ha presented in the EIS (and approved by PA 10_0015) and meets the area of 213.3 ha specified in the DPIE-RR correspondence dated 28 November 2017 (Ref: OUT17/47234).

4.2.8 Habitat Corridor

The Vickery State Forest adjoins Rocglen to the west and is declared under the *Brigalow and Nandewar Community Conservation Area Act 2005* to be within Community Conservation Area (CCA) Zone 4 Vickery. CCA Zone 2 Kelvin is located approximately 3.5 km to the east of Rocglen. This land, which was formally known as the Kelvin State Forest, is reserved under the *National Parks and Wildlife Act 1974* as an Aboriginal area.

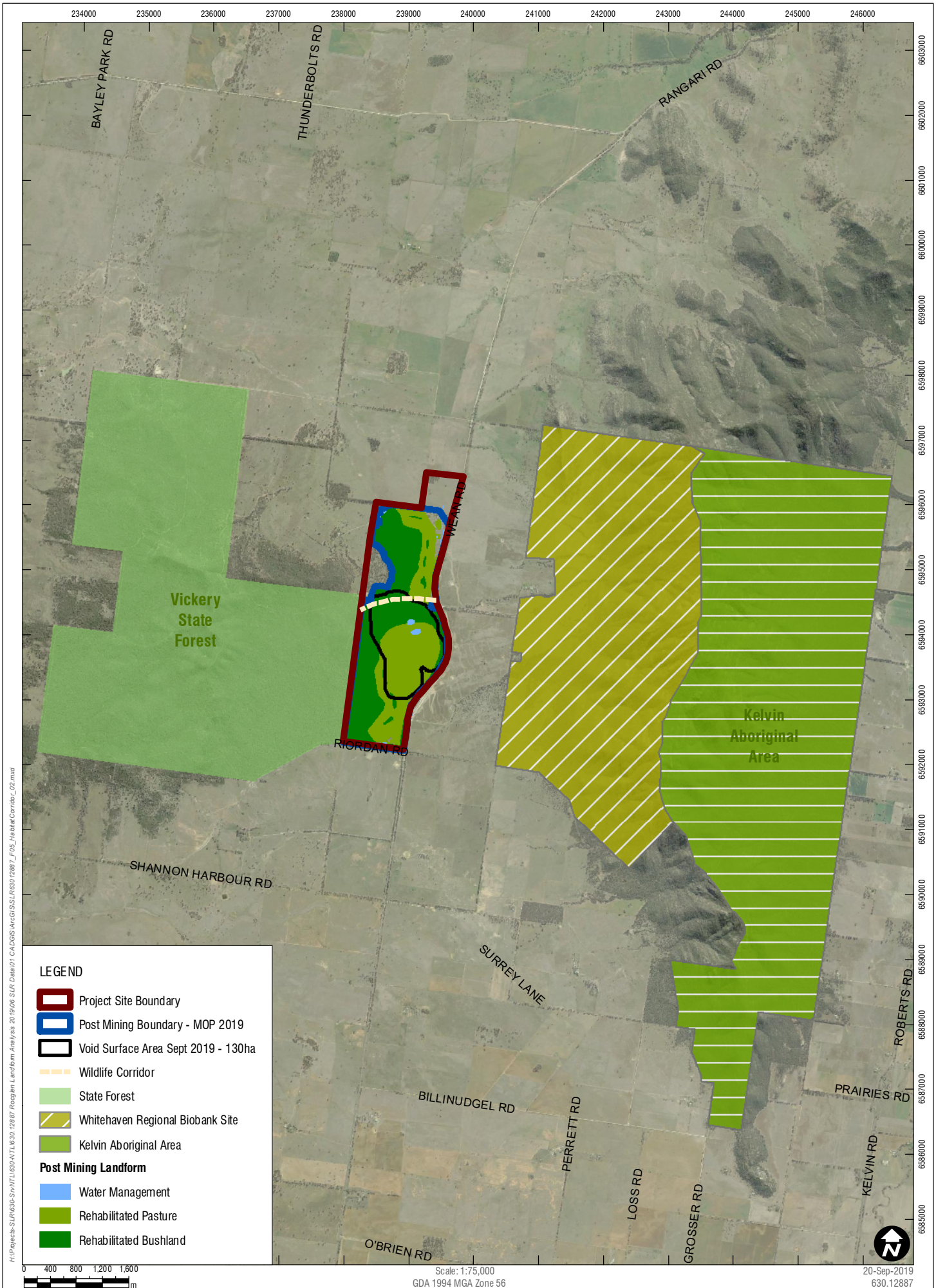
The locations of the CCA Zone 4 Vickery and CCA Zone 2 Kelvin are shown in **Figure 4.**

The Whitehaven Regional BioBank Site (presented in **Figure 4**) provides for the long-term conservation of approximately 1,500 ha of land owned by Whitehaven to the east of Rocglen. This area of land has been registered as a BioBank Site under Part 7A of the *Threatened Species Conservation Act 1995* (TSC Act). It is being actively managed via a *BioBanking Management Plan* with in-perpetuity management funding, and has the highest level of conservation status outside of National Parks via a *BioBanking Agreement* registered on the land title in perpetuity.

The approved post mining landform (EIS 2011) provided for a habitat corridor to be established between the final void and the reshaped Northern emplacement dump. This habitat corridor runs approximately from west to east, providing a linkage across the project site between the Vickery State Forest to the west and the Whitehaven Regional BioBank Site to the east. The habitat corridor will consist of native open woodland species commensurate with the existing remnant bushland to the west of the site (Vickery State Forest) and to the east of the site, creating a viable connection with the surrounding environment allowing wildlife movement across the site.

The Closure MOP V3 post mining landform also provides a continued focus on providing this linkage with the width of the proposed habitat corridor being consistent with that approved in the 2011 EIS.

Figure 4 shows the location of the habitat corridor within the Closure MOP V3 post mining landform.



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Closure MOP V3
Habitat Corridor

FIGURE 4

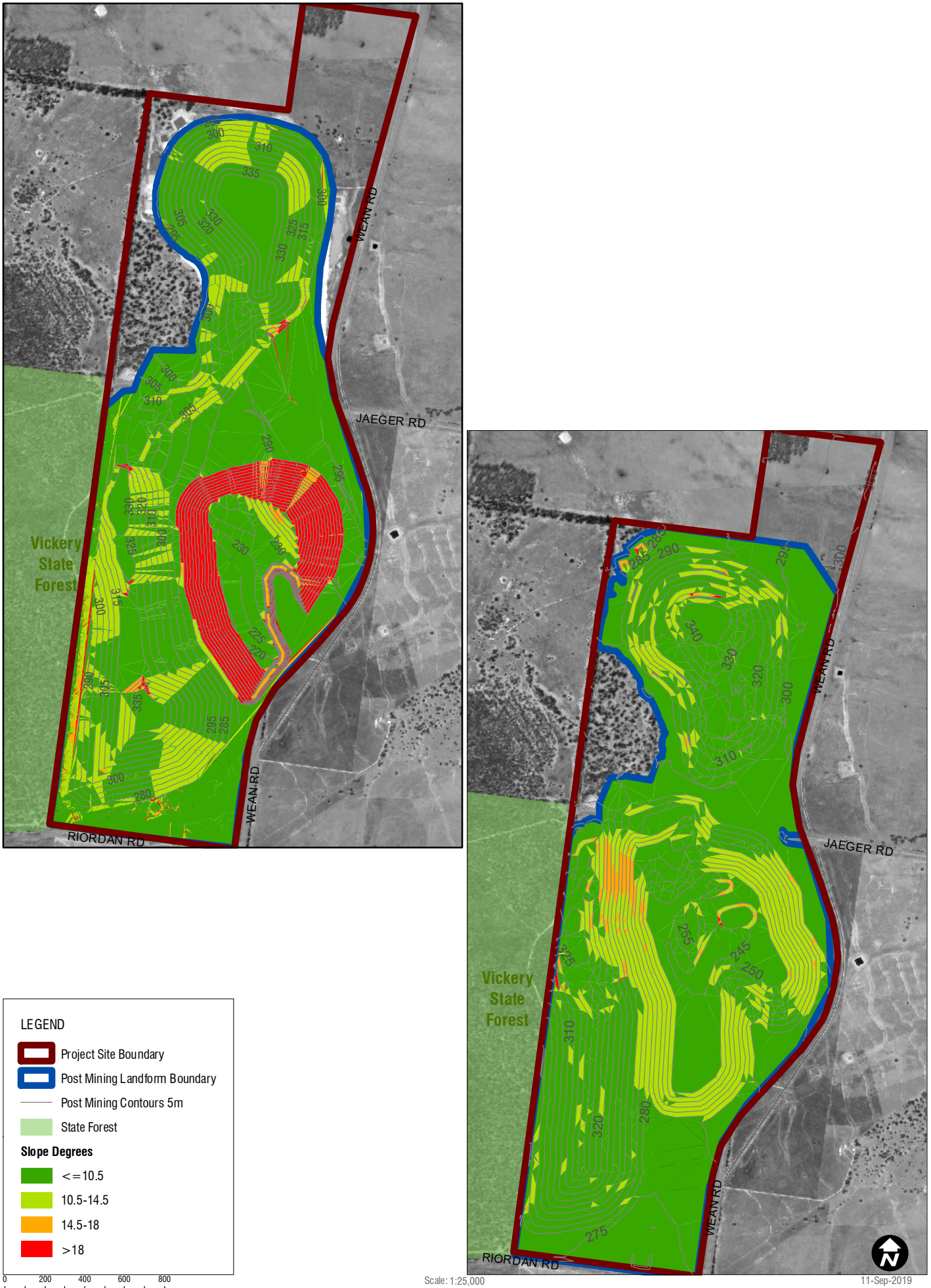
4.3 Slope Analysis

Table 4 and **Figure 5** present a comparison of the slopes of the 2011 EIS Approved Post Mining Landform and the Closure MOP V3 Landform.

Table 4 Slope Comparison

Slope (degrees)	Area within Slope Class (ha)		
	EIS Approved Landform	Previous Briefing Paper Landform	Closure MOP V3 Landform
<=10	254.8	225.1	310.6
11-14	60.3	118.8	78.5
15-18	6.6	9.9	6.3
>18	44.0	11.8	0.3
Total Area	**365.7**	**365.7**	**395.7**

As presented in **Table 4**, the majority of the site in the Closure MOP V3 landform has slopes of less than 10 degrees. Furthermore, the design of the Closure MOP V3 landform has significantly reduced the area with slopes greater than 14 degrees by 44 ha from 50.6 ha to 6.6 ha. The Closure MOP V3 landform has also eliminated the highwall from the final open cut void and hence minimising the area with slopes greater than 18 degrees.



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EIS and Closure MOP V3
Slope Comparison

FIGURE 5

4.4 Comparison of EIS Approved and Closure MOP V3 Post Mining Landforms

Table 5 presents a comparison of key elements of the 2011 EIS Approved post mining landform and the Closure MOP V3 landform as shown in **Figure 2**.

Table 5 Comparison of EIS Approved and Closure MOP V3 Post Mining Landform

Aspect	EIS Approved Post Mining Landform	Previous Briefing Paper Landform	Closure MOP V3 Post Mining Landform	Comment
Void / Final Depression				
Depth	Maximum depth 220 m (AHD)	Maximum depth 220 m (AHD)	Maximum depth 240 m (AHD)	There is has been a reduction in the proposed maximum void/final depression depth.
Footprint	Approximately 68 ha	Approximately 122.5 ha	Approximately 130 ha	There is an increase in void/final depression footprint of 62 ha. It is noted that the footprint of the final depression has been assumed to be the same as the overall catchment area as the flattening of the lowwalls to the north and the reduction in depth of the final depression has resulting in a less defined final void boundary.
Catchment Area	Approximately 117 ha	Approximately 152 ha	Approximately 130 ha	There is approximately a 13 ha increase in the catchment area to the final void/final depression compared to the EIS landform. During detailed design, surface water management will be designed to ensure water runoff from the Western Emplacement Area is diverted and does not report to the final depression.
Final void water level	220 - 245m AHD	245m AHD	245 m AHD	No detailed water balance has been prepared for the Closure MOP V3 final landform; however, it is unlikely that the backfilling of the void will materially affect the previously determined pit lake recovery level.
Final pit lake size	Approximately 35 ha	Approximately 16 ha	Approximately 8.7 ha	The backfilling of the void and reduction in the depth of the overall landform is likely to reduce the area of a final void lake in comparison with previous landforms. Inundation would be restricted to water dams shown in the floor of the final void.

Aspect	EIS Approved Post Mining Landform	Previous Briefing Paper Landform	Closure MOP V3 Post Mining Landform	Comment
Highwall	Approximately 5.1 ha at 45 degrees Approximately 1,060 m long	Approximately 5.7 ha at 45 degrees Approximately 1,350 m long	N/A	No highwall is proposed in the Closure MOP V3 landform. Material from the Western Emplacement Area will be rehandled into the pit and regarded to generally less than 14 degrees and will be consistent with the lowwalls.
Lowwalls	Grades between 10 and 18 degrees	Grades generally between 10 and 14 degrees with the exception of a steep section at the western end of the final void catchment that is approximately 18 degrees.	Grades within the final depression are between 10 and 14 degrees with the exception of a steep section at the western end of the final void catchment that is approximately 18 degrees.	Grades on lowwalls are generally flatter that the approved landform (refer **Figure 4**).
Northern Emplacement Area				
Landform height	Maximum height ~ 340 m	Maximum height ~ 340 m	Maximum height ~ 340 m	There is no change in the proposed maximum height of the Northern Emplacement Area.
Slopes	Grades no greater than 14 degrees	Grades no greater than 14 degrees	Grades no greater than 14 degrees	Grades on preferred Northern Emplacement Area post mining landform generally as per EIS approved (refer **Figure 4**)
Western Emplacement Area				
Landform height	Maximum height ~ 340 m	Maximum height ~ 340 m	Maximum height ~ 330 m	Material from the Western Emplacement Area will be rehandled to backfill the final open cut void. There is approximately a 10 m reduction in the proposed maximum height of the Western Emplacement Area
Slopes	Grades no greater than 14 degrees	Grades no greater than 14 degrees	Grades generally no greater than 10 degrees	Grades on preferred final landform generally as per EIS approved (refer **Figure 4**)
Land Use				
Rehabilitation Area Pasture	Approximately 148 ha	Approximately 157 ha	Approximately 156.3 ha	Approximately an additional 10 ha of pasture rehabilitation will be established in comparison with the EIS final land use.
Rehabilitation Area Bushland	Approximately 206 ha	Approximately 201 ha	Approximately 220 ha	Based on the GIS data presented in Plan 4 of the MOP, approximately 14 ha of additional bushland rehabilitation will be established in comparison with the EIS approved area of 206 ha and will exceed the 213 ha requested by DPIE_RR.

Aspect	EIS Approved Post Mining Landform	Previous Briefing Paper Landform	Closure MOP V3 Post Mining Landform	Comment
Habitat Corridor	Habitat corridor to be established between the void and the reshaped Northern emplacement dump.	Habitat corridor to be established between the void and the reshaped Northern emplacement dump.	Habitat corridor to be established between the void and the reshaped Northern emplacement dump.	There is no material change to the proposed habitat corridor. Refer **Section 5.2.**

5 Land and Soil Capability Assessment

5.1 Methodology

The Land and Soil Capability Assessment Scheme; Second Approximation (OEH 2012) outlines the methodology for determining the Land and Soil Capability (LSC) classification of an area to identify its capability to support a range of agricultural land uses. The scheme uses the biophysical features of the land and soil to derive detailed rating tables for a range of land and soil hazards.

The LSC Classes give an indication of the land management practices that can be applied to a parcel of land without causing degradation of the land and soil on site and to the environment, ecosystems and infrastructure offsite. The LSC Classes are described in **Table 6**.

Table 6 Land and Soil Capability Classification

Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land**: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land**: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

5.2 Required LSC Class to Support the Post mining Land Use

As presented in **Section 4.2** the proposed post mining land use of the site is a mixture of rehabilitated bushland and rehabilitated pasture. In order to support the proposed post mining land use it is considered that the LSC Classes presented in **Table 7** would be required.

Table 7 Required LSC Class to support the post mining land use

MOP V3 Post mining Land Use	Minimum Required LSC Class	Comment
Rehabilitated bushland	LSC 7 or better	This classification indicates very low capability land, with extremely severe limitations for most land uses. It is generally unsuitable for any type of cropping or grazing due to its limitations. As the land has low agricultural capability, rehabilitating LSC 7 land to native bushland is an appropriate post mining land use.
Rehabilitated pasture	LSC 6 (or better)	This classification indicates low capability land with very limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. It is considered capable for a limited set of land uses such as grazing, forestry, nature conservation and some horticulture.

5.3 Calculating LSC Class

The biophysical features of the land that are associated with various hazards are broadly soil, climate and landform and more specifically: slope, landform position, acidity, salinity, drainage, soil depth; and climate.

Based on the information presented in the Soil Study (GSSE 2010) and preliminary analysis, the limiting factors in determining the LSC Class of the post mining landform are likely to be slope (and water erosion hazard) and the depth of soil within the post mining landform.

5.3.1 Slope Analysis

The slope of the post mining landform impacts upon the LSC Class of the due to the risk of water erosion causing loss of soil materials and nutrients from the landscape and its subsequent deterioration. **Table 8** presents the slope classes used to determine the LSC Class.

Rocglen lies within the Eastern NSW Division, and the appropriate criteria for this division were used in the assessment. **Figure 6** presents the slope analysis of the proposed post mining landform in accordance with the slope classes presented in **Table 8.**

Table 8 Slope class for each LSC Class for determining water erosion hazard

NSW division	Slope Class (%) for each LSC Class)							
	Class 1	Class 2	Class 3	Class 4[1]	Class 5[2]	Class 6	Class 7	Class 8
Eastern and Central	<1	1 to <3	3 to <10 or 1 to <3 with slopes > 500 m length	10 to <20	10 to <20	20 to <33	33 to <50	>50
Western Division	<1	1 to <3	1 to 3	3 to 5	3 to 5	5 to 33	33 to 50	>50

1 – No gully erosion or sodic/dispersible soils are present.

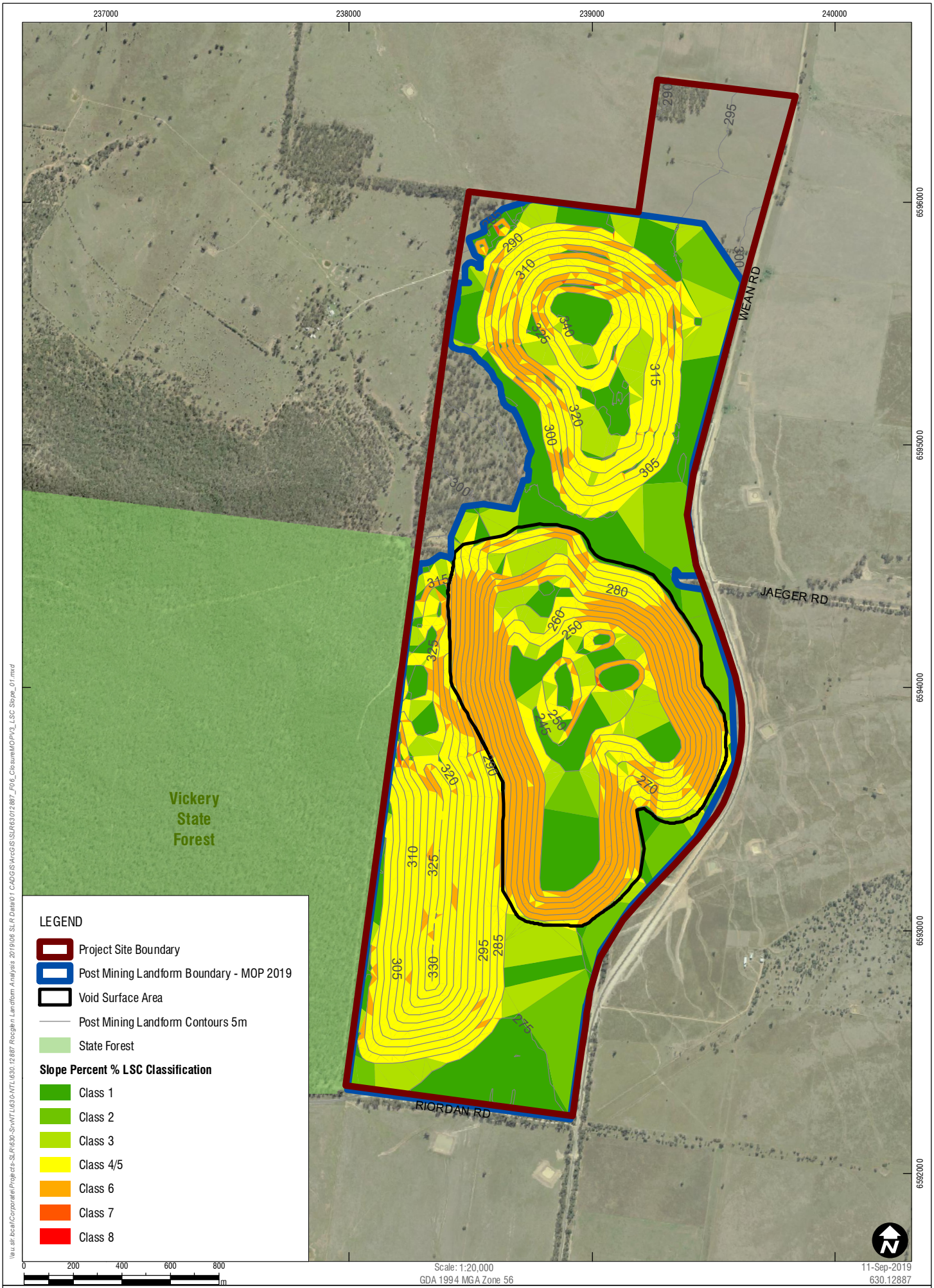
2 – Gully erosion and/or dispersive subsoils are present.

As presented in **Figure 6** the majority of the site is LSC Class 6 or better and is therefore capable of supporting the proposed post mining land use shown in **Figure 2**.

In addition, **Table 9** presents a comparison of the areas within each LSC Class based on the slope analysis. The Closure MOP V3 post mining landform design increases the amount of land in LSC Class 6 or better by approximately 75 ha from 320.2 ha to 395.4 ha.

Table 9 LSC Class Comparison

LSC Class	Area within Slope Class (ha)		
	EIS Approved Landform	Previous Briefing Paper Landform	Closure MOP V3 Landform
1	54.2	46.1	85.6
2	27.1	45.3	35.5
3	58.7	55.1	51.4
4	155.6	94.5	143.7
6	24.5	111.8	79.2
7	41.4	6.1	0.3
8	4.1	6.7	0
Total Area	**365.7**	**365.7**	**395.7**



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Closure MOP V3
LSC Slope Classification

FIGURE 6

5.3.2 Soil Depth

In accordance with the *Land and Soil Capability Assessment Scheme* (OEH 2012), shallow soils and rockiness reduce the land use capability of soils and land. The shallower the soils and more rock outcrop, the less volume of soil is available for storing nutrients and water. Determining the LSC Class based on soil depth and rockiness is undertaken in accordance with **Table 10**.

Table 10 LSC Class for shallow soils and rockiness hazard

Rocky outcrop (% coverage)	Soil depth (mm)	LSC Class
Nil	>1000	1
<30% (localised)	>1000	2
	750 to <1000	3
	500 to <750	4
	250 to <500	6
	0 to <250	7
30 to 50 (widespread)	>1000	4
	750 to <1000	5
	250 to <750	6
	0 to <250	7
50 to 70 (widespread)	>1000	6
	500 to <1000	6
	250 to <500	7
	0 to <250	7
>70	n/a	8

As outlined in Section 3.2.7 of the Closure MOP V3, where resources allow, topsoil and subsoil will each be spread to a nominal depth of between 100 to 150 mm across the rehabilitated landform, giving a combined depth of soil material on the rehabilitated landform of between 200 and 300 mm. In accordance with **Table 10**, this depth of soil spreading will provide a LSC Class 6 or 7.

In order to achieve the desired post mining LSC Class 6 or better for rehabilitation pasture areas it is recommended that available stockpiled soil resources be preferentially spread in these areas to achieve a soil depth of greater than 250 mm.

6 Slope Stability and Safety

The EIS approved final landform included a remaining highwall approximately 1060 m long at 45 degrees.

Material from the Western Emplacement Area will be used to partially backfill the open cut void, which will result in a reduced final depression. As outlined in **Section 4.4**, no highwall will now remain in the post mining landform and all slopes will generally be regraded to less than 14 degrees.

To ensure the stability of slopes retained in the post mining landform, geotechnical assessment and survey of all key areas will be undertaken by an appropriately qualified Geotechnical Engineer to ensure that they have been constructed in accordance with design.

7 Summary and Conclusions

Based on the preceding information, **Table 11** presents a summary of the comparison of the 2011 EIS Approved Post Mining Landform, the previous Briefing Paper Landform and the Closure MOP V3 Post Mining Landform.

Table 11 Summary of Differences and Conclusions

Key Element	2011 EIS Approved Landform	Previous Briefing Paper Landform	Closure MOP V3 Post Mining Landform	Conclusions
Open cut mining extent	Total open cut mining extent ~ 160.2 ha	Not assessed	Total open cut mining extent ~ 151.7 ha	The overall extent of open cut mining is approximately 8.5 ha less than approved.
Void / final depression	Maximum void depth ~ 220 m AHD Total Void footprint ~ 68 ha Total void catchment area ~ 117 ha Void water level ~ 220 to 245 m AHD Void water area ~ 35 ha	Maximum void depth ~ 220 m AHD Total void footprint ~ 122.5 ha Total void catchment area ~ 156 ha Void water level ~ 245 m AHD Void water area ~ 16 ha	Maximum final depression depth ~ 240 m AHD Total final depression footprint ~ 130 ha Total final depression catchment area ~ 130 ha Void water level ~ 245 m AHD Void water area ~ 8.7 ha	Based on the contours provided in Plan 4 maximum depth of the void is 240 m AHD at the water management areas within the final depression. This is shallower than the approved landform and as required by DPIE. The total catchment has been reduced to 130 ha as required by DPIE comparison with the previous design and will be managed through the detailed surface water design to ensure that runoff from the Western Emplacement Area does not report to the final void/depression. The backfilling of the void and reduction in the depth of the overall landform is likely to reduce the area of a final void lake in comparison with previous landforms.

Key Element	2011 EIS Approved Landform	Previous Briefing Paper Landform	Closure MOP V3 Post Mining Landform	Conclusions
Highwall	Total area 5.1 ha (1% of the disturbance footprint). Grades to be approximately 45 degrees. GHA included an assessment of the geotechnical stability of the high wall given the proximity of the re-aligned Wean Road. A minimum separation distance of 50m driven by the outcomes of the geotechnical monitoring (it could in fact be greater if the results indicate instability) Monitoring to commence when the pit is within 250m of Wean Road.	Total area 5.7 ha (1.1% of the disturbance footprint). Grades to be approximately 45 degrees. The minimum distance of the void to Wean Road is 70 m which is 20 m greater than that in the approved landform.	No highwall is proposed to remain in the post mining landform. The final open cut void will be backfilled with slopes generally less than 14 degrees. The minimum distance of the void to Wean Road is approximately 80 m which is 30 m greater than that in the approved landform.	The revised option has eliminated the retention of a highwall in the post mining landform. To ensure the stability of slopes retained in the post mining landform, geotechnical assessment and survey of all key areas will be undertaken by an appropriately qualified Geotechnical Engineer to ensure that they have been constructed in accordance with design.
Lowwalls	Grades to achieve between 10 and 18 degrees Surface water drainage on or over the walls to be minimised. Revegetated to pasture.	Grades generally between 10 and 14 degrees with the exception of a steep section at the western end of the final void catchment that is approximately18 degrees. Surface water management designed to minimise surface water runoff over the lowwalls. Generally revegetated to pasture with exception of steepest sections where it is recommended that bushland would be a more sustainable final land use.	Grades generally between 10 and 14 degrees with the exception of a steep section at the western end of the final void catchment that is approximately 18 degrees. Surface water management will be designed to minimise surface water runoff over the lowwalls.	Grades on lowwalls are generally flatter that the approved landform. As shown in **Table 4**, the Closure MOP V3 landform has reduced the areas of greater than 14 degrees by approximately 44 ha. The detailed drainage design has been developed to manage surface water runoff on the lowwalls via the use of contour banks and drop structures. To ensure the stability of slopes retained in the post mining landform, geotechnical assessment and survey of all key areas will be undertaken by an appropriately qualified Geotechnical Engineer to ensure that they have been constructed in accordance with design.

Key Element	2011 EIS Approved Landform	Previous Briefing Paper Landform	Closure MOP V3 Post Mining Landform	Conclusions
Landform	Landforms to be gently sloping and to blend in with the existing natural landforms. Emplacement to the north max height of 50 m above natural surface. Landform to the west to a maximum height of 340 AHD (consistent with the surrounding natural landform). Grades generally no greater than 14 degrees (outside slopes and also back into the void).	The maximum height of the Northern Emplacement area as constructed is up to 10 m above the EIS approved. The maximum height of the Western Emplacement area is 330 m which is up to 10 m below that approved and consistent with the EIS approved design. Grades of the emplacement areas generally no greater than 14 degrees.	The maximum height of the Northern Emplacement area as constructed is up to 10 m above the EIS approved. The maximum height of the Western Emplacement area is 330 m which is up to 10 m below that approved and consistent with the EIS approved design. Grades of the emplacement areas generally 10 degrees or less.	The preferred landform emplacement areas are generally consistent with the EIS approved landform. As shown in **Table 4**, the Closure MOP V3 landform has increased the area with slopes with 10 degrees or less by approximately 56 ha from 254.8 ha to 310.6 ha.
Land Use	Approximately 148 ha and 213 ha of rehabilitated pasture and bushland respectively.	Approximately 157 ha and 201 ha of rehabilitated pasture and bushland respectively. LSC analysis has been undertaken and shows the landform is capable of supporting the final land use.	Approximately 158 ha and 220 ha of rehabilitated pasture and bushland respectively. LSC analysis has been undertaken and shows the landform is capable of supporting the final land use.	The ratio of bushland to pasture rehabilitation is consistent with the EIS. Based on the LSC analysis the proposed final landform is capable of supporting the final land use of rehabilitated pasture and bushland and will provide a similar LSC to the approved landform. LSC slope analysis shows an increased proportion of the land is LSC Class 6 or better in the preferred landform.
Habitat Corridor	Habitat corridor established between the void and the reshaped Northern emplacement dump to provide linkage from Vickery State Forest across to the Whitehaven Bio-bank site on the Kelvin Range.	The habitat corridor in the preferred option has been maintained as per the EIS approved landform. There is a continued focus on providing linkage from Vickery State Forest across to the Whitehaven Bio-bank site on the Kelvin Range.	The habitat corridor in the Closure MOP V3 option has been maintained as per the EIS approved landform. There is a continued focus on providing linkage from Vickery State Forest across to the Whitehaven Bio-bank site on the Kelvin Range.	No material change.

Key Element	2011 EIS Approved Landform	Previous Briefing Paper Landform	Closure MOP V3 Post Mining Landform	Conclusions
Surface Water Management	Northern and western emplacement to drain towards the Driggle Draggle Creek. Southern and southern portion of the western emplacement will flow through sediments dams and then into SB19. 15ML dam constructed to the North of the void to limit the water that flows into the void, with this water ultimately flowing to the south then onto SB19.	The existing storage capacity of the site is sufficient to manage sediment laden runoff from the final landform in accordance with the Blue Book and EPL requirements. The catchment area reporting to the final void has been reduced as much as practicable through the use of contour banks and existing runoff diversion structures.	Water management and erosion control structures will be installed as required and will be consistent with Blue Book (Landcom, 2004) requirements. Surface water management will be included in the detailed landform design. The catchment area reporting to the final depression will be reduced through the diversion of runoff from the Western Emplacement Area away from the final depression.	Surface water management measures will be designed to manage the potential surface water risks.
Visual	The landform has been designed to blend the post mining landform with the natural landforms around the site. The maximum landform height has been designed to be no greater than 340 AHD.	The landform height remains at a maximum of 340 m AHD. Drop structures and drainage design has included aesthetic considerations to reduce the visual impacts on Wean Road to the east of the site.	The landform height remains at a maximum of 340 m AHD.	There will be no material change that would impact on visual amenity.

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