MIDDLEMOUNT COAL MINE

SOUTHERN EXTENSION PROJECT

EPBC Act Preliminary Assessment Documentation (EPBC 2021/8920)

Attachment I

Fauna Connectivity Management Plan

middlemount coal PTY LTD ABN 49 122 348 412

SUSTAINABLE PARTNERSHIPS
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SOUTHERN EXTENSION PROJECT ROPER CREEK DIVERSION 2 FAUNA CONNECTIVITY MANAGEMENT PLAN

MIDDLEMOUNT QLD

July 2025

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Version	Purpose	Author	Reviewed / approved by	Date
0.1	Draft	Scott van Barneveld	Daniel Joyce	25/05/2023
1.0	Client Comment	Scott van Barneveld	Daniel Joyce	30/05/2023
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Project Number: ESQ5851

Our Document Reference: ESQ5851-BEC-REP-MiddlemountCoal-SouthernExtension-FCMP-rev4.0

1. Introduction

Background

The Middlemount Coal Mine is an existing mine operated by Middlemount Coal Pty Ltd (MCPL), located approximately 90 kilometres (km) north-east of Emerald and approximately 3 km to the south-west of the Middlemount Township, Queensland (Qld) (Figure 1). The Southern Extension Project (the Action) provides for the continuation of open cut coal mining operations at the Middlemount Coal Mine.

The Middlemount Coal Mine operates under Environmental Authority (EA) EPML00716913. MCPL is seeking approval of the Action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2021/8920).

The Draft Fauna Connectivity Management Plan (FCMP) was developed to manage temporary connectivity impacts on the Greater Glider (southern and central) (*Petauroides volans*) and Koala (*Phascolarctos cinereus*) during the rehabilitation of Roper Creek Diversion 2.

This mapping is to be considered indicative only and all derivations (e.g., vegetation communities) are best approximations and subject to errors including individual interpretation and reliance on information provided to Bio Aus where were not independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping etc. should be placed upon this map without independent validation of the information by the user. Bio Aus takes no responsibility for any subsequent error losses etc. that may arise from the use of this data without independent verification.	Project Manager: DJ	Figure Name: Location of Middlemount Mine	Biodiversity AUSTRALIA	
	Drawn by: DB	Location: Middlemount Mine		
	Date: July 2025	Client: Middlemount Coal Pty Ltd	Job Number: ESQ5851	Spatial Reference: MGA Zone 55/GDA 2020 Inset Scale: 1:70,000

Figure 1: Site Location

1.1 Proposed Action

The main activities associated with the Action include:

- extension of the open cut pit to the south
- realignment and extension of the approved (but not yet constructed) eastern diversion of Roper Creek (Roper Creek Diversion 2)
- realignment of Roper Creek
- minor extensions to the East Dump
- re-positioning of the approved southern flood levee and associated water management infrastructure
- extension of the southern flood levee and associated water management infrastructure
- continued development of sediment dams and other waste management equipment and structures
- continued development of haul roads and internal roads
- continued development of soil stockpiles, laydown areas and borrow areas
- a change to the final landform for the end of the mine life, and
- continued extraction of run-of-mine (ROM) coal up to approximately 5.7 million tonnes per annum (Mtpa) using conventional open cut mining equipment.

The Action will partially impact Koala and Greater Glider (southern and central) habitat connectivity along the existing Roper Creek (Figure 2).

Vegetation clearance associated with the extension will progressively occur following approval of the Action. The clearing extent associated with the Action is shown below in Figure 2. This plan is focused on managing and minimising impacts on Koala and Greater Glider (southern and central) connectivity caused by the removal of habitat along Roper Creek.

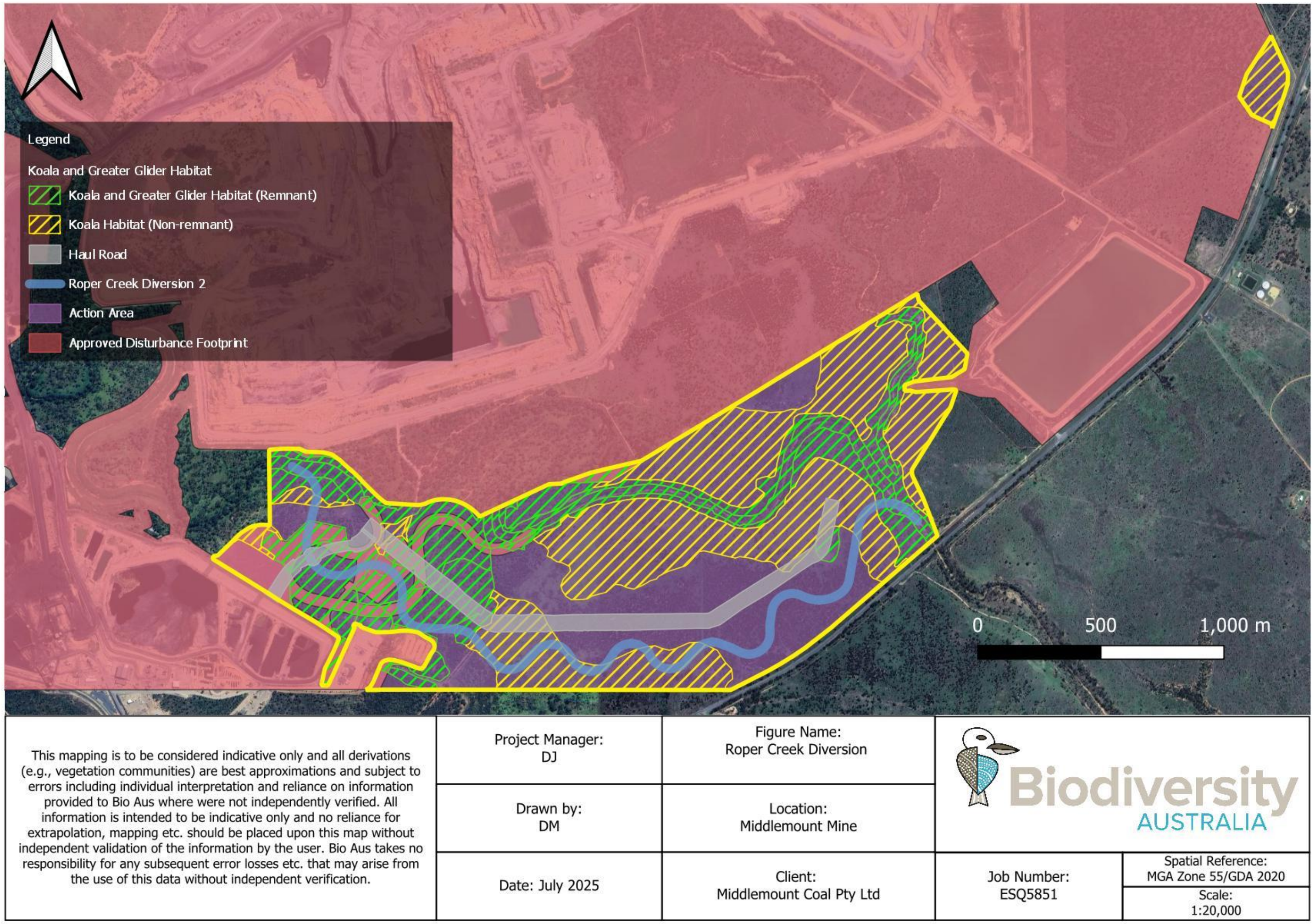


Figure 2: Roper Creek Diversion 2 and Koala and Greater Glider habitat.

1.2 Objectives

The objectives of this Fauna Connectivity Management Plan are to describe:

- mitigation and management activities to be implemented to facilitate safe movement corridors for the Koala and Greater Glider (southern and central)
- monitoring activities to evaluate the success of the implemented mitigation and management activities.
- Key Performance Indicators (KPI's) of the monitoring program to indicate success of the activities.
- potential risks and contingency measures in the event KPI's are not achieved.

2. Background Information

2.1 Summary of Previous Site Investigations and Literature Review

A desktop and literature review was undertaken to determine the most suitable and practical habitat connectivity measures for the site, as well as describing the information used to assess the measures.

Previous ecological assessments of the Action Area and immediate surrounding area include:

- Naturecall Environmental (2014) Ecological Monitoring for Offset Area, Middlemount Coal Mine.
- Naturecall Environmental (2016) Vegetation Validation and Terrestrial Habitat Assessment for North-east Extension Offset Area.
- Biodiversity Australia (2020) Middlemount Coal Mine Southern Extension Project Terrestrial Ecology.
- Biodiversity Australia (2021) Southern Extension Proposed Offset Baseline Assessment.

These investigations observed a number of Koalas and Greater Gliders within and immediately surrounding the Action Area. However, no assessments have been undertaken to assess and confirm Koala and Greater Glider (southern and central) movement through / from the Action Area to habitat located East and West with the current limitations in place.

2.2 Vegetation Communities for Greater Gliders and Koalas on Site

The Action Area consists of:

- approximately 164.19 hectares (ha) of vegetation in the early stage of regrowth from past clearance and
- approximately 86.03 ha of remnant woodland, largely represented by Eucalypt woodlands (mostly Poplar Box woodlands) and small occurrences of Acacia dominated woodlands

Approximately 183 ha of known and potential Koala habitat and 81.70 ha of known and potential Greater Glider habitat occurs within the Action Area. The regional ecosystems (REs) identified on site as known and potential habitat include:

- RE 11.3.2- *Eucalyptus populnea* woodland on alluvial plains
- RE 11.3.2b - *Eucalyptus camaldulensis* (sometimes *E. populnea* and/or *E. tereticornis*) woodland in drainage depressions.
- RE 11.3.25 - *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines
- RE 11.3.7 - Corymbia spp. open woodland on alluvial plains
- RE 11.7.4. - *Eucalyptus decorticans* and/or Eucalyptus spp., Corymbia spp., Acacia spp., *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust

These REs are known habitats for the two species providing foraging (Koala food trees) and breeding (hollows) habitat for Greater Gliders.

2.2.1 Fauna Movement Landscape Assessment

The existing Roper Creek provides connectivity for Greater Gliders and Koalas:

- upstream (west) of the Action Area consisting of the offset areas provided for the Middlemount Coal Mine, owned and managed by MCPL. The cumulative area of these existing biodiversity Offset Areas is 5,861.4 ha of which a significant area consists of habitat for Koalas and Greater Glider.
- downstream (east) of the Action Area which consists of minimal and highly degraded habitat along roper creek and to the east of the mine site including habitat containing Greater Gliders on Roper Creek.

The Project will temporarily impact connectivity until such time as the vegetation along the proposed Roper Creek Diversion 2 establishes.

3. Habitat Impact Mitigation Measures

The Southern Extension Project will involve progressive open cut pit development and vegetation clearance. Vegetation clearance will commence following approval of the Action and progress in a southerly direction (Figure 2). During this period MCPL will implement mitigation measures to improve connectivity and monitor and evaluate key performance indicators for connectivity of habitat along the Roper Creek Diversion 2.

MCPL has existing mitigation systems in place including:

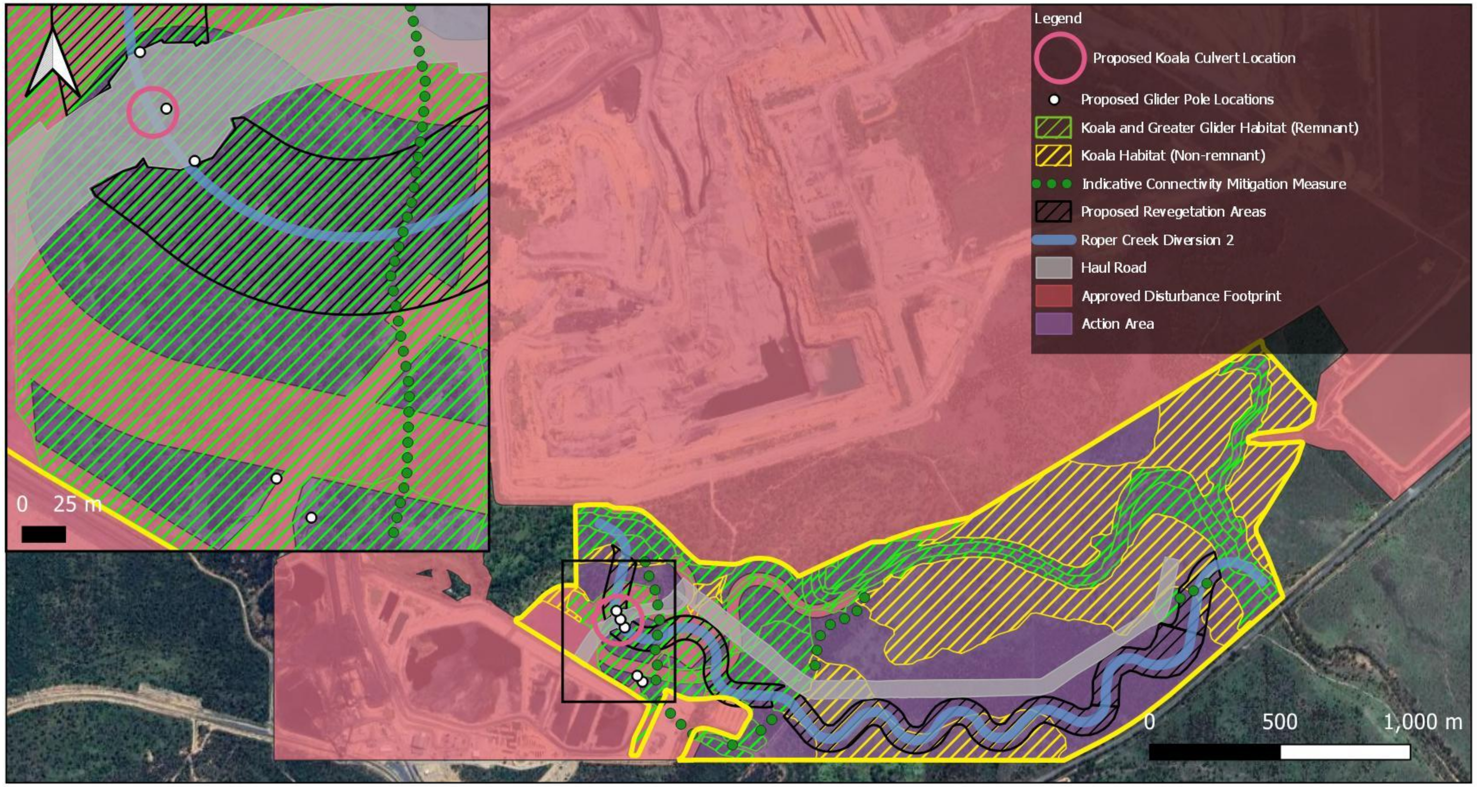
- Several approved Offset Areas including state-based offsets for connectivity, actively managed by MCPL immediately to the west of the site.
- The establishment of a new biodiversity offset area for the proposed Action (i.e. the proposed Southern Extension Offset Area) including state-based offsets for connectivity.

The Southern Extension Offset Area has been developed in accordance with the EPBC Act, Environmental Offsets Policy and the EPBC Act Offsets Assessment Guide. The Southern Extension Offset Area is approximately 1551.16 ha in size, comprising approximately 1303.77 ha of remnant vegetation (mostly used by both Greater Gliders and Koalas), and approximately 250.95 ha of non-remnant/ regrowth vegetation. The biodiversity offset area provides for the enhancement and conservation of woodlands, particularly Poplar Box woodlands, that provide important habitat for both Greater Gliders and Koalas.

3.1 Pre-Clearing Management Actions

Vegetation clearing will be undertaken progressively, to mitigate impacts on Koala and Greater Glider habitat specially in the area surrounding Roper Creek. To ensure vegetation clearing is carried out in a controlled manner the following actions will be implemented, where relevant:

- The clearing boundary will be clearly marked before vegetation removal commences (e.g. with survey pegs) in order to prevent inadvertent clearance beyond what is required.
- Pre-clearing surveys will be conducted by qualified ecologists or Fauna Spotter Catchers and including use of thermal scopes to increase detection of both Koalas and Greater Gliders.
- Hollow-bearing trees will be marked during pre-clearing surveys. Prior to felling, hollow bearing trees will be vibrated/shaken and left standing for 24 hours to allow fauna to relocate. Upon felling, all hollows will be checked for fauna.
- Hollows (greater than 10 centimeter [cm] Diameter) from felled large trees will be cut out and relocated to the Roper Creek Diversion 2 rehabilitation area.
- Fauna spotter-catchers will be in attendance during clearing.
- Installation of fauna crossings (tunnels and glider poles) to facilitate connectivity to the west of the Action Area will be installed prior to clearing activities (Figure 3).



This mapping is to be considered indicative only and all derivations (e.g., vegetation communities) are best approximations and subject to errors including individual interpretation and reliance on information provided to Bio Aus where were not independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping etc. should be placed upon this map without independent validation of the information by the user. Bio Aus takes no responsibility for any subsequent error losses etc. that may arise from the use of this data without independent verification.	Project Manager: DJ	Figure Name: Existing Fauna Connectivity	Biodiversity AUSTRALIA	
	Drawn by: DM	Location: Middlemount Mine		
	Date: July 2025	Client: Middlemount Coal Pty Ltd	Job Number: ESQ5851	Spatial Reference: MGA Zone 55/GDA 2020 Scale: 1:12,000

Figure 3: Proposed fauna crossings, corridors and revegetation areas.

4. Koala Habitat Connectivity

4.1 Koala Habitat Requirements and Movements

Koalas need varying levels of habitat connectivity depending on the quality of habitat and their home range in a particular area. Home ranges vary considerably between Koala populations and range in size from 1ha to 100ha (Department of Environment and Science [DES] 2022). The size of home ranges is related to the availability of food resources and large eucalypts. In the Middlemount region it is anticipated that home ranges of Koalas will be at least several hectares due to the sparse nature of vegetation, seasonal availability and quality of food resources.

Koalas will sometimes disperse from their home ranges especially in the breeding season between June-January. Koalas can travel long distances, especially subadults that are dispersing to find a new home range (up to 10km), but most movements are substantially less than this. When travelling, Koalas typically use the ground rather than the canopy (Dexter et al. 2016). If properly designed habitat connectivity measures are present within an individual Koala's home range, for example refuge poles and culvert underpasses, they will incorporate these elements as part of their home range.

4.2 Culvert Underpasses for Koalas

4.2.1 Culvert use by Koalas and design requirements

The haul road that is proposed as part of the Southern Extension Project will require a safe avenue for Koalas to cross the haul road, mitigating the chance of vehicle strike. The proposed location of a Koala culvert underpass is shown in Figure 3.

Koalas readily use culvert underpasses to safely pass beneath roads and other linear infrastructure and are expected to begin using newly constructed culverts as quickly as three weeks after construction of the culvert (AMBS 2012; Dexter et al. 2016). Koalas are known to use culverts as small as 900x900 millimeters (mm) (DES 2022) however a 3mx3m linear box culvert is preferable to allow more permeation of natural light and the installation of "crossing furniture" as recommended by the *Queensland Koala-sensitive Design Guideline* (DES 2022). Vegetation structure around fauna crossings and culvert underpasses has a substantial effect on the use of crossings (McGregor et al. 2017). As such wherever practicable habitat connectivity will be maintained from the forest patch up to, and ideally leading in to, the culvert.

Koala culverts will be designed to:

- provide dry passage,
- have light visible at the end rather than having the appearance of a cave,
- have a timber structure running above the ground,
- be fenced to direct Koalas into the culvert, with a fence height of 1.8m with 300mm of unclimbable flashing at the top,
- contain safe retreats (escape poles) for predator avoidance; and,
- have vegetation extending from the nearest habitat to within as close as practicable to the culvert entrance.

While most Koalas will cross through culverts along the ground, they will occasionally choose to traverse using the elevated platforms or "culvert furniture". Importantly, many other species will use elevated timber platforms installed in a culvert so there is value in including this "crossing furniture" in any culvert design. In addition, these platforms provide important retreat sites for Koalas if there are predators present. Timber platforms or poles will be at least 150mm in diameter and ideally be sourced from any locally cleared timber where practicable (DES 2022; Dexter et al. 2016).

For Koalas, escape routes to avoid predators are highly important, so that in the event of a predator such as a fox or a dog chasing a Koala through a culvert, the Koala may escape by climbing up an "escape pole" or elevated timber platform. These structures are placed either at the end of the culvert or within the culvert itself (DES 2022; Dexter et al. 2016; Phillips and Fitzgerald 2014).

4.2.2 Culvert Fencing

Fencing of culvert underpasses is essential to improve the use of culverts by directing wildlife away from the road and into culverts. Fences need to be properly designed or they could increase the mortality of animals at the end of the fence (Phillips and Fitzgerald 2014; Plante et al. 2019).

To reduce road mortality, when the culvert is constructed, fences should either be continuous or sufficiently long to encourage fauna passage along the fence to the culvert rather than to the fence ends (Gunson et al. 2011; Spanowicz et al. 2020; Plante et al. 2019). While many recommendations are that a fence needs to be at least 50 metres (m) long at each side of the culvert (Nowakowski et al. 2022), it is recommended by DES (2022) that fences for Koala use should extend at least 150 m either side of the culvert entry. Fence construction should be of chain-link fences approximately 1.8 m high with the top 300 mm being unclimbable sheet metal (Plate 1).

Escape structures should be installed along the fence in strategic locations on the "wrong" (road infrastructure) side of the fence to prevent Koalas being trapped on the road. This allows for Koalas to climb away from the roadside if they are trapped on the infrastructure side of the fence, and to escape potential predators.

Plate 1: A culvert for Koala crossing below a railway line showing crossing furniture and fencing (source DES 2022).

5. Greater Glider Habitat Connectivity

5.1 Habitat Requirements and Movements

There are areas of suitable, but degraded, habitat within the Action Area in which Greater Gliders have been observed during previous survey work. The species has also been recorded outside of the Action Area and is commonly found in the adjacent offset areas (Biodiversity Australia 2021; Naturecall 2014; Naturecall 2016).

Gliding distance for the species has been reported in the literature up to 100m, but the species likely glides shorter distances than this more frequently. A glide of 75 m has been measured that was from a tree canopy 45 m high, which gives a glide angle of 31° (R. Kavanagh pers. comm.).

Glider pole spacing and design must factor in the following parameters:

- Gliding angle of species,
- Maximum gliding distance for the species,
- Include an error margin in gliding distance to account for landing part way up the pole,
- Account for obstacles that may interfere with gliding, i.e., vehicles, and
- Slope of the land and tree height at all connection points.

5.2 Glider Poles

Greater Gliders have not been recorded using glider poles, however there are many examples of glider poles benefiting habitat connectivity for other gliding mammals in Australia and overseas (Lee et al. 2023, Littlewood et al. 2020). It is important to provide suitable gliding sites for habitat connectivity in areas that do not contain trees over 20 cm diameter at breast height (DBH). Glider poles may provide an avenue for habitat connectivity. The indicative recommended locations for glider poles is presented in Figure 3.

5.2.1.1 Glide pole height calculations

Biodiversity Australia undertook a literature review to assess the glide pole requirements of the Greater Glider (Glide Pole Assessment Report May 2023). The outcome of this assessment identified the following calculations are used to determine the suggested glide pole height for greater gliders:

<u>Estimated glide angle</u>: 31°

<u>Road crossing distance</u>: approx. 70m

<u>Crossing distance if centre pole included in haul road</u>: approx. 35m.

<u>Equation</u>: $Tan\ (31) = \frac{x}{35} \quad = \quad 0.60086 = x/35 \quad = \quad \mathrm{x} = 21\mathrm{m}$

Minimum glide pole height to cross a distance of 35m, based on a gliding ratio of 31° is 21m high.

Preferred glide pole height to cross a distance of 35m, landing >10m above the ground is 25m high. A justification is provided below.

5.3 Existing Eucalyptus regrowth maintenance

The proposed Action Area proposed for the establishment of Roper Creek Diversion 2 contains regrowth Eucalyptus species. Where possible these existing regrowth individuals will be retained to minimise the time until suitable size and age eucalyptus trees are present and suitable to act as connectivity habitat for the Greater Glider.

5.4 Revegetation of Greater Glider Food Trees and Large Eucalypts

Greater Gliders require trees of a DBH in excess of 200mm and will use regrowth but only when suitable denning sites are available, and the structure and composition of the regrowth is adequate. There will be a partial loss of connectivity along Roper Creek. Habitat revegetation along the Roper Creek Diversion 2 will re-establish connectivity once the revegetation trees have developed to a DBH of over 200mm with the incorporation of glider poles mitigating the impact during this period.

In the Middlemount region the preferred food trees for Greater Gliders are *Eucalyptus tereticornis*, *E. populnea*, *E. crebra*, *E. melanophloia* and *Corymbia tessellaris* and *Corymbia clarksoniana*. These species are the same as those required by Koalas in the region and revegetation requires the same actions as provided above for Koala habitat regeneration. Proposed revegetation areas are mapped in Figure 3.

6. Summary of Connectivity Management Actions

On ground assessment to date has identified the presence of Greater Gliders within the proposed Action Area and surrounding area. However, no assessments have been undertaken to assess and confirm Koala and Greater Glider movement through the Action Area to habitat located East and West of the site. Confirmation of connectivity corridors use has not been undertaken.

Setting KPI's based on use of the proposed connectivity infrastructure is difficult if there is no current use occurring. A monitoring plan to assess the current use of the likely existing connection is proposed. The monitoring plan would be undertaken along the length of Roper Creek which would be impacted by the Southern Extension Project to confirm current use and allow for the setting of KPI's based on these.

Table 1 outlines management actions, key performance indicators, timing and remedials actions to be undertaken prior to clearing Roper Creek fauna habitat connectivity.

Table 1: Management Actions Prior to Clearing Roper Creek Fauna Habitat Connectivity

Action	Details	Key performance indicator for success	Timing	Responsibility	Action if KPI not met
On ground baseline Assessment of current connectivity use (camera installation)	Undertake a survey to determine current use of Roper Creek as a connectivity passage to allow determination of KPI usage	Completion of survey / monitoring and development of KPI	Ongoing until Roper Creek connectivity is completely cleared	MCPL	Undertake survey
Construction of Koala Culvert (Haul Road)	Construct the Koala culvert under haul road	Culvert in place	Prior to clearing of Roper Creek	MCPL	No clearing activities to occur around Roper Creek until culvert complete
On ground assessment to confirm placement of Glider poles	On ground assessment to confirm placement of glider poles and design by suitably qualified ecologist	Completion of on ground assessment, glider pole design and development of survey plan confirming location	Prior to clearing of Roper Creek	Ecologist	Undertake survey
Construction of Glider poles	Construct Glider Poles	Glider poles in place	Prior to clearing of Roper Creek	MCPL	No clearing activities to occur around Roper Creek until glider pole construction complete

7. Monitoring and Reporting of Connectivity Success

Table 2 outlines management actions, key performance indicators, timing, and remedial actions for monitoring fauna habitat connectivity success.

Table 2: Actions and Key Performance Indicators to Monitor Success of Fauna Habitat Connectivity Mitigation Measures

Action	Details	Key performance indicator for success	Timing	Responsibility	Action if KPI not met
Monitoring use of Koala Culvert with PIR cameras	PIR cameras to be installed to monitor fauna use of the culvert. Cameras to be checked fortnightly for functionality and battery life. All images from cameras will be kept in a secure database for reporting and monitoring purposes. All species captured on PIR cameras are to be identified and noted in a database including the time, date, direction of travel and location of the image. Additional monitoring and reporting of Koala strikes on haul road.	Evidence of Koala use of culvert and glider use of poles	Immediately following the completion of the construction of the culvert underpass	Ecologist	If no utilisation of culvert by Koalas detected after three months, move cameras. If, after moving cameras, no use by target species is identified within two months, review management plan and activities.

Action	Details	Key performance indicator for success	Timing	Responsibility	Action if KPI not met
Monitoring use Glider poles with PIR cameras	PIR cameras to be installed to monitor fauna use of the culvert and glider poles. Cameras to be checked fortnightly for functionality and battery life. All images from cameras will be kept in a secure database for reporting and monitoring purposes. All species captured on PIR cameras are to be identified and noted in a database including the time, date, direction of travel and location of the image.	Evidence of Koala use of culvert and glider use of poles	Immediately following the completion of the construction of the glider poles	Ecologist	If no utilisation of glider poles detected after three months, move cameras. If, after moving cameras, no use by target species is identified within two months, review management plan and activities.
Mapping and monitoring growth and density of trees within revegetated Roper Creek Diversion 2 areas	Suitable trees are established and managed until they provide suitable habitat for Koalas and Greater Gliders. Tree growth mapped and	Trees established and reached DBH of 200mm	Five years after revegetation and every three years thereafter until trees reach a DBH of 200mm.	MCPL	All tree mortality to be reported and trees replaced as soon as practically possible

Action	Details	Key performance indicator for success	Timing	Responsibility	Action if KPI not met
for suitable habitat for greater gliders and koalas	measured (height, DBH). Monitor plantings for loss and replace any that fail.				
Retention of all age classes of Eucalypts wherever possible along Roper Creek Diversion 2	All eucalypts located along Roper Creek Diversion 2 are to be mapped prior to clearing. Flag all trees and saplings adjacent to the diversion route that are to be retained.	Trees and saplings flagged and retained where possible	Prior to clearing of Roper Creek Diversion 2	MCPL	Eucalypts not able to be retained due to clearing activities augmented with plantings

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A-1 Glide Pole Assessment Report

Biodiversity AUSTRALIA

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GLIDE POLE ASSESSMENT REPORT

MIDDLEMOUNT COAL

July 2025

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1. Introduction

1.1 Background

The Middlemount Coal Mine is an existing mine operated by Middlemount Coal Mine Pty Ltd, located approximately 90 kilometres (km) north-east of Emerald and approximately 3 km to the south-west of the Middlemount Township, Queensland (Qld) (Figure 1). A proposed extension, The Southern Extension Project (the Action) provides for the continuation of open cut coal mining operations at the Middlemount Coal Mine until 2037.

The Middlemount Coal Mine operates under Environmental Authority (EA) EPML00716913. In April 2021, the Action was approved under Chapter 5, Part 7 of the Qld Environmental Protection Act 1994 (EP Act) through a major amendment of EA EPML00716913. MCPL is also seeking approval of the Action under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (EPBC 2021/8920).

This glide pole assessment report has been developed in conjunction with a Fauna Connectivity Management Plan (FCMP) to assist in the design and implementation of suitable crossing infrastructure that facilitates the movement and dispersal of greater gliders (*Petauroides volans*) throughout the landscape, in response to future mine expansions and waterway diversions. Proposed locations of glide pole installation are provided in this report, however field assessments will be required to validate the proposed locations.

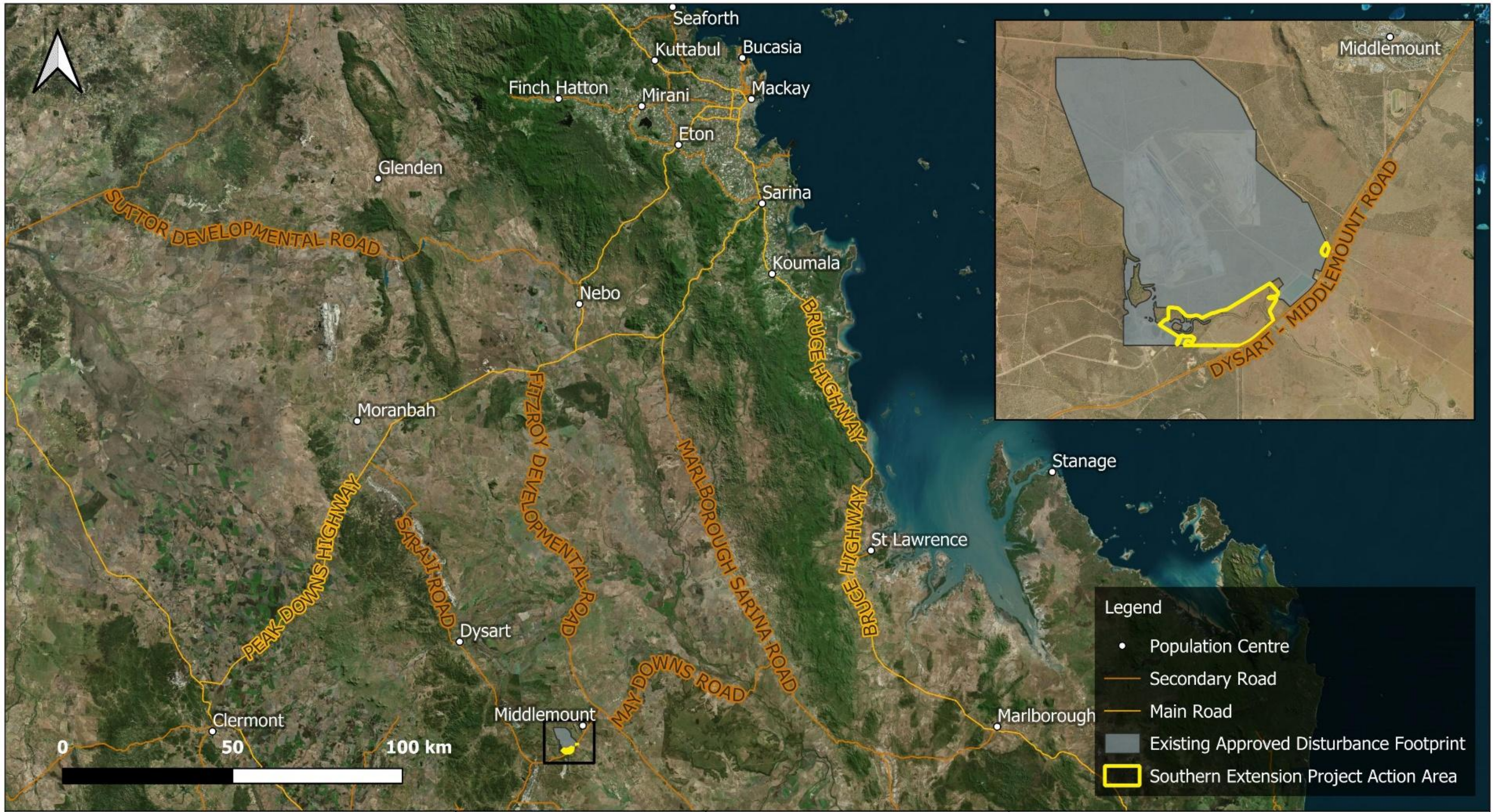
This report provides some background on the use of fauna crossing structures, its relevance to greater gliders, and whilst the species is not currently known to use crossing structures, this report outlines a method to develop glide poles for gap crossing. The glide pole recommendations made in this report should be used in conjunction with recommendations provided in the FCMP, which include the importance of planted vegetated corridors to facilitate fauna dispersal.

2. Background Information

2.1 Greater Glider Records

Greater gliders (*Petauroides volans*) occur throughout remnant habitat surrounding the Middlemount Mine, with recent records (since 2017) indicating a preference for the creekline habitats along Roper Creek as well as a number of occurrences in the Middlemount Coal offset sites immediately to the west of the mine site. These habitats largely feature remnant mature eucalypt trees containing hollows, which is consistent with the species preference for larger trees for foraging, large hollows and sheltering. Around Middlemount Mine, the species have typically been observed in REs 11.5.3, 11.3.2 and 11.3.7, which may suggest a local preference for eucalypt species associated with these REs including;

- *Eucalyptus populnea* (Poplar Box)
- *E. melanophloia* (Silver-leaved Ironbark)
- *E. crebra* (Narrow-leaved Ironbark)
- *Corymbia clarksoniana* (Clarkson's Bloodwood)
- *C. tessellaris* (Moreton Bay Ash)
- *C. dallachiana* (Dallachy's Ghost Gum)



This mapping is to be considered indicative only and all derivations (e.g., vegetation communities) are best approximations and subject to errors including individual interpretation and reliance on information provided to Bio Aus where were not independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping etc. should be placed upon this map without independent validation of the information by the user. Bio Aus takes no responsibility for any subsequent error losses etc. that may arise from the use of this data without independent verification.	Project Manager: DJ	Figure Name: Site Location	Biodiversity AUSTRALIA	
	Drawn by: NE	Location: Middlemount Coal, Southern Extension		
	Date: July 2025	Client: MCPL	Job Number: ESQ5883	Spatial Reference: WGS 84 / Pseudo-Mercator Scale: 1:1600000

Figure 1: Location of the Subject Site, Middlemount Mine, Queensland

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	Drawn by: DM	Location: Middlemount Mine		
	Date: July 2025	Client: Middlemount Coal Pty Ltd	Job Number: ESQ5851	Spatial Reference: MGA Zone 55/GDA 2020 Scale: 1:20,000

Figure 2: Roper Creek Diversion 2

3. Methods

3.1 Desktop and Literature Review

The desktop and literature review was undertaken to determine:

- scientific understanding for the utility of crossing infrastructure for greater gliders.
- possible suitable designs of glide poles for the species.
- recommended areas for installation that may facilitate fauna connectivity between remnant habitat patches following the progressive expansion of the mine extent.
- Confirm design parameters of the glider poles to ensure highest possible likelihood of use

Scientific articles were obtained via journals and databases accessed through scientific institutions and open platforms. Other previous reports and government-based resources were utilised including:

- Department of Climate Change, Energy, the Environment and Water (DCCEEW) – Species Profile and Threats Database. (DCEEW, 2023).
- Department of Environment and Science (DES) – Certified Regional Ecosystem Mapping Database. This will include DES Regional Ecosystem Mapping, Essential Habitat and Regrowth Vegetation Mapping under the VMA. (DES, 2023).
- Biodiversity Australia reports (2017-2023) on Annual Offset Management and Impact Assessments.

4. Results

4.1 Desktop and Literature Review

4.1.1 Species Ecology

Greater gliders are listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and also Endangered in Queensland under the *Nature Conservation Act (2016*) (NC Act). Home range estimates for the species range from 1.4 – 19.3 ha (DCCEEW 2022), depending on the quality of habitat, particularly the number suitable denning sites.

Greater gliders occur in tall, open eucalypt forests throughout most of eastern Australia (Lindenmayer, Cunningham, Tanton et al., 1990). Greater gliders feed almost exclusively on eucalypt foliage (Kavanagh and Lambert 1990). They use gliding locomotion to move between trees and are dependent on tree cover for movement through their home ranges, which are commonly in the order of 1.4–3 ha (Kehl and Borsboom 1984, Comport et al. 1996, Kavanagh and Wheeler 2004) but may reach up to 19.3 ha in hollow limited environments (Smith et al. 2007).

Density estimates range from 0.1 to 3.8 individuals/ha (Kehl and Borsboom 1984, Comport et al. 1996, Smith et al. 2007). Dispersing distances have been reported of greater gliders of 1–7 km (Tyndale-Biscoe and Smith 1969a, Pope et al. 2004, Taylor et al. 2007). Thus, it is reasonable to infer that individuals migrating between patches can become established and breed, and there appears to be no sex bias to dispersal. Gliding distance for the species has been reported in the literature up to 100m, but the species likely glides shorter distances than this more frequently. A glide of 75 m has been measured that was from a tree canopy 45 m high, which gives a glide angle of 31° (R. Kavanagh pers. comm.).

Glider pole spacing and design must factor in the following parameters:

- Gliding angle of species

- Maximum gliding distance for the species
- Include an error margin in gliding distance to account for landing part way up the pole.
- Account for obstacles that may interfere with gliding, i.e., vehicles.
- Slope of the land and tree height at all connection points.

4.1.2 Crossing Infrastructure Uses in Australia

Due to the increase in habitat fragmentation, the development of infrastructure to assist animal movement between forest patches has become an increasingly used conservation tool (Mitrovich et al. 2018). Recent Australian studies have shown the effectiveness of land bridges, rope bridges and glide poles in facilitating animal movement (Jones et al. 2011; Pell and Jones 2015; Macgregor et al. 2017; Goldingay et al. 2011; Soanes et al. 2015, 2018). As well as re-connecting fragmented habitat, crossing infrastructure can have positive effects on the demographic and genetic conditions of populations (Soanes et al. 2018). Increasing usage of these structures may prove extremely useful in the long-term conservation of common and threatened arboreal species.

4.1.3 Glide Poles in Australia

Currently, there is no evidence to suggest that greater gliders will utilise glide poles for gap crossing (Goldingay, Taylor and Ball 2011). Glide poles were first described by Ball and Goldingay (2008) who demonstrated how wild squirrel gliders were able to use tall wooden poles to cross between habitat fragments. The animals in the study showed a natural tendency to climb and glide between the wooden poles. The usage of glide poles by different gliding mammals has since been extensively studied, and shows similar positive usage (Goldingay, Taylor and Parkyn 2019). Glide poles have been installed and successfully utilised by small gliders in eastern NSW, for example, particularly along highways. The frequent use of glide poles by gliding mammals has been shown in some study sites (Taylor and Goldingay 2012a, 2012b; Soanes et al. 2015). Several arboreal gliding species were observed using glide poles along the Oxley Highway in NSW, including squirrel and sugar gliders (*P. breviceps*), feather-tailed gliders (*Acrobates frontalis*), and yellow-bellied gliders (*Petaurus australis*) (Goldingay, Taylor and Parkyn 2019).

4.1.4 Glide Poles, Forest Patches and Dispersal of Greater Gliders

Models have predicted that greater gliders are able to persist in landscapes which feature forest patches, if contiguous forest is not available (McCarthy and Lindenmayer 1999). However, the species prefers fewer larger sized patches to many small patches. The minimum patch size should be 3ha (McCarthy and Lindenmayer 1999). Given the highly modified landscape surrounding Middlemount mine, and with the additional modifications associated with the future expansions, effort should be given to improving and developing forest patches in between remnant greater glider habitat, with the added use of crossing infrastructure to help facilitate dispersal.

Greater gliders may demonstrate a reluctance to cross large gaps in the canopy, given the species are strict canopy obligates and do not travel along the ground. This suggests large, treeless gaps between glide poles would be undesirable for the species, and therefore supplementary vegetation planting would be required for any potential for successful habitat connectivity. We therefore recommend a combination of replanting/revegetation, habitat improvement (i.e. cattle exclusion to allow regrowth) and glide pole installation in areas deemed suitable for connectivity.

4.1.5 Proposed Glide Pole Installation Location

The proposed glide pole installation locations, and areas suggested for revegetation, are presented in Figure 5. Field surveys will be required to determine the final glide pole installation location. The following areas are recommended for revegetation:

- Along the extent of the Roper Creek Diversion 2.
- Within habitat gaps between existing greater glider habitat and proposed corridors.

Glide pole installation is recommended:

- Over the haul road crossing of Roper Creek. In order to cross the 70-75m distance of the road, it is suggested that 3 poles be installed; i.e. two on the outside edges of the road and one in a centre median strip.
- If required: over other minor roads that remain following the Roper Creek diversion (pending field survey for final determination).

4.1.5.1 Glide pole height calculations

The following calculations are used to determine the suggested glide pole height for greater gliders:

Estimated glide angle: 31°

Road crossing distance: approx. 70m

Crossing distance if centre pole included in haul road: approx. 35m.

Equation: $Tan\ (31) = \frac{x}{35} \quad = \quad 0.60086 = x/35 \quad = \quad \mathrm{x} = 21\mathrm{m}$

Minimum glide pole height to cross a distance of 35m, based on a gliding ratio of 31° is 21m high.

Preferred glide pole height to cross a distance of 35m, landing >10m above the ground is 25m high. A justification is provided below.

Glide pole designs have been previously made for smaller gliding mammals including the squirrel glider and yellow-bellied glider, and these designs take into consideration the height dropped by the animal mid glide. By using a glide ratio (glide distance divided by height dropped), an estimate of the distance a glider could theoretically travel from a glide pole can be made (Goldingay, Taylor and Parkyn, 2019).

There is no known glide ratio for the greater glider, and thus these calculations should be applied with some caution. A glide ratio of 2.0 has been applied in this scenario (based on the glide ratio of the yellow-bellied glider*), which suggests an individual could theoretically glide 42m from a 21m high pole (*2.0 glide ratio x 21m pole = 42m*). This would place a greater glider on the landing pole approximately 7m off the ground (*42m glide – 35m gap distance = 7m*). A landing height of 7m above the ground may be insufficient for safely crossing the haul road, upon which very large mining vehicles may traverse. Therefore, the preferred glide pole height should be closer to 25m in height to ensure gliders are able to cross whilst avoiding contact with vehicles using the haul road. A 25m high pole would theoretically mean (based on the glide ratio of yellow-bellied gliders) greater gliders may land upon the adjacent pole approximately 15m off the ground.

In the case that only 2 poles can be installed at the haul road (i.e. no centre pole), minimum pole heights would need to be between 40-45m in height, which would be difficult to source.

Additionally, glider pole height may be reduced for those installed along the Roper Creek Diversion 2 as landing height could potentially be reduced as long as the pole distance is calculated as detailed above.

**Note: the greater glider is on average heavier and larger than a yellow-bellied glider.*

4.1.5.2 Glide pole design

Suitable contractors can be engaged to produce glide poles based on the specifications provided for the Hall Road crossing. Height and distance can be assessed for the Roper creek diversion 2 installation, however the other features should remain the same. Contractors will be able undertake the necessary engineering steps when installing the poles also.

Height: 21-25m

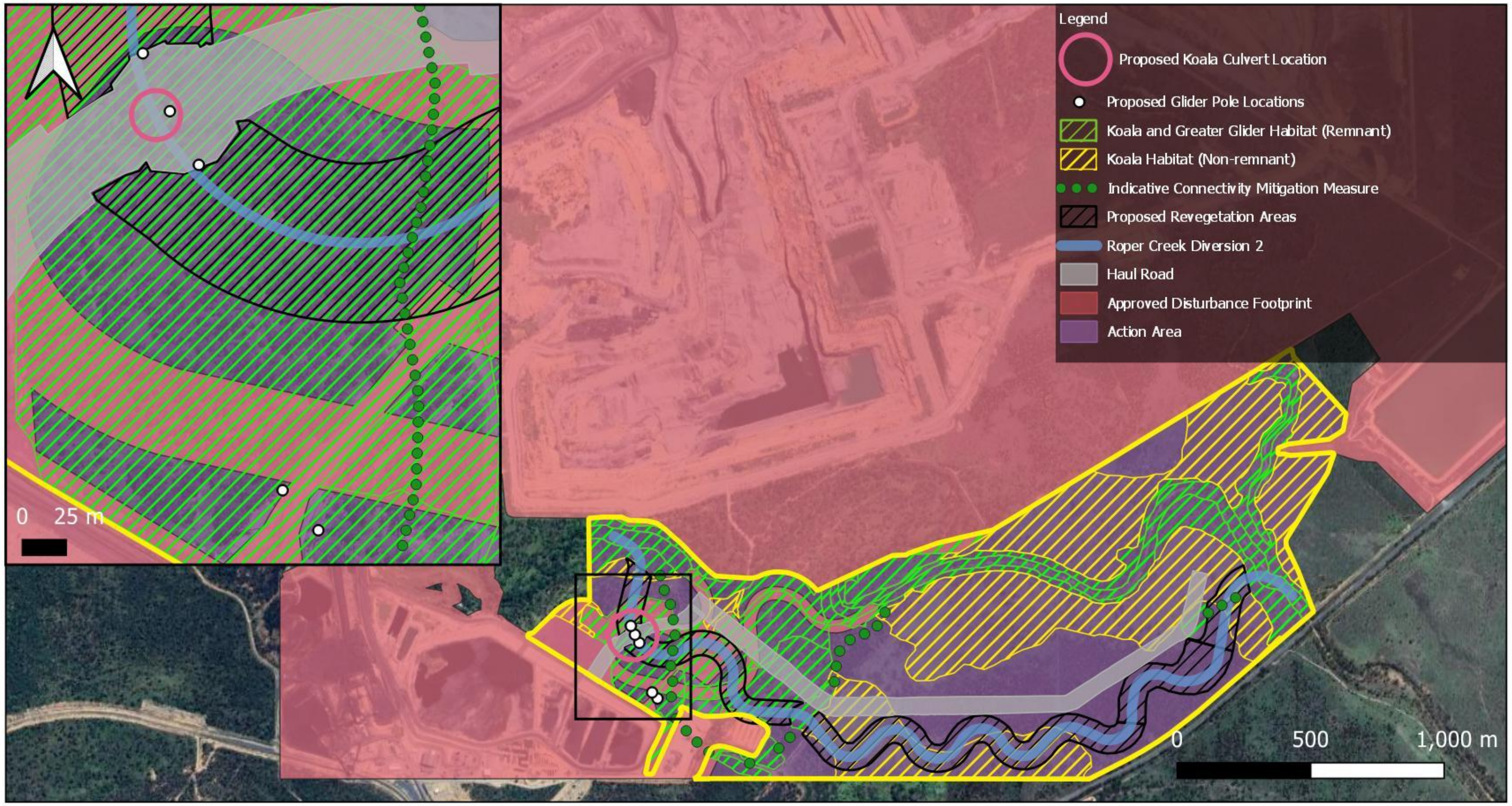
Glide pole spacing: 30-35m

Launching platform: Horizontal crossbars ~2m length (see Photo Plate 1).

Installation of other features on glide pole: Some glide poles have been designed with PVC piping on the upper portion of the pole to provide refuge for gliders in the event of threat from predators (See Photo Plate 1). We do not recommend the installation of piping or nest boxes on poles situated near road crossing, as we do not want to encourage glider habituation at roadsides. However, glide poles installed within vegetation/in other crossing locations may have nest boxes installed if other suitable hollows are not present nearby. Greater gliders are known to utilise nest boxes in certain situations.

Surrounding vegetation: Glide pole installation will depend on the location of surrounding vegetation/corridors which will be able to facilitate movement on/off the glide poles. It should be noted that greater gliders show a preference for mature forest with well-developed hollows (DCCEEW 2022, Visintin et al. 2021), and therefore planted corridors would take a substantial length of time to reach a maturity to be of habitat value to greater gliders.

Photo Plate 1: Example of horizontal crossbars installed at the top of glide poles. Depending on launch direction, 1 or 2 crossbars may be required. PVC pipe refuge observed in the 2nd photo. Photo credit: A. Marks.



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	Drawn by: DM	Location: Middlemount Mine		
	Date: July 2025	Client: Middlemount Coal Pty Ltd	Job Number: ESQ5851	Spatial Reference: MGA Zone 55/GDA 2020 Scale: 1:12,000

Figure 3. Proposed glide pole installation location and location of habitat connectivity restoration

5. Conclusion

This report has provided information for the development of proposed crossing infrastructure for the greater glider across the Middlemount Mine extent. Whilst greater gliders are not currently known to utilise crossing structures for dispersal, calculations have been made based on similar species to determine potentially suitable glide pole heights for gap crossing. The following was determined:

Proposed glide pole height: 21-25m

Proposed glide pole spacing: 30-35m

Proposed glide pole features: 2m horizontal crossbars, nest box addition only in vegetated areas, not at road crossings.

Greater glider connectivity between fragmented habitat patches as a result of the Middlemount mine Southern Expansion may be improved through installation of glide poles, and through following recommendations provided in the FCMP. Whilst there is no evidence to suggest greater gliders use glide poles for the purpose of gap crossing, establishing vegetated corridors and opportunity for dispersal with glide poles may improve the likelihood of connectivity between fragmented greater glider habitat patches over the long term.

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