Jellinbah Group

LAKE VERMONT MEADOWBROOK PROJECT ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 10 TERRESTRIAL ECOLOGY

arc ENVIRONMENTAL SOLUTIONS

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10 Terrestrial Ecology

10.1 Environmental objectives and performance outcomes

10.1.1 Flora and fauna

This chapter has been prepared to assist the DES in carrying out the environmental objective assessment in respect of the following environmental objectives prescribed in the Project ToR:

- The activity will be operated in a way that protects the environmental values of land, including soils, subsoils, landforms and associated flora and fauna.
- There will be no potential or actual adverse effect on a wetland as part of carrying out the activity.
- The proposed project will minimise serious environmental harm to areas of high conservation value and special significance and sensitive land uses in adjacent places.
- The location of the activity is on a site that protects all environmental values relevant to adjacent sensitive use.
- The proposed project will manage the impacts on the environment by seeking to achieve ecological sustainability, including, but not limited to, protected wildlife and habitat.
- Critical habitat will receive special management considerations and protection through a management plan for the proposed Project.
- The proposed Project will avoid significant residual impacts to matters of national environmental significance (MNES) and matters of state environmental significance (MSES), mitigate impacts where they cannot be avoided and offset any residual impacts.
- The proposed project will provide for the conservation of the marine environment, particularly the Great Barrier Reef Marine Park.
- The construction, operation and decommissioning of the proposed project will be consistent with all statutory and regulatory requirements of the Federal, State and local governments and be consistent with their relevant plans, strategies, policies and guidelines that relate to the terrestrial and aquatic ecological environment.

As part of the Project assessment of potential impacts to terrestrial ecology values, a Terrestrial Ecology Assessment has been undertaken by AARC Environmental Solutions Pty Ltd (AARC, 2022) and is provided as Appendix G, Terrestrial Ecology Assessment. The assessment was prepared in consideration of the:

- 'EIS Guideline–Terrestrial Ecology' (DES 2022);
- 'EIS Guideline–Matters of National Environmental Significance' (DES 2020); and
- 'EIS Guideline–Biosecurity' (DES 2020).

Various other applicable guidelines and strategies have also been utilised and referenced throughout these studies.

The detailed assessment presented in this chapter and the relevant appendices demonstrates that the Project will achieve the requirements of the ToR and, through this, the requirements of Schedule 8, Part 3, Division 1 and Division 2 of the EP Regulation.

Specifically, the Project will achieve item 2 of the performance outcomes for each flora and fauna objective in satisfaction of section 2(4) of Schedule 8 of the EP Regulation because the Project will be operated in a way that achieves all of the following:

a) Activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land.

b) Areas disturbed will be rehabilitated or restored to achieve sites:

   i) that are safe and stable;

   ii) where no environmental harm is being caused by anything on or in the land; and

   iii) that are able to sustain an appropriate land use after rehabilitation or restoration.

c) The Project will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants.

d) The application of water or waste to the land will be sustainable and managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

e) Areas of high conservation values and special significance likely to be affected by the proposal will be identified and evaluated, and any adverse effects on these areas will be minimised (including any edge effects on the areas), and critical design requirements will prevent emissions having an irreversible or widespread impact on adjacent areas.

f) The Project and its components will be carried out on the site in a way that prevents or minimises adverse effects on the use of surrounding land and allows for effective management of the environmental impacts of the Project.

10.2 Regional and local setting

The Project is within the Brigalow Belt Bioregion (Figure 3.3). This bioregion occupies over a fifth of Queensland, extending from Townsville in the north to near the border of New South Wales in the south. The Brigalow Belt Bioregion encompasses a broad climatic gradient and a diversity of soils and topography and is host to a high diversity of flora and fauna (DES 2018a). The Brigalow Belt Bioregion is divided by the Great Dividing Range into the Brigalow Belt South Bioregion and the Brigalow Belt North Bioregion—the Project is within the Brigalow Belt North Bioregion (DoEE 2016a) (Figure 3.3).

The Brigalow Belt North Bioregion is characterised by woodlands of:

- Ironbark (Eucalyptus melanophloia, E. crebra);
- Poplar Box (*E. populnea*);
- Browns Box (*E. brownii)*;
- Brigalow (*Acacia harpophylla*);
- Blackwood (*A. argyrodendron*); and
- Gidgee (*A. cambagei*) (NRS 2000).

The Project is also within the Fitzroy River Basin, which encompasses an area of 142,545 km^2 and contains the Comet, Dawson, Fitzroy, Isaac, Mackenzie and Nogoa River sub catchment areas (BoM 2020a).

The Project lies within the Isaac River sub catchment, which covers an area of 22,364 km^2, comprising the catchments of the Isaac and Connors Rivers. The Isaac River is approximately 4.2 km to the east of the study area and flows south from north of Moranbah and converges with the Mackenzie River approximately 150 km south-east of the study area. The Mackenzie River converges with the Dawson River to form the Fitzroy River, which eventually discharges into the Coral Sea south-east of Rockhampton.

The region is described as subhumid, semi-tropical to semi-arid with predominantly summer rainfall (DEWHA 2008a, DoEE 2016a). Based on data sourced from the Bureau of Meteorology (BoM) Weather Station at the Moranbah Airport spanning 2012 to 2022 (BoM 2020b), mean maximum monthly temperatures range between 24.1°C in June and 35.4°C in December and mean minimum monthly temperatures range between 8.5°C (July) to 21.5°C (January).

Similar maximum and minimum monthly temperatures are recorded at the Clermont Airport spanning 2010 to 2022 (BoM 2020c).

The Booroondarra BoM Weather Station (BoM 2020d) approximately 30 km south of Dysart and approximately 45 km south of the study area records April to September are typically drier months, with mean monthly rainfall ranging from 16.1 mm to 33.8 mm, and October through to March signifies the wet season, with mean monthly rainfall ranging from 41.3 mm to 73.7mm.

Land use within the Brigalow Belt North Bioregion is primarily beef cattle grazing on pastoral leases and coal mining (DEWHA 2008a). There are 17 resource developments (approved and proposed) that occur within 50 km of the Project area. These Projects include:

1) the Bowen Gas Project;
2) Saraji Mine;
3) The Saraji East Project (proposed);
4) Olive Downs/Olive Downs North Mine;
5) Winchester South Project (proposed);
6) Eagle Downs Mine;
7) Vulcan Complex;
8) Dysart East Mine;
9) Peak Downs Mine;
10) Duania Mine;
11) Caval Ridge Mine;
12) Poitrel Mine;
13) Millennium Mine;
14) Isaac Downs Mine;
15) Moorvale Mine;
16) Moranbah South Mine;
17) Isaac Plains East Mine.

Nearby resource developments are shown on Figure 3.1 (Chapter 3, Project Description). Arrow Energy's Bowen Gas Project involves the development of coal seam gas resources in an area of approximately 8,000 km^2 that extends from approximately 30 km north of Glenden to approximately 10 km south of Blackwater. The Bowen Gas Project includes ATP tenements that overly the Project site.

The watercourses of Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek traverse the study area in an easterly direction and are tributaries of the Isaac River (Figure 10.1).

Boomerang Creek is an ephemeral fifth order stream that traverses the northern portion of the study area. Hughes Creek flows into Boomerang Creek near the western boundary of MDL 429. The headwaters of Boomerang Creek and Hughes Creek occur to the west of the study area and traverse the tenure of the Saraji Mine.

One Mile Creek, a third order stream, traverses the study area from the south-west until its confluence with Boomerang Creek towards the north-eastern boundary of the study area.

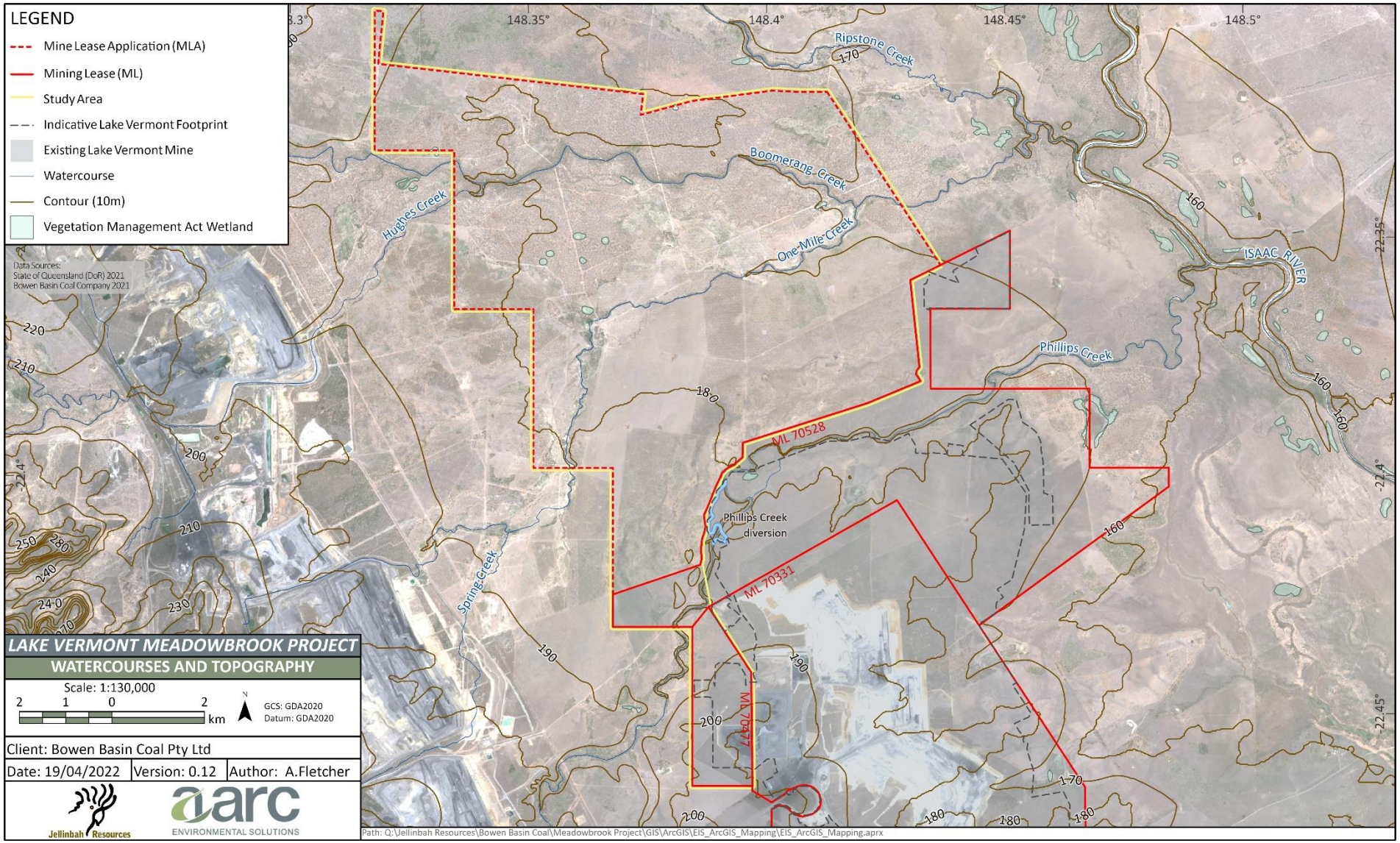

Figure 10.1: Waterways and topography

Phillips Creek is a fourth order stream that traverses the proposed Project infrastructure corridor within ML 70528. Phillips Creek continues to meander in an easterly direction to the south of the study area before converging with the Isaac River.

Boomerang Creek, Hughes Creek, One Mile Creek, Phillips Creek and the Isaac River are defined watercourses under the *Queensland Water Act 2000*.

Ripstone Creek, also a third order stream, occurs to the north of the study area and flows eastward before flowing into Boomerang Creek to the east of the study area. The Olive Downs Coking Coal Project has approval to divert a section of Ripstone Creek to the north of the study area.

There are eight vegetation management wetlands within the Project area and 10 HES wetlands outside the Project boundary. Six of the HES wetlands are mostly associated with the floodplain and prior drainage channels of the Isaac River, three are associated with flood channels and drainage systems and one is at the eastern boundary of the Lake Vermont Mine ML area.

The topography of the study area is generally flat to gently undulating, with elevations ranging between 160 m and 190 m Australian Height Datum (Figure 3.14, Chapter 3, Project Description). The topography of the study area is representative of the surrounding region. Land Zones 3, 4 and 5 occur within the study area.

10.3 Study area and methodology

The terrestrial ecology assessment has been undertaken by AARC Environmental Solutions (Appendix G, Terrestrial Ecology Assessment) to assess the potential impacts of the Project on terrestrial ecology values.

The Project was determined to be a controlled action under the EPBC Act (EPBC Referral 2019/8485) on 22 November 2019. The assessment of EVNT flora and fauna values was conducted according to the listed status of the values at the time of the controlled decision.

The EPBC listing for the Koala is noted to have changed from vulnerable to endangered in early 2022, and the EPBC listing for the Greater Glider changed from vulnerable to endangered in July 2022. Both species were assessed as vulnerable listed species. Further details of the impact assessment for the Koala are provided in section 0 and Greater Glider in 10.6.8.

The terrestrial ecology surveys have been undertaken by suitably qualified personnel. The flora survey and RE mapping amendment submission has been undertaken by a suitably qualified botanist. Field assessments, reporting and reviews were conducted by experienced ecologists with more than 20 years of experience. The list of personnel relevant to the Project ecological assessments is provided in Appendix G, Terrestrial Ecology Assessment (Section 7.1).

10.3.1 Study area

The terrestrial ecology assessment study area comprises a proposed MLA area, located over a portion of MDL 303 and MDL 429 (Figure 10.1) and an area of land to the south of the MLA within the existing Lake Vermont Mine (within ML 70477 and ML 70528) (Figure 3.2, Chapter 3, Project Description). Project land within the existing MLs is related to the proposed infrastructure corridor, which facilitates connection between the existing Lake Vermont Mine infrastructure and the proposed Project site (Figure 3.2, Chapter 3, Project Description). The MLA is used for grazing and is maintained partially as cleared agricultural areas and vegetated woodland. The entirety of the land within the proposed MLA is owned by the Proponent.

10.3.2 Desktop assessment

A desktop assessment has been undertaken to identify and present the ecological values mapped to exist within the terrestrial ecology study area. The desktop assessment includes a review of Commonwealth and State databases and mapping, literature reviews, ecology assessments from the existing Lake Vermont operations, ecological assessment from surrounding projects and aerial photographs.

Searches have been undertaken within a 50 km buffer on the EPBC Act Protected Matters Search Tool and the DES Wildlife Online search and WildNet Wildlife Records. The results of the desktop assessment (Appendix G, Terrestrial Ecology Assessment, Section 6) have informed the field survey design and methodology.

10.3.3 Field survey

Terrestrial ecology surveys have been undertaken by suitably qualified ecologists in accordance with all required permits and approvals. Seasonal surveys have been undertaken within the Project area over 46 days in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April), and spring 2021 (6–10 September).

The field assessments have been conducted in accordance with the following survey guidelines:

- Commonwealth guidelines:
  - 'Survey guidelines for Australia's threatened reptiles' (DSEWPaC 2011a);
  - 'Survey guidelines for Australia's threatened birds' (DEWHA 2010a);
  - 'Survey guidelines for Australia's threatened mammals' (DSEWPaC 2011b);
  - 'Survey guidelines for Australia's threatened bats' (DEWHA 2010b);
  - 'EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)' (DoE 2014a);
  - 'Draft Referral Guidelines for the nationally listed Brigalow Belt reptiles' (DSEWPaC 2011c);
  - 'Draft referral guideline for 14 migratory birds listed under the EPBC Act' (DoE 2015); and
  - 'Species Profile and Threats Database' outlined survey requirements for EPBC Act listed species likely or with potential to occur;
- State Guidelines:
  - 'Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland (V5.0)' (Neldner *et al*. 2019);
  - 'Flora Survey Guidelines–Protected Plants (V2.01)' (DES 2019);
  - 'Management of endangered plants' (Cropper 1993);
  - 'Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (V3.0)' (Eyre *et al.* 2018);
  - 'Targeted species survey guidelines: Common death adder *Acanthophis antarcticus*' (Rowland and Ferguson 2012); and
  - 'Targeted species survey guidelines: Glossy black-cockatoo *Calyptorhynchus lathami'* (Hourigan 2012).

This report uses nationally accepted taxonomy for flora from the Australian Plant Census (APC 2020), and the nomenclature for fauna follows the Australian Biological Resources Study Faunal Directory (ABRS 2020).

The total flora survey effort includes:

- 54 secondary sites surveyed;
- 245 quaternary sites sampled; and
- Rapid flora observations at approximately 500 locations.

The total fauna survey effort summary is provided in Table 10.1:, and the locations of the flora and fauna survey sites are presented in Figure 10.2 and Figure 10.3, respectively.

Table 10.1: Summary of fauna survey effort

Survey method	Survey effort					Total survey effort
	Autumn survey 2019	**Spring survey 2019**	**Autumn survey 2020**	**Autumn survey 2021**	**Spring survey 2021**	
Systematic fauna site						
Elliott trapping	4 sites (MF01–MF04) x 20 traps x 4 nights = 320 trap nights	6 sites (MF05 - MF10) x 20 traps x 4 nights = 480 trap nights	1 site (MF14) x 20 traps x 4 nights = 80 trap nights	—	—	880 total trap nights
Pitfall trap lines	4 sites (MF01–MF04) x 4 pitfalls x 4 nights = 64 trap nights	6 sites (MF05 –MF10) x 4 pitfalls x 4 nights = 96 trap nights	1 site (MF14) x 4 pitfalls x 4 nights = 16 trap nights	—	—	176 total trap nights
Funnel trapping	4 sites (MF01–MF04) x 6 funnels x 4 nights = 96 trap nights	6 sites (MF05 –MF10) x 6 funnels x 4 nights = 144 trap nights	1 site (MF14) x 6 funnels x 4 nights = 24 trap nights	—	—	264 total trap nights
Automated camera trapping	4 sites (MF01–MF04) x 1 camera x 4 nights = 16 trap nights	9 sites (MF05 –MF13) x 1 camera x 4 nights = 36 trap nights	1 site (MF14) x 1 camera x 4 nights = 4 trap nights	—	—	56 total trap nights
Bird surveys	2 person hours per site (MF01–MF04) = 8 person hours	Minimum 1 person hour per site (MF05–MF13) = 12 person hours at fauna sites	2 person hours per site (MF14) = 2 person hours	—	—	22 total person hours
Spotlight searches	1 person hour per site (MF01–MF04) = 4 person hours	1 person hour per site (MF05–MF13) = 9 person hours at fauna sites	2 person hours per site (MF14) = 2 person hours	—	—	15 total person hours
Call playback sessions	2 sessions per site (MF01–MF04) = 8 sessions	2 sessions per site (MF05–MF10) + 1 session per site (MF11–MF13) = 15 sessions	2 sessions per site (MF14) = 2 sessions	—	—	25 sessions
Habitat searches	2 person hours per site (MF01–MF04) = 8 person hours	Minimum 1 person hour per site (MF05–MF13) = 11 person hours at fauna sites	1 person hour per site (MF14) = 1 person hour	—	—	20 total person hours

Survey method	Survey effort					Total survey effort
	Autumn survey 2019	Spring survey 2019	Autumn survey 2020	Autumn survey 2021	Spring survey 2021	
Echolocation call detection	(2 sites [MF01, MF02] x 1 bat detector x 3 nights) + (2 sites [MF03, MF04] x 1 bat detector x 4 nights) = 14 detection nights	8 sites (MF05–MF08, MF10–MF13) x 1 bat detector x 3 nights = 24 detection nights	1 site x 1 bat detector x 3 nights = 3 detection nights	—	—	41 total detection nights
Supplementary micro bat survey sites						
Harp trapping	—	—	6 sites (MH01-MH06) x 1 trap x 5 nights = 30 trap nights	—	—	30 total trap nights
Mist netting	—	—	4 sites (MH01, MH05, MH06, MF14) x 1 mist nets x 1 hour = 4 trap hours	—	—	4 total trap hours
Echolocation call detection	—	—	3 sites (MH02 –MH04) x 1 bat detector x 3 nights = 9 detection nights	—	—	9 total detection nights
Spotlight searches	—	—	2 person hours at 3 sites (MH01, MH05, MH06) = 6 person hours	—	—	6 total person hours
Supplementary surveys						
Bird surveys	20 person hours of bird surveying	30 person hours of bird surveying	10 person hours of bird surveying	—	—	60 total person hours
Spotlight searches	4 person hours of spotlighting	6 person hours of spotlighting	5 person hours of spotlighting	35mins per site x 2 persons per site (MSS01, MSS02, MSS03 and MSS04) + 7 person hours of opportunistic spotlighting = 11.6 person hours	11 person hours of spotlighting	37.6 total person hours

Survey method	Survey effort					Total survey effort
	Autumn survey 2019	**Spring survey 2019**	**Autumn survey 2020**	**Autumn survey 2021**	**Spring survey 2021**	
Habitat searches	20 person hours of habitat searching	30 person hours of habitat searching	5 person hours of habitat searching	—	—	55 total person hours
Habitat assessment	—	—	—	—	20 Koala and Greater Glider sites, 11 Ornamental Snake sites, 20 water body assessments for Squatter Pigeon and Australian Painted Snipe	

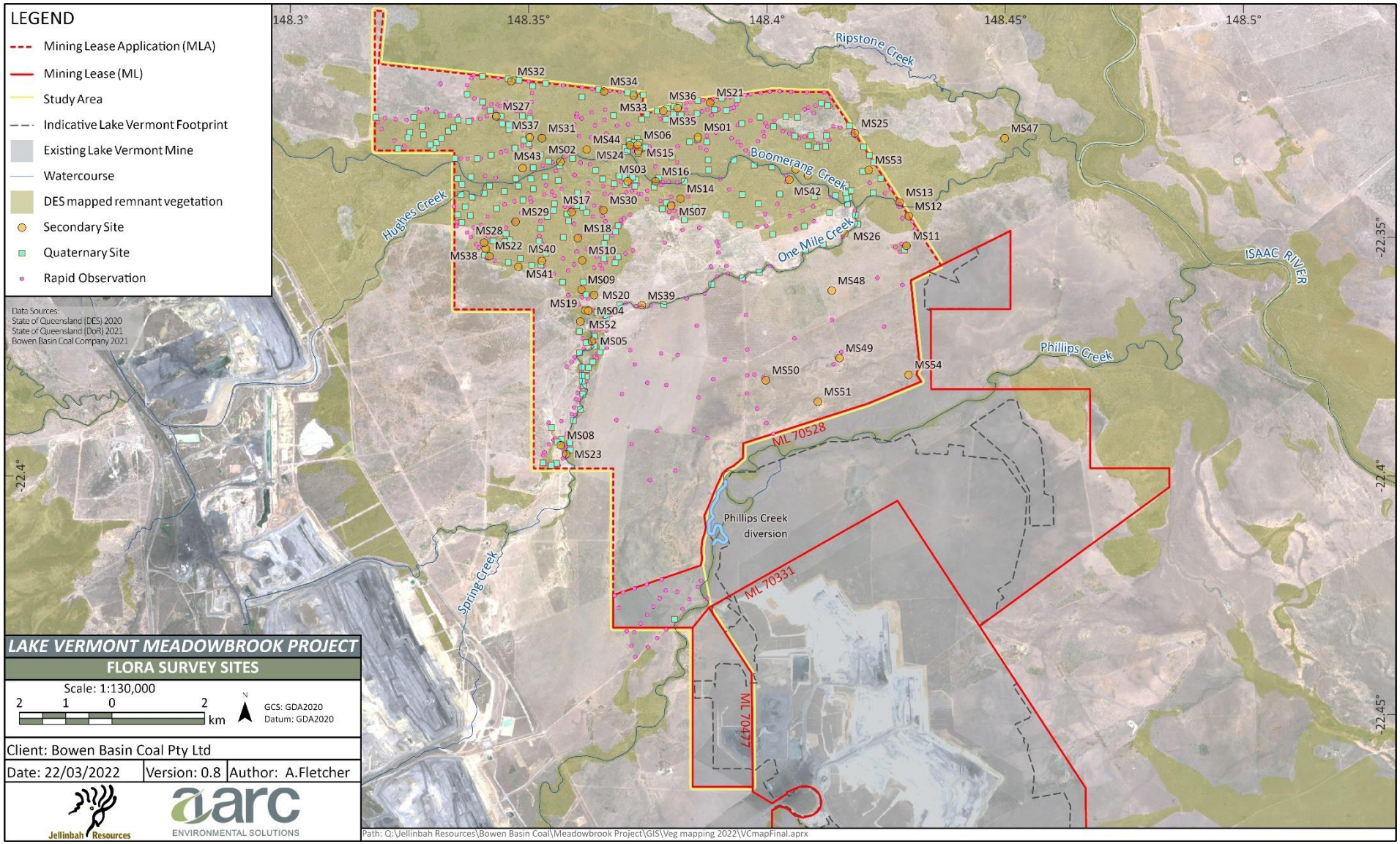

Figure 10.2: Flora survey sites

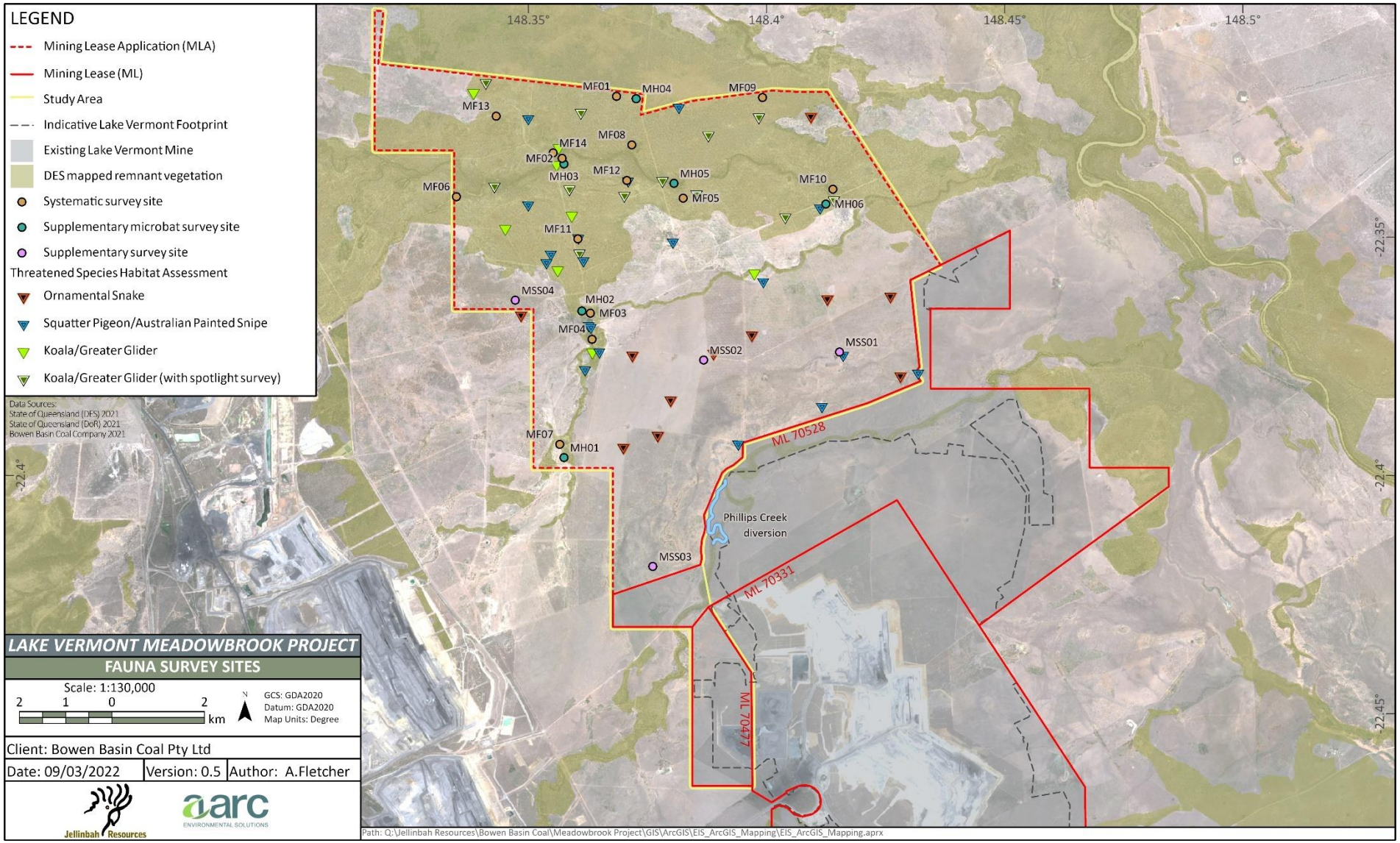

Figure 10.3: Fauna survey sites

10.3.4 Groundwater dependant ecosystems methodology

The BoM GDE Atlas mapping identifies areas of high, moderate and low potential terrestrial GDEs associated with the riparian vegetation of watercourses. A Groundwater dependent ecosystems assessment of the study area has been undertaken by 3D Environmental and is detailed in Appendix I, Groundwater dependent ecosystems.

10.3.4.1 Study area

The GDE assessment area comprises the proposed MLA and surrounding potential impact area, including the Isaac River to the east of the Project.

10.3.4.2 Desktop assessment

A desktop assessment has identified that the BoM GDE Atlas mapping shows areas of high, moderate and low potential terrestrial GDEs associated with riparian vegetation of watercourses in the Project area (Appendix I, Groundwater dependent ecosystems, Section 3.1).

GDE Atlas mapped 'Low Potential' for Terrestrial GDEs associated with elevated residual plains (typically RE 11.5.3), 'High Potential' and 'Moderate Potential' for Terrestrial GDEs associated with floodplain alluvium (typically RE 11.3.2, RE 11.3.3 and R E11.3.25) vegetation and watercourses.

There are no springs mapped within proximity to the assessment area, although the Isaac River (east of MDL439) and Phillips Creek (on the southern fringe of MDL439) are mapped as 'High Potential' Aquatic GDEs. Other larger creeks (i.e. Boomerang Creek and Ripstone Creek) are mapped as 'Moderate Potential' Aquatic GDEs. There are also numerous floodplain wetlands, including RE 11.3.27 and RE 11.5.17, scattered across the area that are mapped as 'Moderate Potential' Aquatic GDEs.

10.3.4.3 Field survey

A field survey of GDEs was completed between 15 August and 19 August 2021 by 3D Environmental, as detailed in Appendix I, Groundwater Dependent Ecosystems (Section 3). The field assessment methodology is consistent with the 'Field Investigations of Potential Terrestrial Groundwater dependent ecosystems within Australia's Great Artesian Basin' (Jones *et al.* 2020) and supplemented with additional methodologies derived from:

- 'Australian groundwater-dependent ecosystem toolbox part 1: assessment framework' (Richardson *et al.* 2011);
- 'Information Guidelines Explanatory Note–Assessing groundwater dependent ecosystems' (IESC 2018);
- 'Information Guidelines Explanatory Note: Assessing groundwater dependent ecosystems' (Doody *et al.* 2019); and
- 'Identifying groundwater dependent ecosystems–A guide for land and water managers' (Eamus 2009).

Eighteen sites were selected to provide representative coverage of the major vegetation types and landform elements that are most likely to be groundwater dependent (Figure 10.4). The sites have been assessed or inspected during the GDE field survey, with the exception of site 12, which was inaccessible.

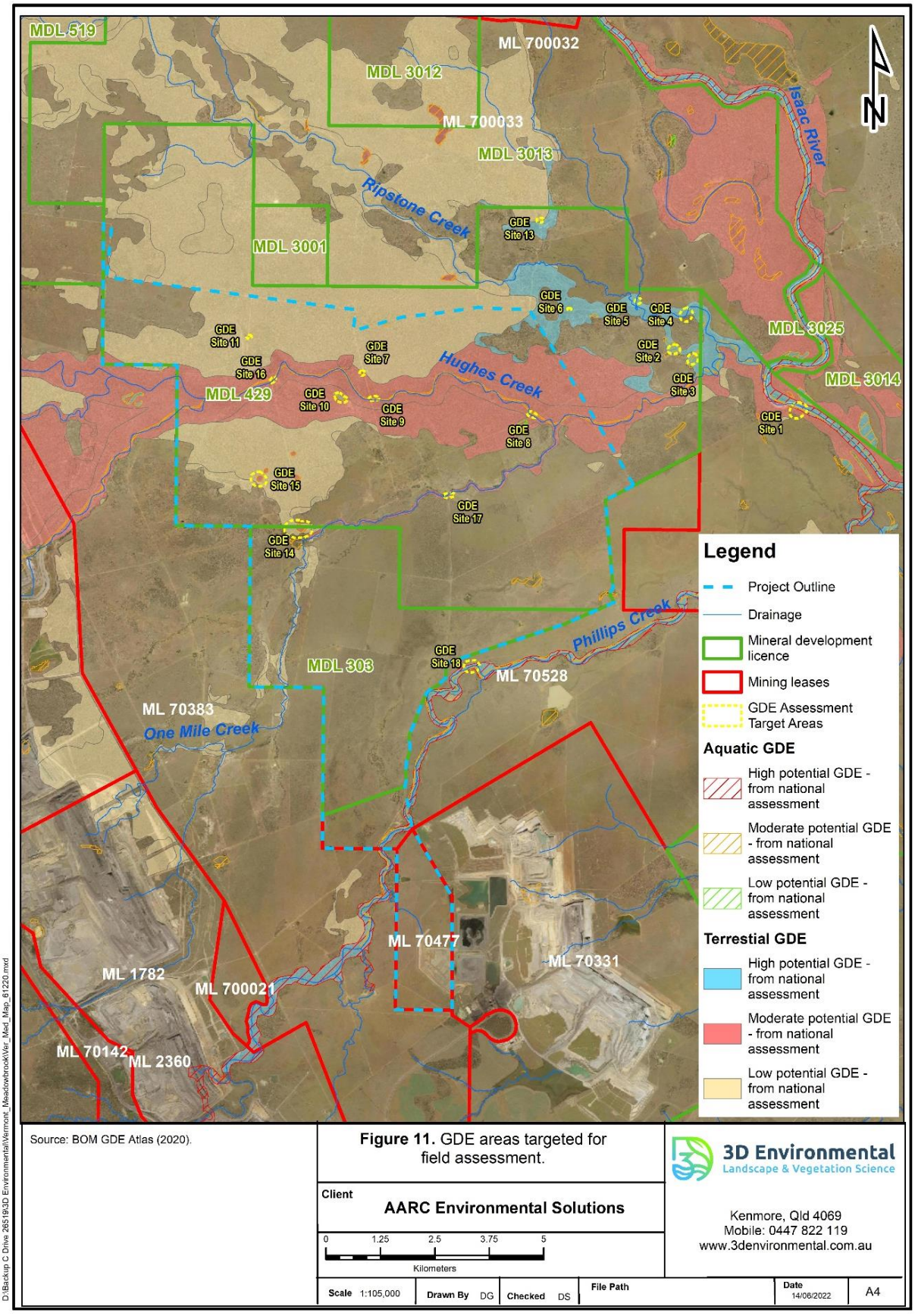

Figure 10.4: GDE assessment targeted for field assessment

The assessment undertaken included:

- one site on the Isaac River floodplain and channel;
- five sites in wetlands on alluvial floodplains or broad land surfaces;
- five sites in areas of vegetation associated with Boomerang Creek;
- four sites in areas of vegetation associated with Ripstone Creek;
- one site in an area of vegetation associated with One Mile Creek; and
- one site in an area of vegetation associated with Phillips Creek.

The field survey methods to assess groundwater-dependence of the surveyed vegetation community included:

- leaf water potential;
- soil moisture potential; and
- stable isotope analyses of:
    - soil moisture;
    - xylem water; and
    - groundwater collected from monitoring bores.

Full details of the field methodology and laboratory analyses are provided in Appendix I, Groundwater Dependent Ecosystem Assessment (Section 3).

10.4 Terrestrial ecological values

This section outlines the terrestrial ecology values identified for the Project, as detailed in Appendix G, Terrestrial Ecology Assessment.

10.4.1 Regional Ecosystems

Fifteen remnant REs have been identified within the study area, comprising four 'Endangered' REs, six 'Of Concern' REs and five 'No Concern at Present' REs under the VM Act biodiversity status and four 'endangered', three 'of concern' and eight 'least concern' VM Act status REs. Cleared agricultural areas occupied the majority of the study area (5,431 ha), with some areas of high-value regrowth identified. A description of identified REs is presented in Table 10.2, with the locations of these REs shown in Figure 10.5.

Table 10.2: Ground-truthed vegetation communities within the study area

Map unit	Vegetation community	Associated RE	VM Act status[1]	BD status[2]
1: Brigalow Woodlands				
VC 1a	Remnant Brigalow woodland on alluvial plains.	11.3.1	Endangered	Endangered
VC 1b	Remnant Dawson Gum woodland with Brigalow on undulating Cainozoic clay plains.	11.4.8	Endangered	Endangered

Map unit	Vegetation community	Associated RE	VM Act status[1]	BD status[2]
VC 1c	Remnant Brigalow with Yellowwood woodland with occasional Dawson Gum on Cainozoic clay plains.	11.4.9	Endangered	Endangered
VC 1d	High-value regrowth Brigalow.	—	—	—
2: Eucalypt Woodlands				
VC 2a	Remnant Poplar Box woodland on alluvial plains.	11.3.2	Of Concern	Of Concern
VC 2b	Remnant Coolibah woodland on alluvial plains.	11.3.3	Of Concern	Of Concern
VC 2c	Remnant Eucalypt and Bloodwood spp. Woodland on alluvial plains.	11.3.4	Of Concern	Of Concern
VC 2d	Remnant Poplar Gum and Clarkson's Bloodwood woodland on floodplains.	11.3.9	Least Concern	No Concern at Present
VC 2e	Remnant Poplar Box with occasional Clarkson's Bloodwood and Silver-leaved Ironbark woodland on sand plains.	11.5.3	Least Concern	No Concern at Present
VC 2f	Remnant Poplar Gum woodland on Cainozoic sand plains.	11.5.8c	Least Concern	No Concern at Present
VC 2g	Remnant Narrow-leaved Red Ironbark woodland on Cainozoic sand plains.	11.5.9c	Least Concern	No Concern at Present
VC 2h	Remnant Clarkson's Bloodwood and Poplar Gum woodland, often with a dense low tree layer dominated by Paperbark Tea-tree.	11.5.12	Least Concern	No Concern at Present
3: Riparian Woodlands				
VC 3a	Remnant River Red Gum or Blue Gum woodland fringing drainage lines.	11.3.25	Least Concern	Of Concern
4: Vegetation associated with wetlands				

Map unit	Vegetation community	Associated RE	VM Act status[1]	BD status[2]
VC 4a	Remnant River Red Gum, Poplar Gum and/or Blue Gum fringing lacustrine wetlands.	11.3.27b	Least Concern	Of Concern
VC 4b	Remnant Coolibah open woodland fringing palustrine wetlands.	11.3.27f	Least Concern	Of Concern
VC 4c	Palustrine swamp with fringing Blue Gum woodland in depressions on Cainozoic sand plains and remnant surfaces.	11.5.17	Endangered	Endangered

1 Endangered; Of Concern; Least Concern
2 Endangered; Of Concern; No Concern at Present

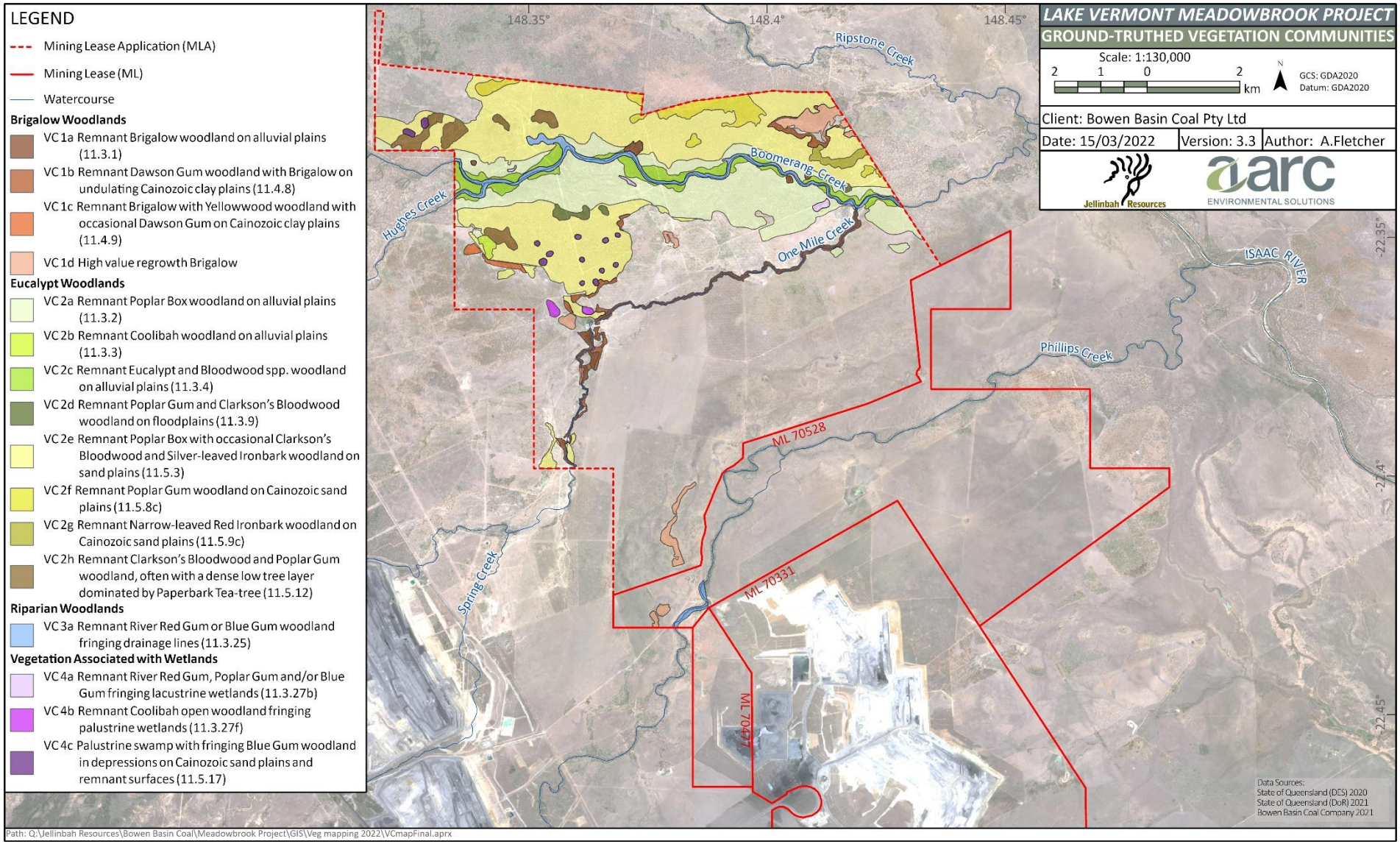

Figure 10.5: Ground-truthed vegetation communities within the study area

10.4.2 Threatened Ecological Communities

Two TECs defined under the EPBC Act have been identified through surveys as being present within the terrestrial ecology study area:

1) Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (Brigalow TEC); and

2) Poplar Box Grassy Woodland on Alluvial Plains TEC (Poplar Box TEC).

These TECs are listed as endangered under the EPBC Act.

10.4.2.1 Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC

Areas of Brigalow vegetation have been recorded within the study area, and many of these areas met the condition thresholds of the EPBC Act listed endangered Brigalow TEC. A total of 154.5 ha of Brigalow TEC, occurring over 23 patches, have been identified, as shown in Figure 10.6.

The Brigalow TEC vegetation recorded at the study area is comprised of vegetation representing RE 11.3.1, RE 11.4.8 and RE 11.4.9.

10.4.2.2 Poplar Box Grassy Woodland on alluvial plains TEC

Areas of Poplar Box woodland vegetation have been recorded within the study area, and many of these areas met the Class B, good quality condition thresholds of the EPBC Act listed Poplar Box TEC. A total of 656.6 ha of Poplar Box TEC occurring over eight patches have been identified, as shown in Figure 10.6.

The Poplar Box TEC recorded at the study area comprises vegetation representing RE 11.3.2.

10.4.3 Flora species of conservation significance

No conservation significant flora species have been observed within the study area.

10.4.4 Fauna species of conservation significance

10.4.4.1 EPBC Act and NC Act listed species

Five fauna species listed as threatened under the EPBC Act and NC Act have been identified during the field surveys (Figure 10.3), namely the:

1) Ornamental Snake;

2) Squatter Pigeon (Southern);

3) White-throated Needletail;

4) Koala; and

5) Greater Glider.

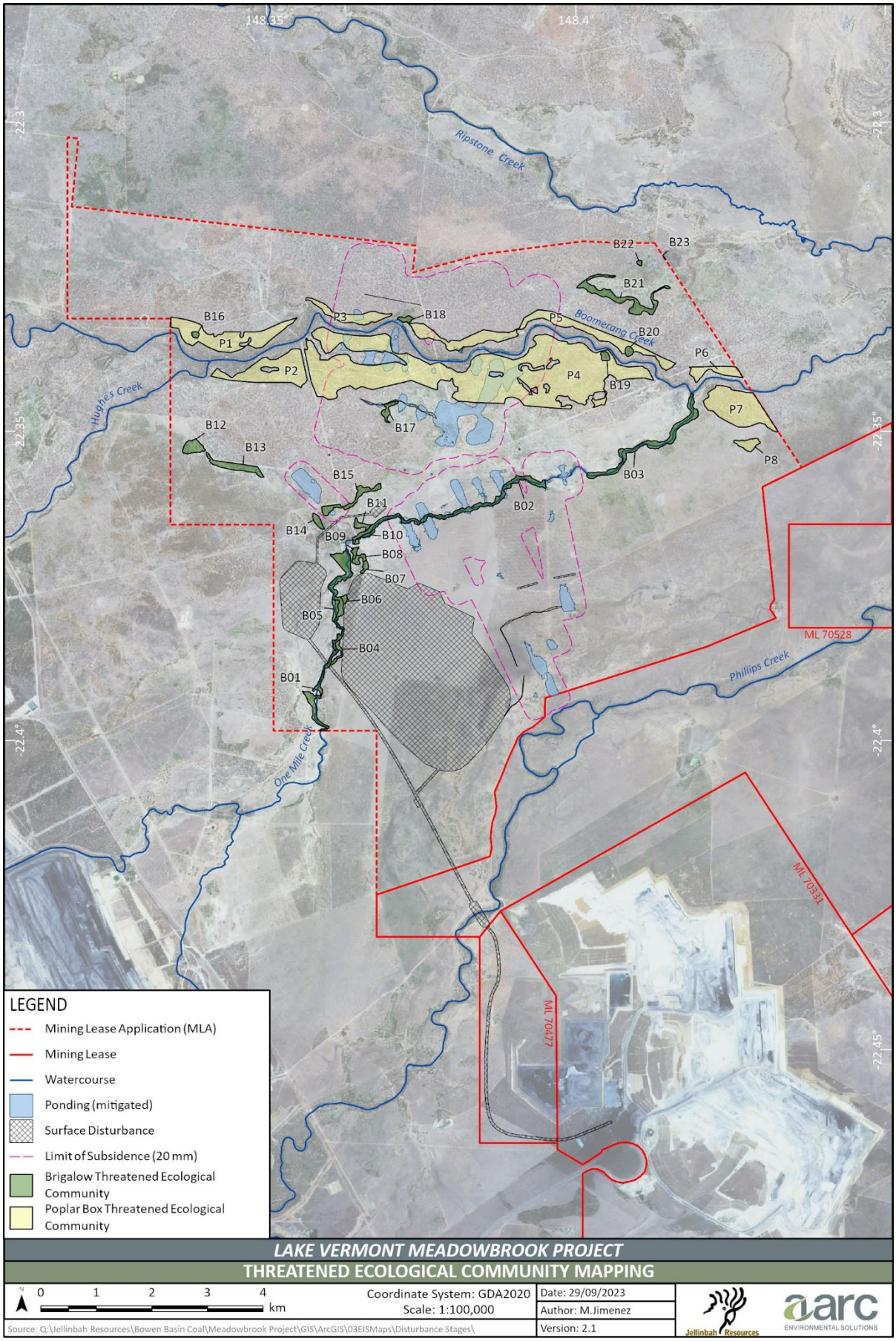

Figure 10.6: Threatened ecological communities within the study area

All of these species were listed as Vulnerable under the EPBC Act and NC Act at the time of the controlled action decision (and Terms of Reference determination) for the Project. Since the time of the controlled action decision for the Project however (and the grant of the Terms of Reference) it is noted that some changes have occurred to the listing status of some of these five species. Specifically, the EPBC Act and NC Act listing status for the Koala and the Greater Glider has changed from Vulnerable to Endangered (during 2022). With these changes occurring after the controlled action decision (and Terms of Reference determination for the Project) this assessment considers the impacts to these species in accordance with their listing status' at the time of the controlled action decision (and Terms of Reference determination) for the Project.

The Short-beaked Echidna, listed as a non-migratory Special Least Concern species under the NC Act, has also been observed during the surveys.

An additional threatened species, the Australian Painted Snipe, has also been considered to have a moderate likelihood of occurring within the Project area.

10.4.4.2 EPBC Act listed migratory species

Two species listed as migratory under the EPBC Act and as Special Least Concern (migratory) species under the NC Act have been recorded by the surveys (Table 10.3):

1) the White-throated Needletail (also listed as Vulnerable); and

2) the Crested Tern (*Thalasseus bergii*).

Table 10.3: Conservation significant fauna species recorded within the study area

Family	Scientific Name	Common Name	NC Act Status[1]	EPBC Act Status[2]
Reptiles				
Elapidae	*Denisonia maculata*	Ornamental Snake	V	V
Birds				
Apodidae	*Hirundapus caudacutus*	White-throated Needletail	V, SLC	V, Mi
Columbidae	*Geophaps scripta scripta*	Squatter Pigeon (Southern)	V	V
Laridae	*Thalasseus bergii*	Crested Tern	SLC	Mi
Mammals				
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	V
Pseudocheiridae	*Petauroides volans*	Greater Glider	V	V
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	SLC	—

[1] NC Act conservation status: E = Endangered, V = Vulnerable, SLC = Special Least Concern

[2] EPBC Act conservation status: V = Vulnerable; Mi = migratory

10.4.5 Environmentally Sensitive Areas

Endangered REs are considered category B, Environmentally Sensitive Areas (Schedule 19, EP Regulation) and are present in the Project area. Endangered REs recorded in the study area are presented in section 10.4.1. The connectivity of surrounding landscapes in the vicinity of the Project area are relatively low, and the habitats are fragmented and disturbed by historic clearing of native vegetation for cattle grazing. There are some areas of riparian corridors along watercourses with connectivity to habitat. An assessment of Project impacts to habitat fragmentation and connectivity within the study area is presented in Section 10.5.2.4 and assessment of the connectivity of the Project area and surrounding landscape is detailed in Section 10.7.2.

10.4.6 Pest species

Nine introduced fauna species have been recorded within the study area through the detection of scats, tracks, traces, camera trap detection or direct observation:

1) the Cane Toad *(Rhinella marina);*
2) European Cattle *(Bos taurus)*;
3) Wild Dog *(Canis famuiliaris)*;
4) European Red Fox *(Vulpes vulpes)*;
5) Red Deer *(Cervus elaphus)*;
6) Feral Cat *(Felis catus)*;
7) House Mouse *(Mus musculus)*;
8) Rabbit *(Oryctolagus cuniculus)*; and
9) Feral Pig *(Sus scrofa)*.

Six of the introduced fauna species are restricted matters under the Biosecurity Act (Qld).

Thirty-five introduced flora species have been identified within the study area. Of these, seven are listed as restricted matters under the Biosecurity Act (Qld) (Table 10.4).

Table 10.4: State declared introduced flora

Species	**Common name**	**Weeds of National Significance**	***Biosecurity Act 2014* (Qld) status**
Harrisia martinii	Harrisia Cactus	—	Category 3
Parthenium hysterophorus	Parthenium	✓	Category 3
Opuntia stricta	Common Prickly Pear	✓	Category 3
Cardiospermum grandiflorum	Balloon vine	—	Category 3
Lantana camara	Lantana	✓	Category 3
Cryptostegia grandiflora	Rubber Vine	✓	Category 3
Opuntia tomentosa	Velvety Tree Pear	✓	Category 3

No flora pest species identified are listed as Biosecurity Act prohibited matters. However, five of the introduced flora species are identified as Weeds of National Significance. Exotic pasture grasses, such as Buffel Grass, dominated the ground layer in many areas, both within remnant and non-remnant vegetation. A range of other introduced grasses and forbs are also present across the study area in low to moderate abundance (Appendix G, Terrestrial Ecology Assessment, Section 8.4).

10.4.7 Groundwater dependant ecosystems

The Groundwater dependent ecosystems assessment (Appendix I, Groundwater dependent ecosystems, Section 5.2) identified two types of GDEs present within the potential impact area of the Project:

1) Groundwater dependent vegetation developed on drainage features and associated alluvial landforms present along Boomerang Creek and Hughes Creek in the Project area (and Phillips Creek and the Isaac River outside the Project area) (GDE type 1); and

2) Groundwater dependent wetland vegetation developed on a perched groundwater lens to the east of the Project area (GDE type 2).

The identified GDEs are shown in Figure 10.7. Impacts on aquatic ecology values associated with GDEs are considered in Chapter 11, Aquatic Ecology.

Type 1 GDEs present on alluvial landforms use groundwater that is seasonally recharged by surface flows and flooding. The conceptual model of these GDEs is shown in Figure 10.8 and Figure 10.9 (for dry and wet season scenarios). Type 2 GDE on a perched groundwater lens uses water that is recharged from percolating surface water captured at an alluvial unconformity. This GDE is mapped as an HES wetland under the 'Environmental Protection Regulation 2008 (Qld)' and the conceptual model of this GDE is shown in Figure 10.10 and Figure 10.11 (for dry and wet season scenarios). Neither identified GDE type uses water held in regional Tertiary aquifer or coal seams.

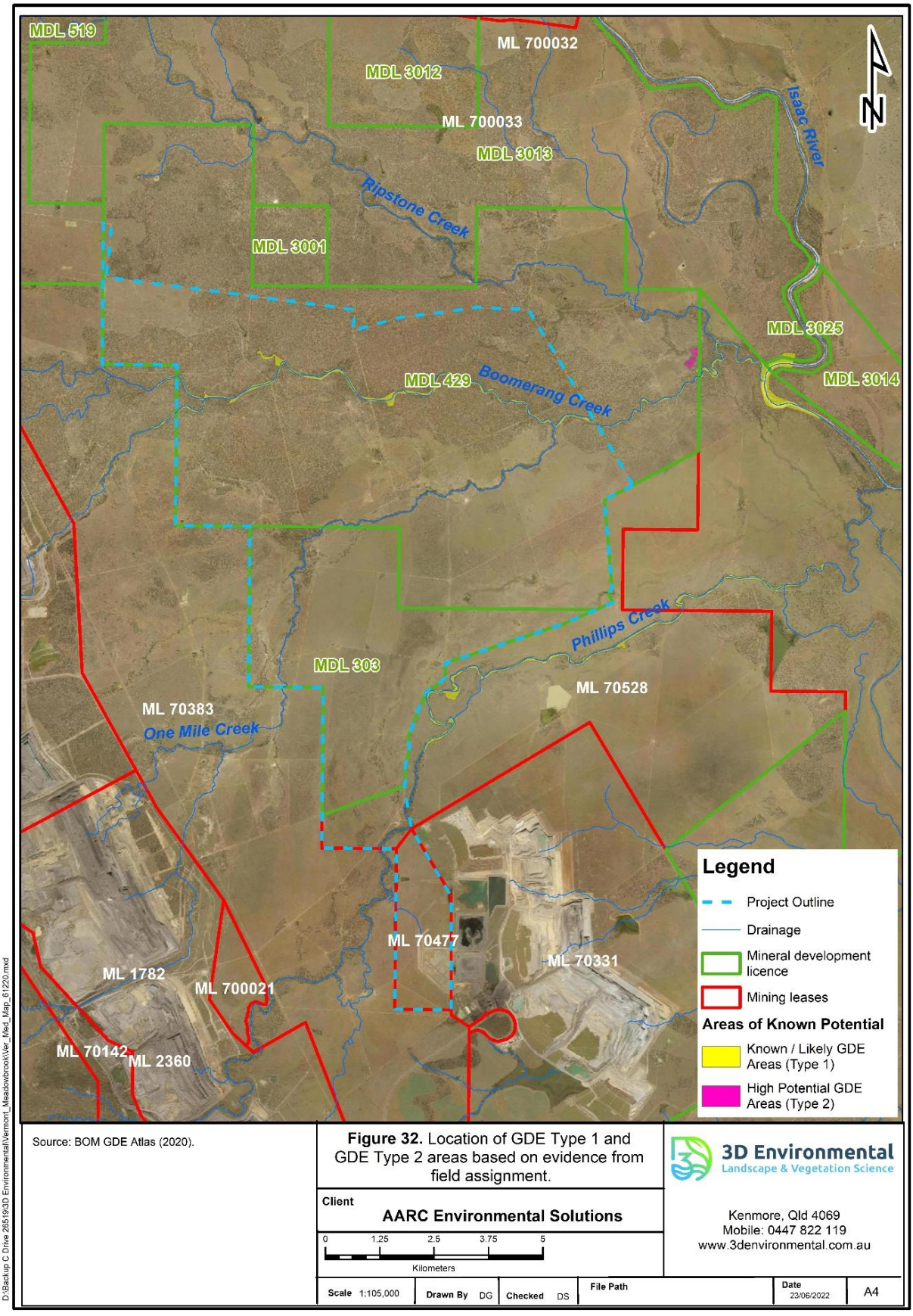

Figure 10.7: Location of GDE Type 1 and GDE Type 2 areas

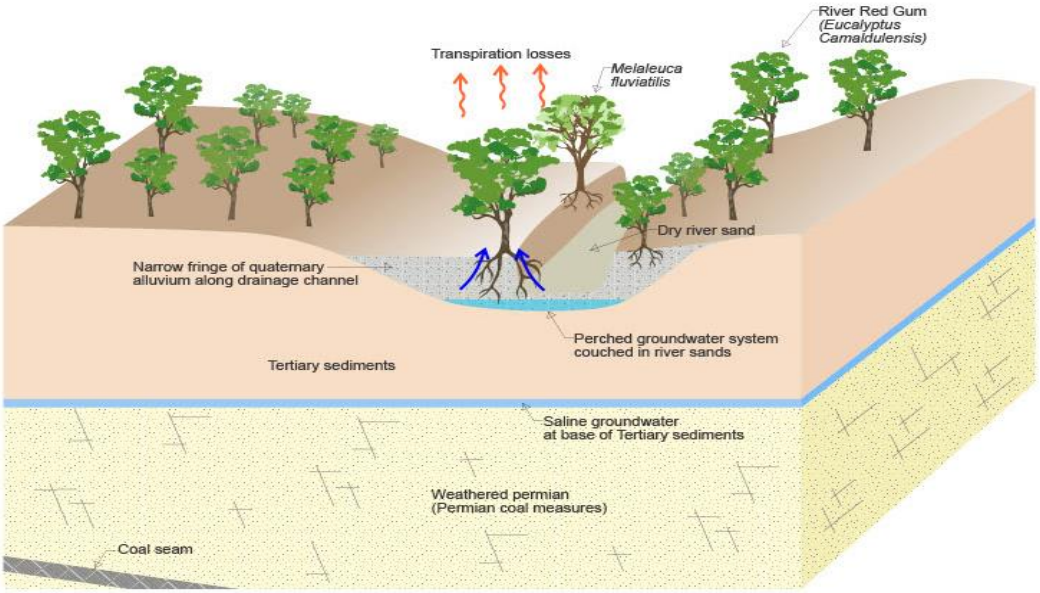

Figure 10.8: Boomerang Creek GDE dry season scenario

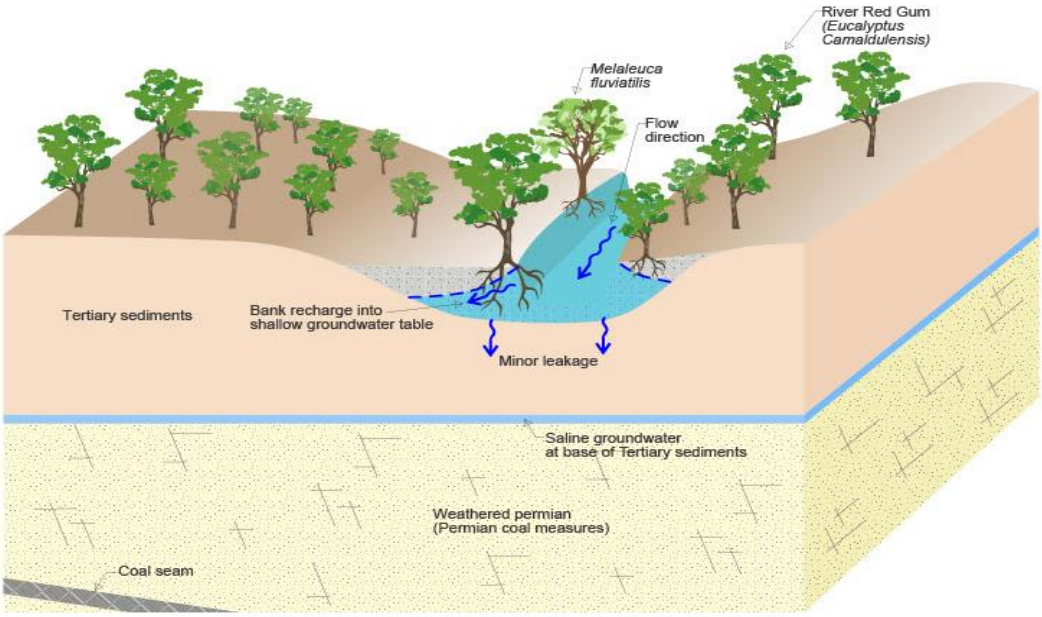

Figure 10.9: Boomerang Creek GDE flooding regime

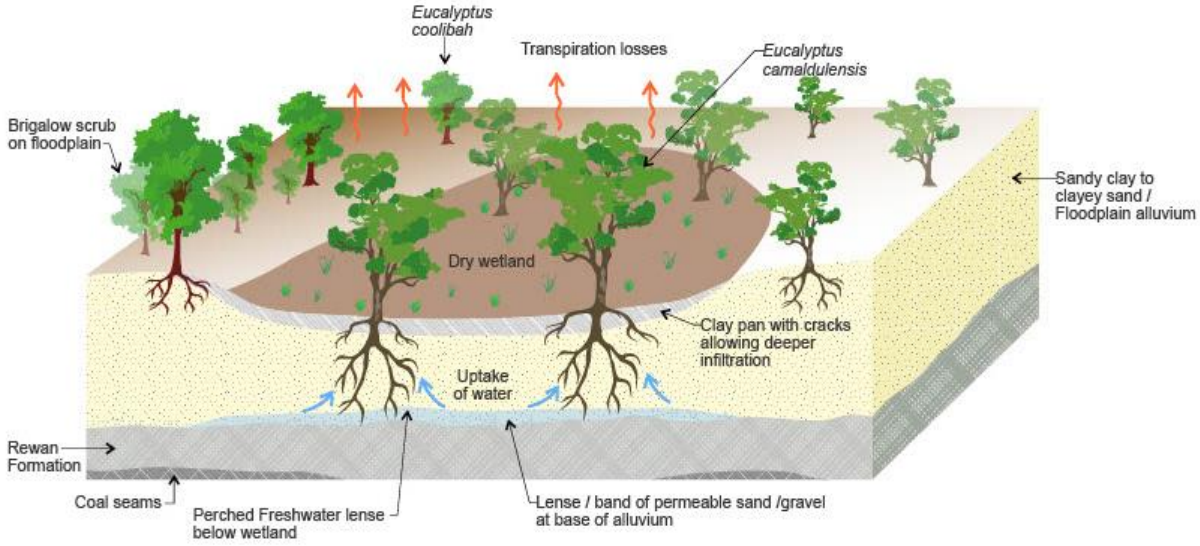

Figure 10.10: Groundwater dependent wetland perched lenses dry season scenario

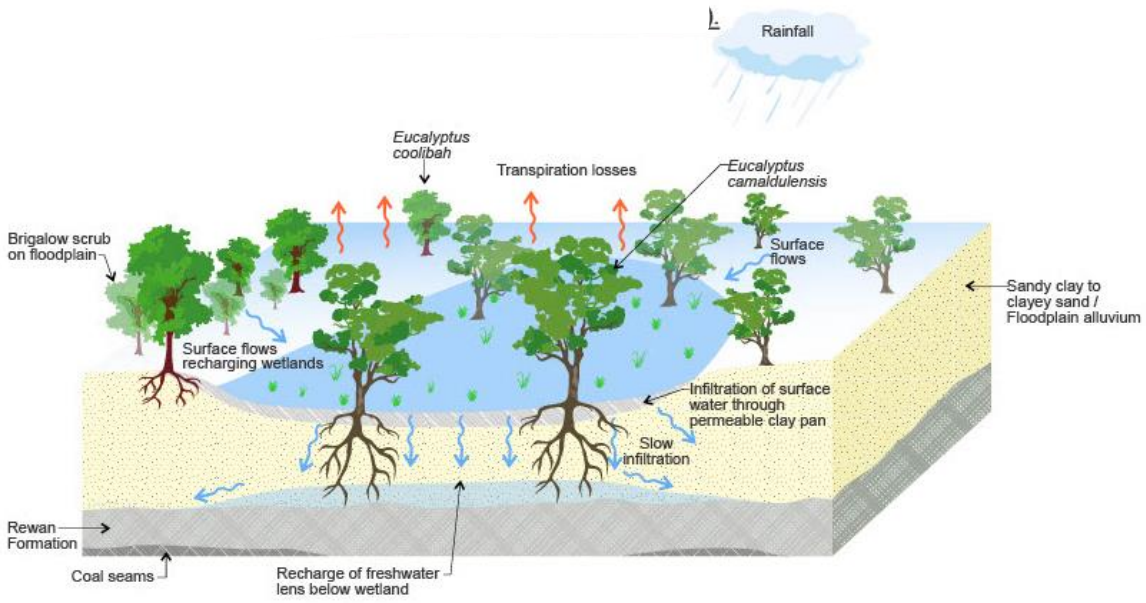

Figure 10.11: Groundwater dependent wetland perched lenses flooding regime

Ten HES wetlands have been identified within the vicinity of the Project. All HES wetlands are assessed to be surface features with limited infiltration of surface water into underlying sediments and no inferred hydraulic linkage between surface waters and groundwater, with the exception of HES wetlands 8 and 10. HES wetland 8 is identified as a type 2 GDE and discussed above, and HES wetland 10 is identified as a potential GDE, or surface feature, and is within the disturbance footprint of the approved Olive Downs project that will be removed by that project (DPM Envirosciences 2018).

10.5 Potential impacts to terrestrial ecology values

This section describes the potential impacts resulting from the Project in relation to flora and fauna values, as identified in Appendix G, Terrestrial Ecology Assessment (Section 10 and 11).

The impact assessment includes consideration of terrestrial ecology impacts associated with all phases of the Project, including construction, operation and decommissioning.

The Project has been considered to comprise four distinct stages of potential impact on terrestrial ecology values, as identified in Figure 10.12, which includes:

1) Stage 1, Project construction—occurs over approximately 2 years (Project Year -1 to Project Year 0);

2) Stage 2, mining of the southern longwall panels—occurs over approximately 8 years (Project Year 1 to Project Year 8);

3) Stage 3, mining of the northern longwall panels—occurs over approximately 15 years (Project Year 9 to Project Year 23); and

4) Stage 4, open-cut pit—occurs over approximately 11 years (Project Year 20 to Project Year 30).

10.5.1 Direct impacts

The majority of the Project area is occupied by cleared agricultural areas that has been subject to past clearance and modification. The Project would require the clearance of approximately 12.2 ha of remnant vegetation over the life of the Project, and the subsidence ponding areas are predicted to affect approximately 96.9 ha.

Native vegetation communities/regional ecosystems that would be cleared due to the Project occur more widely in the surrounding landscapes and subregions. Less than 0.02% of the total remnant regional ecosystems within the Isaac-Comet Downs subregion would be cleared by the Project.

Impacts on terrestrial ecology values will be avoided through Project design where possible, with further mitigation and management measures described in Section 10.8. Where impacts will be unable to be avoided and significant residual impacts are predicted, offsets have been proposed, as described in Section 10.9.

10.5.1.1 Land clearance

Remnant and regrowth vegetation communities within the study area are shown in Figure 10.12. Vegetation will be progressively cleared for the Project, which will impact endangered, of concern and least concern (no concern at present) vegetation communities under the VM Act. Discussions on the impact of subsidence ponding to vegetation is presented in Section 10.5.2.1.

Clearing and impacts from subsidence ponding will cause the removal or degradation of vegetation that also provides suitable habitat for a range of flora and fauna species. The native vegetation communities or REs proposed to be cleared and impacted by the Project are presented in Table 10.5.

The Project footprint includes 801.7 ha of cleared agricultural areas, portions of which provide habitat to fauna species. The portions of cleared agricultural areas within the disturbance footprint identified as providing fauna habitat are outlined in Section 10.8.1. The areas of predicted subsidence and ponding within the cleared agricultural areas are expected to retain their habitat quality post subsidence.

Gas drainage wells will be drilled and drainage equipment temporarily deployed on each underground mining panel in stages as mining progresses. Gas drainage locations will be accessed *via* existing track networks, with the exception of the north-west portion of stage 3, where access will be gained *via* a proposed new access track (Figure 10.12, and Figure 3.2, Chapter 3, Project Description).

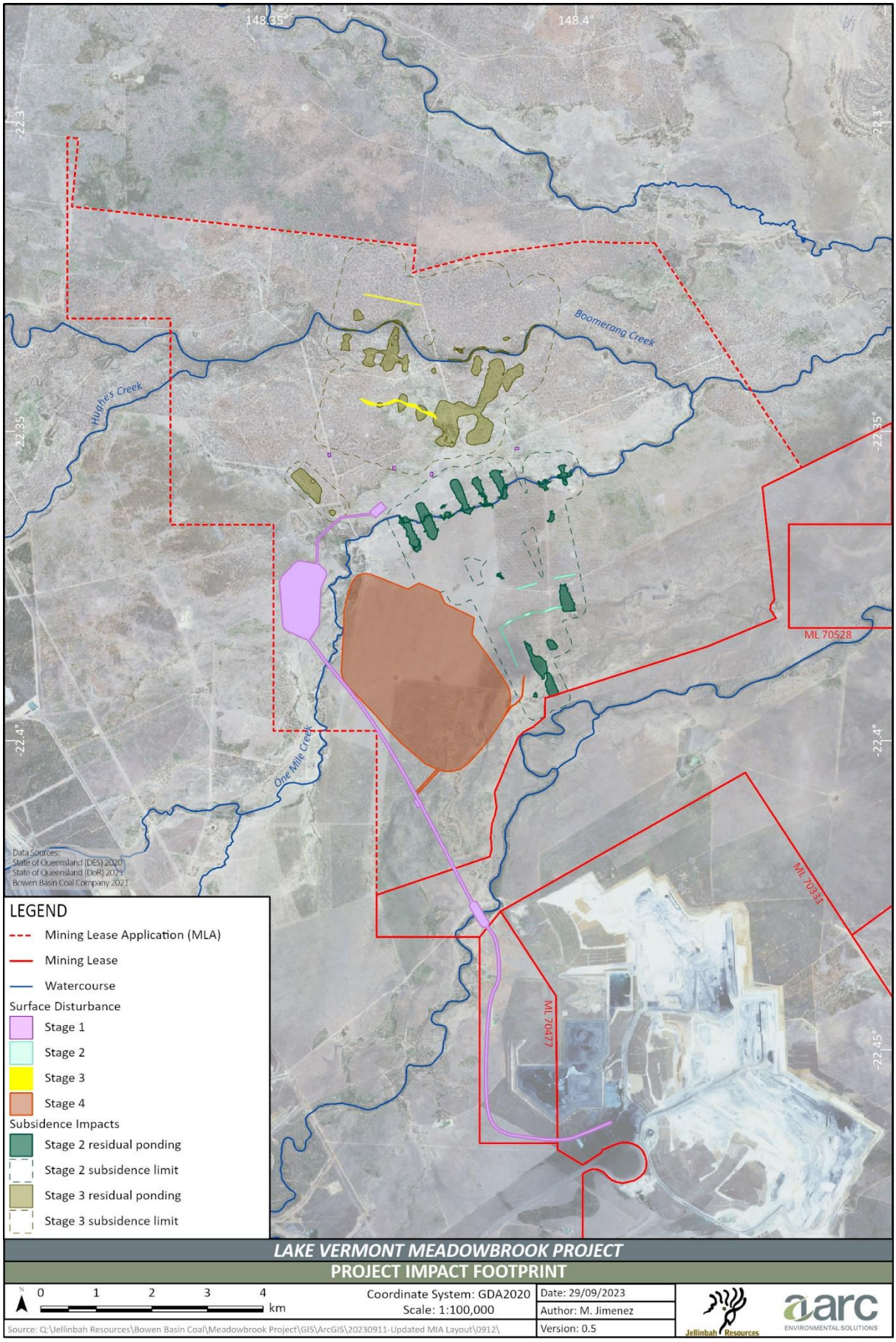

Figure 10.12: Project impact footprint

Table 10.5: Proposed disturbance of vegetation communities

Map unit	Vegetation community	Associated RE	Extent within study area (ha)	Area of disturbance (ha)		
				Stages 1, 2, 3 clearing	Stages 2 and 3 residual ponding	Stage 4 clearing
1: Brigalow Woodlands						
VC 1a	Remnant Brigalow woodland on alluvial plains	11.3.1	106.2	0.3	8.2	3.6
VC 1b	Remnant Dawson Gum woodland with Brigalow on undulating Cainozoic clay plains	11.4.8	51.4	0.3	0.1	3.5
VC 1c	Remnant Brigalow with Yellowwood woodland with occasional Dawson Gum on Cainozoic clay plains	11.4.9	19.4	0.0	0.0	0.0
VC 1d	High-value regrowth Brigalow	—	110.3	1.0	5.1	2.2
2: Eucalypt Woodlands						
VC 2a	Remnant Poplar Box woodland on alluvial plains	11.3.2	960.2	0.0	58.3	0.0
VC 2b	Remnant Coolibah woodland on alluvial plains	11.3.3	12.2	0.0	0.0	0.0
VC 2c	Remnant Eucalypt and Bloodwood spp. woodland on alluvial plains	11.3.4	178.0	0.0	4.9	0.0
VC 2d	Remnant Poplar Gum and Clarkson's Bloodwood woodland on floodplains	11.3.9	22.8	0.3	0.0	0.0
VC 2e	Remnant Poplar Box with occasional Clarkson's Bloodwood and Silver-leaved Ironbark woodland on sand plains	11.5.3	1,593.8	2.6	17.7	0.0
VC 2f	Remnant Poplar Gum woodland on Cainozoic sand plains	11.5.8c	126.5	0.0	0.0	0.0
VC 2g	Remnant Narrow-leaved Red Ironbark woodland on Cainozoic sand plains	11.5.9c	28.0	0.0	0.0	0.0

Map unit	Vegetation community	Associated RE	Extent within study area (ha)	Area of disturbance (ha)		
				Stages 1, 2, 3 clearing	Stages 2 and 3 residual ponding	Stage 4 clearing
VC 2h	Remnant Clarkson's Bloodwood woodland often with a dense, low tree layer dominated by Paperbark Tea-trees	11.5.12	94.5	0.0	0.0	0.0
3: Riparian Woodlands						
VC 3a	Remnant River Red Gum or Blue Gum woodland fringing drainage lines	11.3.25	135.8	1.5	5.2	0.0
4: Vegetation associated with wetlands						
VC 4a	Remnant River Red Gum, Poplar Gum and/or Blue Gum fringing lacustrine wetlands	11.3.27b	10.6	0.0	2.4	0.0
VC 4b	Remnant Coolibah open woodland fringing palustrine wetlands	11.3.27f	11.1	0.1	0.0	0.0
VC 4c	Palustrine swamp with fringing Blue Gum woodland in depressions on Cainozoic sand plains and remnant surfaces	11.5.17	21.3	0.0	0.0	0.0

10.5.1.2 Direct impacts from residual ponding

The proposed underground mining activity will generate subsidence-induced changes to the surface landform, resulting in lower lying areas/surface depressions. Predicted surface depressions will persist post-mining and some portions may hold surface water for a maximum period of several months every few years depending on inflow volumes and soil permeability conditions at the time (Appendix W, Geomorphological Assessment, Section 5.2). These lower lying (subsided) areas of the landform are referred to as areas of residual ponding.

Development of areas of residual ponding is an anticipated change in vegetation structure and composition resultant of the predicted periodic water inundation. For ecological values dependent on standing vegetation, this change has the potential to be equivalent to a direct removal of the habitat (Appendix G, Terrestrial Ecology Assessment, Section 11.1). For the purposes of impact assessment, areas of residual ponding are, therefore, assumed to be subject to a significant residual impact for ecological values dependent on standing vegetation. This is a potentially conservative approach, as inundation may not ultimately be sufficient to permanently alter vegetation structure and composition in these areas. Nonetheless, this conservative approach assumes a worst-case scenario, with ponding modelled to occur infrequently (approximately every few years), rarely to the maximum extend modelled, and ponding areas may be pumped when depths exceed 0.5 m at the deepest location (refer Appendix W, Geomorphology Assessment). Further discussion of the changes induced by ponding to vegetation is presented in Section 10.5.2.1.

The native vegetation communities/REs predicted to be directly impacted by residual ponding are presented in Table 10.5.

10.5.1.3 Changes to flood regime/hydrology affecting wetlands

Potential hydrological impacts on surface water features of the Project area have been identified, with surface water modelling indicating that the Project would result in changes to the hydrology of the watercourses in the Project area (Chapter 9, Flooding and Regulated Structures).

Subsidence-induced troughs (areas of residual ponding) are predicted to develop perpendicular to the One Mile Creek channel and in close proximity to the Boomerang Creek channel (Figure 10.12).

Troughs will be located in accordance with the underlying longwall coal panels, forming as the land subsides following coal extraction. These troughs are considered within the direct impacts of subsidence (Section 10.5.1).

Troughs are expected to become areas of residual ponding, as the depressions will sit lower than the beds of the adjacent watercourses. Changes to the watercourses between troughs and upstream of troughs may also occur. Proposed monitoring of these potential hydrological changes to Boomerang Creek and One Mile Creek are considered through Chapter 11, Aquatic Ecology.

The Project is not expected to have any substantial impact on the stream channel of Phillips Creek (Chapter 8, Surface Water). Surface water modelling indicates that the Project is not expected to result in changes to the surface water hydrology of watercourses such that it would significantly impact terrestrial ecology values. Further, the Project is not expected to result in sufficient changes to flood regimes such that significant impacts on terrestrial ecology values would occur. Changes to flooding regimes are considered in Chapter 9, Flooding and Regulated Structures, and Chapter 11, Aquatic Ecology.

Hydraulic modelling has determined that subsidence will likely cause alteration to the hydrology of three VM Act wetlands. Potential impacts on these wetlands (which are within the stage 3 underground mining footprint) are assessed in Section 10.7. No HES wetlands are within the Project footprint. Potential Project impacts on HES wetlands are discussed in Section 10.4.7 and in Chapter 11, Aquatic Ecology.

10.5.2 Indirect impacts

10.5.2.1 Subsidence

The proposed underground mining will cause surface subsidence. Subsidence predictions are presented in Appendix A, Subsidence Assessment (Section 4), and predicted impacts on surface water values are presented in Appendix F, Surface Water Assessment (Section 7.7.3).

Subsidence vertical movement is predicted to occur over the underground mining areas to a maximum depth of 2.9 m for the stage 2 southern mining area and a maximum depth of 5 m for the stage 3 northern mining area. The maximum horizontal ground movements will typically be less than 1 m in the stage 2 southern mining area and up to 1.6 m in the stage 3 northern mining area. The maximum tilt modelled to develop from subsidence is 38 mm/m. These subsidence effects are expected to develop within six weeks after single seam longwall mining is completed (Appendix A, Subsidence Assessment, Section 4.5).

Surface cracking

Some surface soil cracking is also predicted as a result of subsidence. Tension cracks are expected to develop and close after short periods as the transient tensile strain passes above the retreating longwall. Longer lasting tension cracks can develop in areas of residual tensile strain, which may occur around the perimeter of each longwall panel.

Maximum surface crack widths of up to 200 mm are predicted above the shallower underground mining areas, with a maximum of 50 mm crack widths above the deeper underground mining areas. Cracking depths are predicted to be predominantly less than 1 m up to a potential maximum of 15 m, with no connective cracking from the surface to the mined seams.

Soils affected by cracking are predominantly expected to self-ameliorate through wetting/drying cycles, particularly in areas with shrink swell vertosols which are dominant in the stage 2 underground mining subsidence area and the southeast portion of the stage 3 underground mining subsidence area (refer to Chapter 5, Land Resources). Soil cracks that do not resolve are expected to be amenable to small scale crack rehabilitation involving excavating and backfilling. Monitoring of cracking will be undertaken in accordance with a Subsidence Management Plan prepared for the Project, to facilitate an opportunity for cracking to self-heal, therefore avoiding further disturbance associated with rehabilitation works.

Surface cracking of the size and scale predicted, is not expected to result in impacts to vegetation, however if surface cracking creates conditions which allow soil erosion to develop, vegetation could be impacted as a result of erosion. Erosion will be monitored as part of the proposed Subsidence Management Plan.

Surface crack rehabilitation

If required, crack rehabilitation works will be initiated in consideration of locations of conservation significant species and ecosystems, with work to be undertaken without machinery where possible. The Subsidence Management Plan will integrate an adaptive soil crack management approach such that, where unpredicted subsidence impacts and environmental consequences occur, previously approved processes will be considered to prevent their reoccurrence. Crack management and rehabilitation will include the following:

- surveys for persistent surface cracking;
- scarifying or ripping of minor cracks using light machinery;
- removal of topsoil from cracked areas, excavation and backfilling, and re-spreading topsoil to affected areas;
- natural regeneration through soil seed bank, rootstock material and recruitment; and
- post rehabilitation monitoring.

Rehabilitation work to repair cracking that does not self heal, is expected to be limited to areas of a maximum of three meters wide and will not require the removal of trees. Livestock will be excluded from areas undergoing active subsidence and will not be present in areas subject to crack rehabilitation. The rehabilitation of soil erosion is further detailed in Chapter 5, Land Resources.

Predicted impacts from surface cracking and crack rehabilitation

Tension cracks may form around the perimeter of each longwall panel and the nature and persistence of cracks will be dependent on the depth of cover, panel and pillar width, geology and soil properties. Where persistent soil cracks develop (and are not observed to be self-healing) crack rehabilitation will be conducted in accordance with the Subsidence Management Plan. The rehabilitation of soil cracks will not require any routine clearing of vegetation and will only be conducted where cracks fail to self-ameliorate and/or erosion is observed to be developing. Trees will not be removed for crack rehabilitation. Crack rehabilitation works will be conducted with light machinery and targeted to affected areas in an approach that avoids clearing of understory vegetation. Where targeted understory vegetation removal is required for crack rehabilitation, the site will be immediately remediated, and re-vegetation will be started. Rehabilitated areas will remain under observation to allow monitoring of success of the approaches used.

Where soil cracks are temporary and self-ameliorating, they are not expected to cause any significant impacts to vegetation and fauna habitat quality. The remediation of soil cracks is expected to adequately rehabilitate persistent cracking and the rehabilitation works are not expected to result in significant impacts to terrestrial ecology values.

Subsidence and ponding area impacts

The surface water assessment has identified the areas within the subsidence footprint that will develop potential for residual ponding (post-mining). Mitigation measures to minimise ponding by facilitating drainage in the subsidence footprint have been designed and incorporated into the Project design to minimise the extent of subsidence-induced ponding (Appendix F, Flood Modelling Assessment Report, Section 2.1). Areas subject to predicted residual ponding which cannot be mitigated by drainage works are predicted to experience ponding during flooding events for a maximum period of several months in every few years, although ponding areas may also be pumped when depth exceeds 0.5 m at the deepest location, further minimising ponding extents and duration (refer Appendix W, Geomorphological Assessment). As discussed in Section 10.5.1.2, this changed hydrological regime is considered to be potentially deleterious to the existing vegetation communities particularly ecological values associated with tree species (Appendix G, Terrestrial Ecology Assessment, Section 10.2).

Outside of predicted ponding areas, the broader subsidence footprint is expected to demonstrate no material changes to the surface landform, with impacts to have a short duration (i.e. land movement once the panel is mined). Subsidence-induced changes to the surface landform are not expected to impact ecological values, outside of areas where residual ponding is resultant or disturbance for mitigation works is proposed. Mitigated ponding and subsidence areas are presented in Figure 10.12 and discussed in Chapter 11, Aquatic Ecology. The design of subsidence mitigation works (mitigation drains and mitigation bunds) are overviewed in Chapter 9, Flooding and Regulated Structures.

Monitoring results from similar mining operations in the Bowen Basin have demonstrated that subsidence from underground mining has no broad patterns of impact on vegetation. An assessment of subsidence impacts on vegetation for comparable operations has identified that there would be no change in woodland canopy height or projected foliar cover over the entire longwall panel area (Eco Logical Australia 2015), including the most subsided areas that are likely to be inundated with ponding. Subsidence monitoring of additional existing underground mining projects in the Bowen Basin indicates that subsidence impacts can be minor and non-damaging to the viability and habitat provision of open Eucalypt Woodland and riverine woodland vegetation. At the Grosvenor project, monitoring of impacts on vegetation demonstrates that subsidence-affected areas show no substantial deleterious impact on vegetation conditions in areas of Eucalypt Woodlands (including areas of Poplar Box vegetation, RE 11.3.2) and Brigalow Woodlands (including RE 11.4.9). This is based on an assessment of:

- habitat continuity;
- vegetation cover;
- dominance of natives;
- debris; and
- other indicative features (Engeny 2020).

At the Moranbah North project, monitoring demonstrates that the condition of vegetation impacted by subsidence and waterway diversion is comparable to control sites (Engeny 2021).

Notwithstanding the prediction that the expected subsidence will not result in the death of vegetation, for the purposes of the Project terrestrial ecology assessment, the impact to vegetation from residual ponding is considered to be equivalent to the clearance of tree species and as a result, habitat values dependent on trees. This represents a conservative assessment of the potential subsidence impacts, and it is possible that the Subsidence Management Plan measures will avoid and mitigate potential impacts. The habitat values provided by cleared agricultural areas are considered to be retained, despite residual ponding development, because the pre-mining conditions of these areas involve intermittent ponding of gilgai depressions which will continue post-subsidence and the pre-mining conditions do not include the presence of tree species expected to be susceptible to impact from intermittent ponding. The areas of ponding impact on vegetation communities is presented in Table 10.5. The portions of the subsidence footprint not predicted to undergo ponding are expected to retain viability and continue provision of habitat values and are, therefore, considered not to be subject to any substantial impacts resulting from subsidence.

10.5.2.2 Changes to hydrology

Surface water flows

Hydrological modelling and predicted changes to surface water flows are presented in Appendix Z, Flood Modelling Assessment Report (Section 2).

As identified, the Project subsidence is expected to result in a series of troughs (residual ponds) within the Boomerang Creek channel. Approximately six small troughs are anticipated, and these troughs are predicted to be limited to the sandy stream bed, and not alter the adjacent riparian vegetation. Channel velocity decrease and aggradation of sediment into the stream bed will be promoted in any troughs within the channel bed. Channel velocity increase where the creek drains into the subsided zone is predicted, with potential for marginal increase in bank erosion in this section of the stream. The pillars between subsidence troughs are expected to undergo some initial bed erosion; however, the grade is expected to revert to a pre-mining grade as troughs infill with sediment, which is abundant upstream in Boomerang Creek.

The Project is also expected to result in a series of eight troughs (residual ponds) across the One Mile Creek channel bed which will connect to residual ponding areas up to 500 m from the stream channel. Channel velocity decrease and aggradation of sediment into the stream bed will be promoted in these troughs. Channel velocity increase where the creek drains into the subsidence zone is also predicted, and there is potential for marginal increases in bank erosion in this section of the creek. Channel velocity and bed erosion is expected where the channel enters the second to fifth subsidence troughs. The pillars between subsidence troughs are expected to undergo some bed erosion, with the infilling of subsidence troughs expected to require a long time, as infilling is anticipated to be limited by the supply of sediment due to the existing farm dam upstream of the area. The troughs are predicted to extend into adjacent riparian vegetation, including riparian Brigalow TEC vegetation with impacts to this vegetation assessed in Section 10.6.1.

The Philips Creek channel is not predicted to be impacted by subsidence. Hydrological modelling predicts that potential minor impacts to the flooding and drainage of the Philips Creek flood plain will be mitigated by proposed subsidence ponding mitigation. No impacts to the catchment or stream channel of Philips Creek are predicted (Appendix F, Surface Water Assessment, Section 7.4.3).

The Subsidence Management Plan will include measures for the monitoring of creek morphology and stream bed and bank impacts. Where erosion of stream banks with demonstrable impact on channel form is identified bank protection measures will be considered (Appendix F, Surface Water Assessment, Section 7.4.4). The bank protection measures are expected to be effective in securing stream banks from erosive processes and prevent the impact to terrestrial ecology values including riparian vegetation along subsidence affected watercourses. Notwithstanding this, it should be noted that the predicted ponding areas include the subsidence troughs in Boomerang Creek and One Mile Creek and these predicted ponding areas are considered to be subject to impacts to vegetation comparable to the removal of vegetation (refer Section 10.5.2.1).

There are no predicted impacts on terrestrial ecology values due to changes to surface water flows from the Project. The terrestrial ecology impacts of periodically inundated ponds in subsidence troughs that intersect watercourses is presented in section 10.5.2.

Changes to flood regimes

The predicted changes to flooding regimes as a result of the Project are identified in Chapter 9, Flooding and Regulated Structures. During flood events, the extent of inundation is predicted to be increased at the margins of subsided areas.

Peak flood levels within the subsidence zone are predicted to reduce during flood events, and flow velocities will significantly reduce as water is stored in subsided areas. One Mile Creek shares a floodplain with Boomerang Creek. Within the subsidence zone of the shared One Mile Creek and Boomerang Creek floodplain, peak flood levels would be reduced during flood events for flood events approximately 2% AEP and smaller. For flood events larger than 2% AEP, the impact of predicted subsidence on peak flood levels would be minimal.

Across the entire flood plain, flow velocities are predicted to decrease in portions of the floodplain where water is stored in subsided areas and increase in areas where overbank floodwater drains into subsidence troughs. The increased velocities are predicted to generally remain below 0.75 m/s for a 50% AEP event and 1 m/s for a 2% AEP event, which are predicted to be unlikely to significantly alter floodplain morphology.

The predicted changes to flood hydrology are not predicted to result in any significant impacts on terrestrial ecology values. The functions of flood regimes are expected to be retained for vegetation and habitat features, including areas of gilgai features, which undergo inundation in periodic flood conditions.

10.5.2.3 Impacts to GDEs

Groundwater drawdown

The potential groundwater drawdown impact to GDEs is assessed in Appendix I, Groundwater Dependent Ecosystem Assessment (Section 6). Proposed underground mining development will result in drawdown within the Tertiary aquifer and Quaternary alluvium. Modelling indicates Tertiary aquifer drawdown will occur beneath the Type 1 GDEs along Boomerang Creek and Phillips Creek, and approximately 2 m of drawdown will occur in Tertiary and Quaternary aquifers beneath the Type 2 GDEs. Predicted drawdown in relation to GDEs is shown in Figure 10.13.

The recharge to the perched lens sustaining the type 2 GDE is controlled by surface water infiltration, which will not be substantially impacted by the Project. Recharge is controlled by surface flows, and although drawdown in the Tertiary aquifer beneath the GDE may contribute to marginally increased rates of drying and drainage, the overall risk to the GDE function is considered to be low (Appendix I, Groundwater Dependent Ecosystem Assessment, Section 6.2.3).

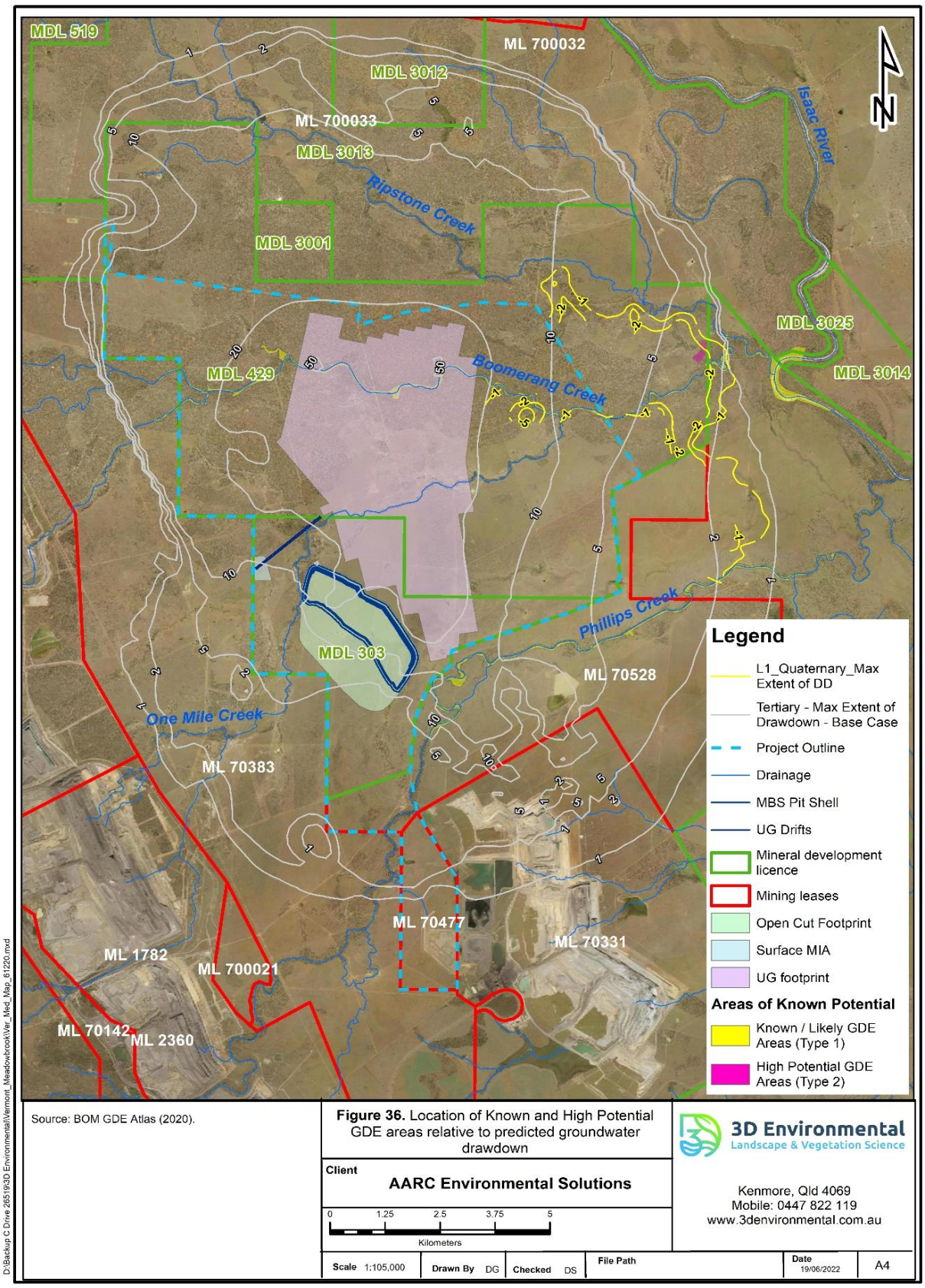

Figure 10.13: Location of known and potential GDEs relative to drawdown

The predicted drawdown may result in more rapid drainage in the perched alluvial groundwater systems that underly Type 1 GDEs on drainage features and alluvial landforms of Boomerang Creek and Phillips Creek. The recharge to alluvial systems sustaining alluvial GDEs is controlled by surface flows and water infiltration, with the groundwater subject to natural fluctuations in response to changing seasonal conditions. The tree species that characterise the vegetation of both GDE types are resilient to the possible reductions in soil moisture availability that may propagate as a result of groundwater drawdown in the Project area. The assessment, therefore, considers the Project to present a low risk to GDEs. (Appendix I, Groundwater Dependent Ecosystem Assessment, Section 7).

Groundwater quality

The potential groundwater quality impact to GDEs is assessed in Appendix I, Groundwater Dependent Ecosystem Assessment (Section 6). The discontinuous groundwater system which supports all types of GDEs identified in the study area is underlain by partially confined saline groundwater systems associated with the regional Tertiary aquifer and aquifers associated with the Permian sediments and coal measures. There is no risk of upward propagation of saline groundwater into the seasonal alluvial or perched lens groundwater system that supports GDEs. Project rock spoil is expected to generate low salinity runoff and seepage that will be contained by sediment dams, with no controlled releases of mine-affected water proposed. Therefore, the risk of water quality changes impacting GDEs is considered low (Appendix I, Groundwater Dependent ecosystem Assessment, Section 6.2.5).

Summary

Drawing on information on GDE presence and function, a risk assessment has been prepared to consider the likelihood of a particular impact occurring, as well as the potential consequences should that impact occur (Table 10.6). The tables presenting likelihood and consequences applied to the risk assessment are detailed in Appendix I, Groundwater Dependent Ecosystem Assessment (Section 6.5). The Project is not expected to significantly impact GDEs. Monitoring of GDEs is also proposed to continue as part of the Project development, as detailed in Section 10.8.3.

10.5.2.4 Habitat fragmentation and connectivity

Land clearing has the potential to fragment vegetation remnants and impact on the continuity of corridors. As described in Section 10.5.1, the majority of vegetation clearance for the Project will occur in the MIA, infrastructure corridor and open-cut mining area. The landscape within which these components are proposed to be situated is already fragmented from nearby areas of woodland vegetation.

The northern portion of the study area contains a large contiguous area of remnant vegetation that provides fauna with significant dispersal opportunities. The relatively small (and temporary) areas of disturbance associated with temporary Project activities (such as gas wells) and residual ponding are unlikely to limit the opportunities for faunal dispersal through the woodland habitats.

Riparian corridors associated with Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek provide east–west fauna movement opportunities through the landscape. The riparian vegetation along these streams is mapped as regionally significant (Boomerang Creek, Hughes Creek, One Mile Creek) or State significant (Phillips Creek) corridors connecting to State significant riparian vegetation along the Isaac River. The riparian corridors associated with these streams provide species with opportunities for movement and dispersal, particularly the Koala and Greater Glider.

While the Project infrastructure corridor primarily traverses cleared agricultural areas, it will also traverse the riparian corridors of Phillips Creek and One Mile Creek. The proposed infrastructure corridor will fragment the riparian vegetation at these locations and may impact on species' ability to disperse along the riparian corridors. The predicted residual ponding along One Mile Creek may impact on species' ability to disperse through the ponding areas. However, although the assessment conservatively considers these areas to be significantly impacted, vegetation will not be cleared, no Project infrastructure will be constructed in riparian subsidence areas to inhibit dispersal and ponding will be infrequent (some extent of ponding expected every

few years and lasting for up to a few months) and therefore no significant impacts to connectivity are expected to result from this predicted ponding.

The avoidance, mitigation and management measures described for direct vegetation clearance/habitat disturbance (Section 5.1) are also relevant to minimising habitat fragmentation and impacts on connectivity.

Table 10.6: Risk assessment for potential impacts to GDEs and residual risk scores

Impact Pathway*	Pre-mitigated Risk			Comments	Management/Mitigation Measures*	Residual Risk Ranking		
	Likelihood	Consequence	Risk			Likelihood	Consequence	Risk
Direct clearing of a GDE	1	Severe	Insignificant	No clearing of GDEs will be undertaken. Margins of GDE habitat should be flagged to ensure no disturbance zones are adhered to.	GDE avoidance	1	Negligible	Insignificant
A total or partial loss or reduction in the volume or pressure of the aquifer being utilised by Type 1 GDEs	2	Moderate	Low	The alluvial groundwater system that supports Type 1 GDEs is perched above the regional aquifer associated with Tertiary sediments and coal seams. Loss of aquifer pressure resulting in up to 10 m of drawdown is predicted for the Tertiary aquifer below Boomerang Creek. This may increase downward drainage from creek alluvium into Tertiary sediments, with some resultant reduction in volume of the perched aquifer that supports Type 1 GDEs during periods of extended drying/ drought. The adaptability of the dominant riparian species to ecological change would suggest these impacts will be 'Low' in areas where aquifer drawdown response is greatest (i.e. >5 m drawdown along Boomerang Creek), and the risk to GDE function will decrease with decreasing levels of drawdown and become insignificant when 'end of mining' drawdown is <1m.	Baseline data collection/Monitoring, Operation of the Project under the existing Lake Vermont Mine EA, including adoption/updating of the existing Lake Vermont Mine Water Management Plan and continued Project groundwater monitoring	2	Moderate	Low

Impact Pathway*	Pre-mitigated Risk			Comments	Management/Mitigation Measures*	Residual Risk Ranking		
	Likelihood	Consequence	Risk			Likelihood	Consequence	Risk
A total or partial loss or reduction in the volume or pressure of the aquifer being utilised by Type 2 GDEs	3	Moderate	Moderate	Risk to the ecohydrological function of Type 2 GDEs requires further baseline data collection to adequately assess. Groundwater modelling indicates <5 m of drawdown in Tertiary sediments associated with HES Wetland 8, which may result in more rapid drying and drainage of the groundwater lens being conceptualised to support GDE function. While recharge of the groundwater lens is *via* surface flow pathways, increased drainage and drawdown may reduce the persistence of the groundwater lens during seasonally dry periods, resulting in declines in the health of terrestrial GDEs.	Baseline data collection/Monitoring, Operation of the Project under the existing Lake Vermont Mine EA, including adoption/updating of the existing Lake Vermont Mine Water Management Plan and continued Project groundwater monitoring	2	Low	Low
A change in the magnitude and timing of volume fluctuations in the aquifer being utilised by GDEs	2	Moderate	Low	Volume fluctuations in the perched groundwater system are regulated by surface flows and local surface water infiltration. These processes will not be impacted during mine development or operation. There will be no direct impact to the integrity of the perched groundwater systems that support Type 1 GDEs. For Type 2 GDEs, increased drainage of perched groundwater may result in more rapid drying and drainage of the supporting groundwater lens, although the impact of this to ecohydrological function is considered to be 'Low'.	Baseline data collection/Monitoring, Operation of the Project under the existing Lake Vermont Mine EA, including adoption/updating of the existing Lake Vermont Mine Water Management Plan and continued Project groundwater monitoring	1	Low	Insignificant

Impact Pathway*	Pre-mitigated Risk			Comments	Management/Mitigation Measures*	Residual Risk Ranking		
	Likelihood	Consequence	Risk			Likelihood	Consequence	Risk
Changes to the interaction between surface flows and aquifers being utilised by a GDE	2	Low	Low	There will be no change to the period between, and timing of, floods or significant rainfall events. These stochastic events provide the dominant control of the fluctuations of groundwater which support GDEs.	Baseline data collection / Monitoring, Operation of the Project under the existing Lake Vermont Mine EA including adoption/updating of the existing Lake Vermont Mine Water Management Plan, and continued Project groundwater monitoring.	1	Low	Insignificant
Change in chemical composition of an aquifer detrimentally impacting the health of a GDE1	2	Low	Low	Controlled releases of mine-affected water that has the potential to impact the chemical composition of infiltrating surface waters will not occur during the life of the mine.	Baseline data collection/Monitoring, Operation of the Project under the existing Lake Vermont Mine EA, including adoption/updating of the existing Lake Vermont Mine Water Management Plan and continued Project groundwater monitoring	1	Low	Insignificant

*Management measures are applied during implementation of a project GDEMMP, after which mitigations can be applied if significant impact GDE function and health is detected.

10.5.2.5 Weeds and pest species

Given the existing disturbance and presence of weeds throughout the Project area (Section 10.4.6), the proposed Project is considered unlikely to increase weed populations or result in the introduction of new weed species.

Pest animal species are already present within the Project area (Section 10.4.6) and impact the terrestrial ecology values, including through the following listed key threatening processes under the EPBC Act:

- biological effects, including lethal toxic ingestion, caused by Cane Toads *(Bufo marinus);*
- predation by the European red fox;
- predation by feral cats;
- predation, habitat degradation, competition and disease transmission by Feral Pigs; and
- competition and land degradation by rabbits.

The provision of scavenging areas (e.g. discarded food scraps and other rubbish) has the potential to increase populations of introduced fauna species in or around the Project area. This risk will be managed through the operation of the Lake Vermont Mine 'Waste Management Plan', which will be updated to manage the risks associated with the Project.

10.5.2.6 Noise and vibration

Noise and vibration associated with construction and operation of the Project has the potential to disrupt the routine activities of fauna species.

Potential sources of noise or vibration in the proposed underground mining area include the ventilation shafts, vehicle movements and the operation of equipment (e.g. haulage trucks, loaders, dozers, drill rigs, compressors and other drilling-related equipment).

The potential for noise and vibration generation in the proposed underground mining area is expected to be low. Construction-related noise generating activities in the underground mining area will typically be localised and of short duration and may induce small movements of fauna species.

The indirect noise impacts on the woodland and other habitats from the open-cut mining activities proposed to be undertaken in the latter stages of the Project, including noise impacts from vehicle movements on the haul road, will be localised and minor, as fauna often readily habituate to continuous noise. While sudden noise (e.g. blasting activities) has the potential to startle native fauna, animals are likely to adapt to the disturbance and/or move to similar habitats in the surrounding landscape.

10.5.2.7 Dust

The proposed construction and mining activities have the ability to generate dust, which has the potential to impact vegetation and fauna. Excessive dust generation can impact on the health and viability of surrounding vegetation. The potential for dust generation in the proposed underground mining area is expected to be low and limited to short-term construction activities (e.g. ventilation shafts or drainage wells) or vehicle movements. Recent studies on the impacts of dust from unsealed roads on vegetation and fauna (Cumberland Ecology 2015; Jones *et al.* 2016) found no evidence that dust has any detrimental impacts on vegetation or fauna abundance. Notwithstanding, personnel and contractors will be required to observe speed limits when driving on access tracks within the underground mining area and surrounds to minimise the generation of dust.

Air quality modelling for the Project has been undertaken, with predictions of dust deposition rates in compliance with the existing Lake Vermont Mine EA limits at all sensitive receptors (Appendix L, Air Quality and GHG Assessment, Section 3.6). The primary haul road from the Project MIA to the existing Lake Vermont Mine CHPP will be sealed to minimise the generation of dust.

Open-cut mining operations and exposed surface areas (e.g. windblown emissions from ROM stockpiles) have the greatest potential to result in the generation and dispersion of atmospheric dust.

Dust control measures will continue to be employed (consistent with the existing Lake Vermont Mine), including the watering of potential dust generating surfaces (to minimise dust emissions) and the progressive rehabilitation of disturbance areas (such as mine waste rock emplacements) to reduce the potential for dust generation.

Given the predicted dust deposition associated with the Project (Appendix L, Air Quality and GHG Assessment, Section 3.6), the risk of impact on the health and viability of surrounding vegetation is considered very low. It is noted that the Project mining activity is primarily underground, with existing coal production levels to be maintained, as opposed to increased.

10.5.2.8 Artificial lighting

Artificial lighting will be established in the Project area, including within the MIA and infrastructure corridor. Project lighting has the potential to affect behavioural patterns of some species. Some bird and bat species, for example, are attracted to insects around lights and could become prey for larger predators (e.g. owls). Artificial lighting can also attract predators and invasive pests, both of which may pose a threat to native fauna (DoEE 2020).

All exterior lighting will be designed to provide a safe working environment. Australian Standard AS/NZS 4282:2019 'Control of the obtrusive effects of outdoor lighting' (Standards Australia 2019) recognises the impact of artificial light on biota (DoEE 2020). To minimise potential impacts of artificial lighting, the placement, configuration and direction of lighting for the Project will be implemented in consideration of this Australian Standard.

10.5.2.9 Vehicle strikes

The movement of vehicles has the potential to increase the incidence of fauna mortality *via* vehicular strikes. Ground-dwelling fauna are most susceptible to this potential impact. The risk of injury or mortality from vehicle strikes is greatest where roads cross fauna movement corridors. The Project infrastructure corridor primarily traverses cleared agricultural areas; however, it will also traverse the riparian corridors of Phillips Creek and One Mile Creek.

A significant contributing risk factor for vehicle strikes is the speed of vehicles. Limiting speed can, therefore, reduce the threat of vehicle strikes to fauna species, such as Koala (DES 2019b). Speed limits will be imposed on roads and tracks within the Project area to reduce the risk of vehicle strikes on native fauna. Safe driving procedures will also be incorporated into site inductions to increase awareness of the risk of vehicle strikes.

10.5.2.10 Bushfire

While plants and animals have a range of mechanisms to survive individual fires, accidental bushfires could potentially occur if mine activities are not appropriately managed. Bushfire prevention and management measures will be implemented for the Project, and fire awareness will be included in the induction of personnel and contractors to minimise the risk of bushfire. Given the implementation of management measures, the Project is unlikely to increase the bushfire potential within the surrounding landscape.

10.5.2.11 Erosion and sedimentation

The Project has the potential to result in erosion of disturbed areas and sedimentation of waterways through the following:

- clearing of vegetation for the development of open-cut pits;
- construction of haul roads and other infrastructure;

- erosion facilitated by soil cracking resultant of surface subsidence; and
- hydrological changes to watercourses due to subsidence.

Vegetation clearance protocols and erosion and sediment control measures will be implemented to minimise potential impacts, as described in section 10.8. Potential erosion resulting from subsidence and soil cracking and erosion of watercourses is considered in section 5.4.1.

10.5.3 Facilitated impacts

Facilitated impacts relate to impacts from other Projects (including by third parties) which are made possible (facilitated) by the Project being assessed (this Project). Facilitated impacts may be expected to occur through the development of an infrastructure project (e.g. a dam, road or rail line) where that development would enable the development of other projects that otherwise may not have been viable (e.g. the development of a road leads to urban development in an undeveloped area).

Given the proposed Project is a continuation of an existing mining operation, the Project will not develop any infrastructure that will facilitate the development of any other Projects. Mining operations will not facilitate the development of any other Projects that could not already be developed. Proposed electrical, water supply and telecommunications infrastructure will link to existing infrastructure at the Lake Vermont Mine and will not facilitate the development of other future projects.

Post-mining, it is proposed that the Project will be reinstated to grazing lands at a similar suitability to that existing prior to mining (Chapter 6, Rehabilitation). It is not considered that the return of lands to an agricultural land use will facilitate the development of projects which would cause additional (facilitated) impacts on those identified for the Project.

As such, there is not expected to be any facilitated impacts from the Project on any flora or fauna values.

10.5.4 Cumulative impacts

Cumulative impacts can be defined as the total impact on the environment resulting from the incremental impacts of the action (the Project) added to other past, present and reasonably foreseeable future actions. Cumulative impacts include direct and indirect impacts on the environment.

Resource developments (approved and proposed) that occur near the Project are provided in Chapter 3, Project Description and shown on Figure 3.1. The majority of nearby developments are approved developments, with the most recent being the Olive Downs Coking Coal Project (in 2020) and the Vulcan Project (September 2021). Other developments currently subject to government assessment include the Saraji East Project and the Winchester South Project.

The Project provides for the continuation and extension of the existing Lake Vermont Mine which is authorised for impacts to prescribed environmental matters including the following:

- regulated vegetation for REs occurring within a defined distance of a relevant watercourse or wetland;
    - RE 11.3.25 within defined distance of relevant watercourse– 28.4 ha;
    - RE 11.3.27 within defined distance of relevant wetland– 3.9 ha; and
- protected wildlife habitat for the Squatter Pigeon – 39.2 ha.

Based on publicly available information, an assessment has been undertaken of the potential cumulative impact of the Project on ecosystem resilience. Ecosystem resilience is the capacity of an ecosystem to respond to changes and disturbances yet retain its basic functions and structures. For ecosystems to be resilient to threats, they need a healthy diversity of individuals, species and populations. The cumulative impact assessment has considered:

- species present (species diversity, abundance and dynamics);
- patterns of species distribution (the communities and ecosystem present that encompass all species);
- broad habitat types (the ecological niches for the range of species present); and
- ecosystem processes.

The Project is within the Brigalow Belt Bioregion (Figure 3.3) and within the Isaac-Comet Downs subregion. The Brigalow Belt Bioregion has experienced considerable modification, particularly over the last 70 years, due to agriculture and mining activity (DES 2018a). Remnant vegetation cover has been reduced, with communities on the more fertile soils being the most affected (DES 2018a). Habitat loss, fragmentation, inappropriate fire regimes, invasive plants and feral animals are relevant threats to the biodiversity values of the bioregion. The current extent of remnant vegetation in the Brigalow Belt Bioregion has been estimated by the Queensland Herbarium as being approximately 15,039,386 ha or 41.2% of the pre-clearing cover (Accad *et al.* 2021). The pre-clearing cover for the Isaac-Comet Downs subregion is estimated at approximately 2,693,397 ha compared to 574,501 ha of remnant vegetation (or 21.3% of the pre-clearing extent) remaining (Accad *et al.* 2021).

The Project has been designed to avoid and/or minimise impacts to remnant vegetation (e.g. by co-locating Project infrastructure and siting infrastructure in primarily cleared agricultural land). However, the Project will result in the disturbance of 818.2 ha, including direct disturbance to 109.1 ha of remnant vegetation, which will add to the vegetation clearance that has or is proposed to occur for other Projects in the region. The remnant vegetation clearance for the Project represents approximately 0.016% of the current extent (Accad *et al.* 2021) of remnant vegetation in the Isaac-Comet Downs subregion. The area of remnant vegetation proposed to be impacted/cleared is comprised of:

- 16 ha of Endangered REs (RE 11.3.1 and RE 11.4.8);
- 63.2 ha Of Concern REs (RE 11.3.2 and 11.3.4); and
- 29.8 ha of Least Concern REs (REs 11.3.9, 11.5.3, 11.3.25, 11.3.27b, and 11.3.27f).

The northern portion of the study area contains a large contiguous area of remnant vegetation that will be subject to small (and temporary) areas of disturbance for gas drainage works in support of underground operations. Gas drainage development will utilise the existing track network across the Project site, with one further track proposed (Figure 3.2). Gas drainage activity will avoid any disturbance to the bed and banks of watercourses, while lopping of branches rather than removal of trees will occur where practicable. Clearing of mature trees will be avoided. Gas drainage sites will, therefore, present minimal, temporary areas of disturbance consistent with that of exploration activity, with disturbance to be rehabilitated upon the completion of each site. Given the nature and extent of this disturbance, gas drainage activities are unlikely to result in a significant impact on the distribution and abundance of wildlife in the Project locality.

The Project infrastructure corridor will traverse the riparian corridors of Phillips Creek and One Mile Creek, resulting in minor fragmentation of the riparian corridor at these locations. The Saraji East Project (BMA 2021) also proposes to construct a transport and infrastructure corridor that will traverse One Mile Creek and Phillips Creek to the west of the Project, which may also affect west–east dispersal opportunities for fauna along these streams. To the east of the Project infrastructure corridor, a diversion of Phillips Creek has been approved for the existing Lake Vermont Mine open-cut mining operations. Further east, dispersal opportunities along One Mile Creek and Phillips Creek would be maintained, providing connection to the Isaac River. The fragmentation and potential impacts to connectivity that would result from the Project is, therefore, unlikely to significantly affect species' movements. The Project will retain the vast majority of the One Mile Creek and Phillips Creek riparian corridors to allow continued fauna movement. Ponding impacts will present more progressively and subtly as distinct from direct vegetation clearance.

The Project is predicted to have a negligible cumulative impact on surface water and groundwater quality and quantity (Appendix E, Groundwater Impact Assessment, Section 6.3.8 and Appendix F, Surface Water Assessment, Section 7.7.3), with a range of mitigation and management measures proposed to be implemented to minimise impacts on terrestrial flora and fauna and their habitats, as described in section 10.5.

The key ecosystem cycles (e.g. water, nutrients) will remain intact and are not expected to be compromised as a result of cumulative impacts.

'Loss of Climatic Habitat Caused by Anthropogenic Emissions of Greenhouse Gases' is listed as a key threatening process under the EPBC Act. It consists of reductions in the bioclimatic range within which a given species or ecological community exists due to emissions induced by human activities of greenhouse gases. Climate change and greenhouse gas emissions associated with the Project are described in Chapter 13, Air Quality.

Project greenhouse gas emissions will contribute to domestic and global emissions. The potential effects of climate change on the nature and extent of the Project have been considered, including those relating to groundwater (Appendix E, Groundwater Impact Assessment, Section 5.8), surface water (Appendix F, Surface Water Assessment, Section 4.1.2) and climate (Chapter 4, Climate). Climate change effects have been factored into the models used by the Surface Water Assessment and Groundwater Assessment, and the predictions of changes to surface water and groundwater conditions as a result of the Project are, therefore, representative of future climate conditions.

The likely impacts of climate change on terrestrial flora and fauna are difficult to predict. However, the potential impacts of the Project are unlikely to significantly exacerbate the expected effects of climate change.

Assessments have been conducted in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a) and 'Queensland Environmental Offsets Policy Significant Residual Impact Guideline' (DEHP 2014) to assess the potential impacts of the Project of MNES and MSES, including those associated with direct, indirect and potential cumulative impacts. The assessments are provided in section 10.6.

The provision of biodiversity offsets in line with Commonwealth and/or State Government policies provide an opportunity to mitigate cumulative impacts. Offsets have been required for many of the Projects within the region and increase areas of protected habitats that will be managed for conservation purposes. Offsets will also be provided for the Project to provide adequate compensation for significant residual impacts on MNES and yield no net conservation loss. The Project's offset requirements are summarised in section 10.9.

10.6 Potential impacts on MNES

A condition to undertake an environmental offset can only be imposed in relation to an MSES at the State level where the same or substantially same impact has not already been assessed under a Commonwealth Act (i.e. the EPBC Act). Therefore, to avoid duplication of assessments for matters listed as both MSES and MNES, dual listed species and communities will be assessed using the 'MNES Significant Impact Guidelines 1.1' of the EPBC Act (DoE 2013a) and residual MSES will be assessed using the 'Queensland Environmental Offsets Policy Significant Residual Impact Guideline' (DEHP 2014).

For MNES that are known, are likely or have the potential to be significantly impacted by the Project, 'significant impact assessments' have been conducted pursuant to the Commonwealth 'MNES Significant Impact Guidelines 1.1' of the EPBC Act (DoE 2013a) on:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (Brigalow TEC);
- Poplar Box Grassy Woodland on Alluvial Plains ecological community (Poplar Box TEC);
- Ornamental Snake;
- White-throated Needletail;
- Squatter Pigeon (southern subspecies);

- Australian Painted Snipe[1];
- Koala;
- Greater Glider; and
- Migratory species.

The impact assessments undertaken for each terrestrial ecology MNES listed above is provided in Appendix G, Terrestrial Ecology Assessment (Section 11). Significant impacts were identified to occur as a result of the Project on the following matters:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (Brigalow TEC);
- Poplar Box Grassy Woodland on Alluvial Plains ecological community (Poplar Box TEC);
- Ornamental Snake;
- Koala; and
- Greater Glider.

The offset requirements for these matters are discussed in section 10.9, and further details regarding the Project's MNES values, impact assessments and offset commitments are provided in Chapter 21, MNES.

Assessment of potential impacts to MNES values is provided in sections 10.6.1 to 10.6.9.

10.6.1 Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC

Description

The Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (Brigalow TEC) occurs within Queensland and New South Wales and is listed as Endangered under the EPBC Act. The Brigalow TEC generally occurs within the 500 mm to 750 mm annual rainfall belt, with a predominance of summer rainfall, although winter rainfall peaks occur in the south of its distribution (DAWE 2021a).

In Queensland, the Brigalow TEC predominantly occurs on flat to gently undulating Cainozoic clay plains that are not associated with current alluvium and on gently undulating landscapes on horizontally bedded fine grained sedimentary rocks (DAWE 2021a). Some remnants, however, are associated with river and creek flats, or with old loamy and sandy plains, basalt plains and hills or with hills and lowlands on metamorphic or granitic rocks (DAWE 2021a). Where Brigalow is dominant, the soils are predominantly cracking clays; however, texture contrast soils are common where Eucalyptus species are co-dominant (DAWE 2021a).

Brigalow flowers between April and October; however, they do not flower every year. Brigalow seedlings are relatively rare in natural landscapes, as the seeds typically remain viable for less than a year (DAWE 2021a). Brigalow has a well-developed horizontal root system, and they produce shoots from these horizontal roots (suckering) in response to disturbance as long as the root stocks remain intact.

The Brigalow TEC comprises patches of vegetation in which Brigalow is one of the most abundant tree species. The tree layer may be dominated by Brigalow or have a co-dominant presence with other species, such as Belah (*Casuarina cristata*) or other Acacia or Eucalyptus species. Within Queensland, the Brigalow TEC is defined by reference to 16 REs, all of which are listed as Endangered under the VM Act.

1 An assessment of the Australian Painted Snipe was included because despite the likelihood of occurrence of the species being potential, the condition and extent of the potential habitat justified assessment. Other potential likelihood of occurrence species of conservation significance were not assessed because Project area does not contain habitat of condition or extent that justified assessment.

The Brigalow TEC can include some vegetation considered 'non-remnant' under State classifications; specifically, Brigalow regrowth that is more than 15 years old can be classified as the Brigalow TEC. Areas of Brigalow regrowth are not considered part of the EPBC Act listed Brigalow TEC if they are of poor quality (e.g. more than 50% perennial weeds) (DoE 2013b).

Survey effort

Vegetation communities within the study area have been mapped and described in accordance with the 'Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland (V5.0)' (Neldner *et al.* 2019). This has included 245 quaternary sites, 54 secondary survey sites and approximately 500 rapid observation sites.

Vegetation community boundaries have been validated in the field using a Global Positioning System and refined using 50 cm resolution red/green/blue aerial imagery collected in April 2019 to produce a ground verified vegetation map.

Brigalow vegetation within the study area has been assessed against the key diagnostic characteristics and condition thresholds described in the Commonwealth approved conservation advice (DoE 2013b) to determine whether each patch of the vegetation community meet the Brigalow TEC status.

Survey outcomes

Four ground-truthed vegetation communities associated with Brigalow woodlands have been mapped within the study area, as shown in Figure 10.6.

Patches of Brigalow vegetation have been assessed as meeting the key diagnostic characteristics and condition thresholds to represent the Brigalow TEC; specifically:

- 88.5 ha of remnant Brigalow woodland on alluvial plains (VC 1a);
- 46.6 ha of remnant Dawson Gum woodland with Brigalow on undulating Cainozoic clay plains (VC 1b); and
- 19.4 ha of remnant Brigalow with Yellowwood woodland with occasional Dawson Gum on Cainozoic clay plains (VC 1c).

Habitat assessment

A total of 154.5 ha of the TEC occurs within the study area. The distribution of Brigalow TEC within the study area is shown in Figure 10.6.

Impact assessment

The Project will directly disturb 0.9 ha of the Brigalow TEC across four patches through vegetation removal for all Project stages (Table 10.7: patches B1, B4, B6, and B17). This will add to the vegetation clearance that has, or is, proposed to occur for other Projects in the region.

Table 10.7: Brigalow TEC extent of disturbance to each patch

Patch	description	RE	Current extent (ha)	Extent of disturbance (ha)		
				Stages 1, 2, 3 clearing (ha)	Stages 2 and 3 residual ponding (ha)	Stage 4 clearing (ha)
B1	Adjacent to One Mile Creek in the western portion of the study area	11.3.1	31.1	**0.3**	0.0	**<0.1**

Patch	description	RE	Current extent (ha)	Extent of disturbance (ha)		
				Stages 1, 2, 3 clearing (ha)	Stages 2 and 3 residual ponding (ha)	Stage 4 clearing (ha)
B2	Adjacent to One Mile Creek in the central portion of the study area	11.3.1	24.9	0.0	**6.9**	0.0
B3	Adjacent to One Mile Creek in the eastern portion of the study area	11.3.1	23.0	0.0	0.0	0.0
B4	Patch to the west of the open-cut pit	11.4.8	2.4	**~0**	0.0	**<0.1**
B5	Patch to the east of the MIA	11.4.9	2.8	0.0	0.0	0.0
B6	Patch to the west of the open-cut pit	11.4.8	1.2	0.0	0.0	**0.2**
B7	Patch to the north of the open-cut pit	11.4.8	1.6	0.0	0.0	0.0
B8	Patch to the north of the open-cut pit	11.3.1	2.4	0.0	0.0	0.0
B9	Patch to the north of the open-cut pit	11.4.8	1.5	0.0	0.0	0.0
B10	Patch to the north of the open-cut pit	11.4.8	2.0	0.0	0.0	0.0
B11	Patch to the north of the open-cut pit	11.4.8	2.5	0.0	0.0	0.0
B12	Isolated patch to the south of Hughes Creek	11.4.9	6.6	0.0	0.0	0.0
B13	Isolated patch to the south of Hughes Creek	11.4.9	10.0	0.0	0.0	0.0
B14	Isolated patch to the north of the MIA and ETL	11.4.8	2.6	0.0	0.0	0.0
B15	Isolated patch to the north of the MIA and ETL	11.4.8	9.0	0.0	**0.1**	0.0
B16	Isolated patch to the north of Boomerang Creek	11.3.1	1.1	0.0	0.0	0.0
B17	Isolated patch to the south of Boomerang Creek	11.4.8	3.6	**0.3**	**<0.1**	0.0
B18	Isolated patch to the north of Boomerang Creek	11.3.1	2.0	0.0	0.0	0.0
B19	Isolated patch to the south of Boomerang Creek	11.3.1	2.0	0.0	0.0	0.0
B20	Isolated patch to the north of Boomerang Creek	11.3.1	1.9	0.0	0.0	0.0

Patch	description	RE	Current extent (ha)	Extent of disturbance (ha)		
				Stages 1, 2, 3 clearing (ha)	Stages 2 and 3 residual ponding (ha)	Stage 4 clearing (ha)
B21	Isolated patch to the north of Boomerang Creek and adjoining Brigalow high-value regrowth	11.4.8	19.7	0.0	0.0	0.0
B22	Isolated patch in the north-east of the study area	11.4.8	0.6	0.0	0.0	0.0
B23	Isolated patch in the north-east of the study area adjoining offsite Brigalow vegetation	11.3.1	0.1	0.0	0.0	0.0
Total	**—**	**11.3.1**	**154.5**	**0.6**	**7.0**	**0.3**

Above the underground mining area, temporary gas wells and temporary access tracks will be located to avoid impacts to patches of the Brigalow TEC.

Areas of residual ponding are expected to occur within the subsidence footprint area, including adjacent to Boomerang Creek and One Mile Creek. The predicted residual ponding will impact 7.0 ha and three patches of the Brigalow TEC (patch B2, B15 and B17). The predicted ponding is considered to have potential to have a deleterious impact to Brigalow TEC vegetation, as described in Section 10.5.1.2. Brigalow TEC vegetation occurs as riparian vegetation adjacent to One Mile Creek, including in reaches of the Creek that will be subject to stream morphology changes from subsidence. The potential stream morphology affected areas are co-located with areas of predicted ponding, and the assessment of stream morphology change impacts and mitigation measures are detailed in Section 10.5.2.2.

Brigalow TEC patches B16 and B18 are located in the subsidence footprint but outside the predicted residual ponding footprint. These areas are not expected to undergo any significant impacts relating from the Project.

Parts of patches B1, B4 and B6 are within the footprint of the stage 4 open-cut pit. The remaining vegetation of these patches will be greater than the minimum patch size TEC condition threshold of 0.5 ha, and they will retain connectivity to other adjoining Brigalow TEC patches. The affected patches are currently adjoining cleared agricultural land, and the clearing for the open-cut pit is not expected to increase edge effects or the likelihood of exotic species abundance or diversity. Therefore, the remaining patches are considered to be unimpacted.

The infrastructure corridor will traverse One Mile Creek, which will fragment a patch of Brigalow TEC vegetation and disturb 0.3 ha of the Brigalow TEC. While the existing patch of Brigalow (patch B1) will be fragmented at this location, approximately 14 ha of Brigalow TEC will remain to the west of the corridor (within the study area), and approximately 30 ha of Brigalow TEC will remain to the east of the corridor. These remnant patches are in good condition and, given the extent of the patches remaining and their current condition, there is no evidence to suggest these patches would become unviable post-impact.

Subsidence drainage works (mitigation channels and mitigation bunds) will be implemented to reduce ponding impacts to the Brigalow TEC; however, some ponding is unable to be effectively mitigated. Mitigation channels and bunds are designed to be implemented away from the mapped Brigalow TEC as far as practicable (Figure 3.2). The northern mitigation channel will impact 0.3 ha of Brigalow patch B17. A very small area of Patch B17 (<0.01 ha) will be impacted by predicted subsidence related ponding. The remaining 3.3 ha of the patch exceeds the minimum TEC patch size criteria and is expected to remain viable.

Patch B2 is a narrow patch of riparian Brigalow adjacent to One Mile Creek, which will be fragmented by the predicted residual ponding. These areas are predicted to experience inundation during flooding events for up to several months every few years (WRM 2022). The patch is currently subject to edge effects from surrounding cleared agricultural areas, and the edge effects on the remaining patches resulting from the

ponding is considered comparable to existing edge effect conditions. The predicted ponding will fragment this patch into a number of patches and each will be larger than the minimum patch size TEC condition threshold of 0.5 ha. The surface water assessment report (WRM 2022) has identified that the intersection of One Mile Creek and the subsidence footprint area will experience increased channel velocity and may receive channel bed scouring and stream bank erosion. Changes to stream morphology within patch B2 will be subject to monitoring, and interventions to control potential erosive process within the creek and TEC patch will be prescribed within a Subsidence Management Plan. The impacts are not expected to affect the viability of the patch.

Patch B15 will undergo a 0.1 ha reduction in patch size as a result of ponding. The patch will not be substantially fragmented, and the patch will remain above the minimum threshold size. The patch is expected to retain viability after the subsidence related impact.

The proposed impact is equivalent to 0.5 % of the Brigalow TEC in the study area and less than 0.01 % for the subregion in which the Project is located. The impact is unlikely to contribute to cumulative impacts to TEC in the subregion. Further discussions of cumulative impacts are provided in section 10.5.4.

The identified Brigalow TEC vegetation was within the groundwater dependent ecosystem assessment study area and no Brigalow TEC patches were identified as being groundwater dependent (refer Section 10.5.2.3). Impacts of erosion and subsidence related cracking and erosion are assessed in Section 10.5.2.11, Section 5.4.1 and Section 5.4.3. Given the proposed monitoring and management measures for erosion, it is considered unlikely that erosion will impact Brigalow TEC vegetation. The Project also has the potential to increase weed and animal pest populations, which have the potential to affect patch viability if pest species are not appropriately managed and infestations develop. However, as described in section 10.5.2, weed and pest management measures will be implemented for the Project. Indirect impacts associated with bushfire risk are considered unlikely, given the bushfire prevention and management measures to be implemented (Section 10.5.2.10).

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts on the Brigalow TEC when possible. The proposed avoidance and mitigation measures for the Brigalow TEC have been outlined in section 10.8. Description of the timing, predicted effectiveness, monitoring, adaptive management and relevant statutory or policy basis of each proposed measure is provided in Appendix G, Terrestrial Ecology Assessment (Section 11.1.1).

Statutory requirements

Conservation, recovery and threat abatement plans relevant to the Brigalow TEC have been considered in the survey effort for assessment of the TEC, the development of avoidance, mitigation and management measures and/or assessment of significant impact for the Brigalow TEC:

- The ‘Approved Conservation Advice for Brigalow’ (*Acacia harpophylla* dominant and co-dominant) ecological community (DoE 2013b), developed at the time of EPBC Act listing, outlines the key diagnostic criteria and condition thresholds for the TEC and the priority conservation actions for the community. The conservation advice also describes areas considered critical to the survival of the community.
- The ‘Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community’ SPRAT profile provides information about the Brigalow TEC, including relevant regulatory considerations and information in relation to its distribution, regional ecosystems within Queensland and associated flora and fauna within the community.
- The SPRAT profile for this community indicates there is no adopted or made Recovery Plan for this community; however, a Recovery Plan is considered to be required. The SPRAT profile also indicates the national Recovery Plan for the listed Brigalow ecological community (Butler 2007) will provide the main framework for the community's recovery. The main objective proposed is to:

Conserve and enhance the environmental values of the brigalow ecological community over the long-term, by working to increase the extent of both remnant and regrowth brigalow and improving its condition and management.

- The SPRAT profile for this community indicates the 'Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads' is relevant to this community.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019) and Australia's actions for nature, including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Conservation of Nature in the South Pacific (Apia Convention) or other relevant international conventions.

Current threats to the Brigalow TEC include (DAWE 2021a) vegetation clearing, overgrazing of the understorey, fire, plant and animal pests, lack of knowledge and climate change.

Significant impact assessment

An assessment of the likelihood of significant impacts on the Brigalow TEC in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a) is provided through Table 10.8.

Table 10.8: Brigalow TEC significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:	
Reduce the extent of an ecological community	The Project would require the clearance of 0.9 ha and result in the potential periodic inundation through residual ponding of 7.0 ha over portions of six patches of Brigalow TEC (Figure 10.6). The remaining vegetation of impacted patches of Brigalow TEC will continue to meet the minimum TEC patch size criteria. The Project will result in the total reduction of the extent of Brigalow TEC in the study area by 7.9 ha.
Fragment or increase fragmentation of an ecological community	All Brigalow TEC patches in the study area have been subject to past disturbance, including clearing, thinning and grazing. Two patches of Brigalow TEC will be fragmented by the clearance and impacts of residual ponding for the Project (patches B1 and B2). Four patches will be partially cleared, but the remaining Brigalow TEC vegetation will retain its connectivity to adjoining vegetation (patches B4, B6, B15 and B17).
Adversely affect habitat critical to the survival of an ecological community	The patches of Brigalow TEC in the study area meet the key diagnostic characteristics of the TEC and are, therefore, critical to the survival of the TEC. The Project will result in the loss of approximately 7.9 ha of Brigalow TEC that is critical to the survival of the TEC. The remaining patches of Brigalow TEC will continue to meet the TEC characteristic criteria thresholds.

Significance criteria	Assessment of significance
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels or substantial alteration of surface water drainage patterns	The impacts of areas of periodic ponding due to surface subsidence, which modify conditions necessary for Brigalow TEC survival, are considered to be a reduction in the extent of the TEC. Management measures will be applied to prevent erosion and sedimentation that may impact Brigalow TEC within the study area. Localised alteration of surface water drainage patterns will be monitored under a Subsidence Management Plan. The Brigalow TEC in the study area has not been identified as a GDE, and modifications to groundwater levels are unlikely to affect the TECs survival (3D Environmental 2022).
Cause a substantial change in the species composition of an ecological community, including causing a decline or loss of a functionally important species	Parts of six Brigalow TEC patches will be impacted by the Project. The partial clearance of these patches may create potential for edge effects on these patches. However, these edge effects are comparable to the edge effects currently affecting the patches that have all been subject to past disturbances and fragmentation. Weed control measures outlined in section 10.8.3 will be implemented throughout the study area to minimise the risk of degradation of Brigalow TEC through change in species composition. The result of the implementation of the mitigation measures proposed in this assessment will be that it is unlikely the retained TEC in the study area will experience a decline or loss of the functionally important species. Bushfire prevention and management measures will be implemented in accordance with the Emergency Response Plan, which will protect the functionally important species of the Brigalow TEC.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • assisting invasive species, which are harmful to the listed ecological community, to become established, or • causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community that kill or inhibit the growth of species in the ecological community	Parts of six Brigalow TEC patches will be impacted by the Project. The remaining areas of the impacted patches may be subject to edge effects. However, the impact is likely comparable to the edge effects currently affecting the patches from past disturbances and land management. The Brigalow TEC of the Project area occurs in a highly modified rural landscape where introduced species have been recorded throughout the TEC. The proposed Project is unlikely to produce pathways for invasive species that are not already present in the study area. Given adherence to the proposed avoidance and mitigation measures, it is unlikely that a substantial reduction will occur in the quality or integrity of the retained Brigalow TEC in the study area. The Project is unlikely to result in the mobilisation of pollutants of any kind into this TEC within or adjacent to the Project area. The Project is not likely to use fertilisers on-site or cause regular mobilisation of herbicides that may impact the Brigalow TEC. Control measures, such as sediment dams, will be in place to minimise the potential for pollutants to affect the Brigalow TEC in the study area.
Interfere with the recovery of an ecological community	The Project will result in the reduction of the extent of the Brigalow TEC by approximately 7.9 ha. This impact represents an interference with the recovery of the Brigalow TEC.
Conclusion	The Project is considered to have a significant impact on 7.9 ha of the Brigalow TEC. The extent of these impact areas is shown in Figure 10.14.

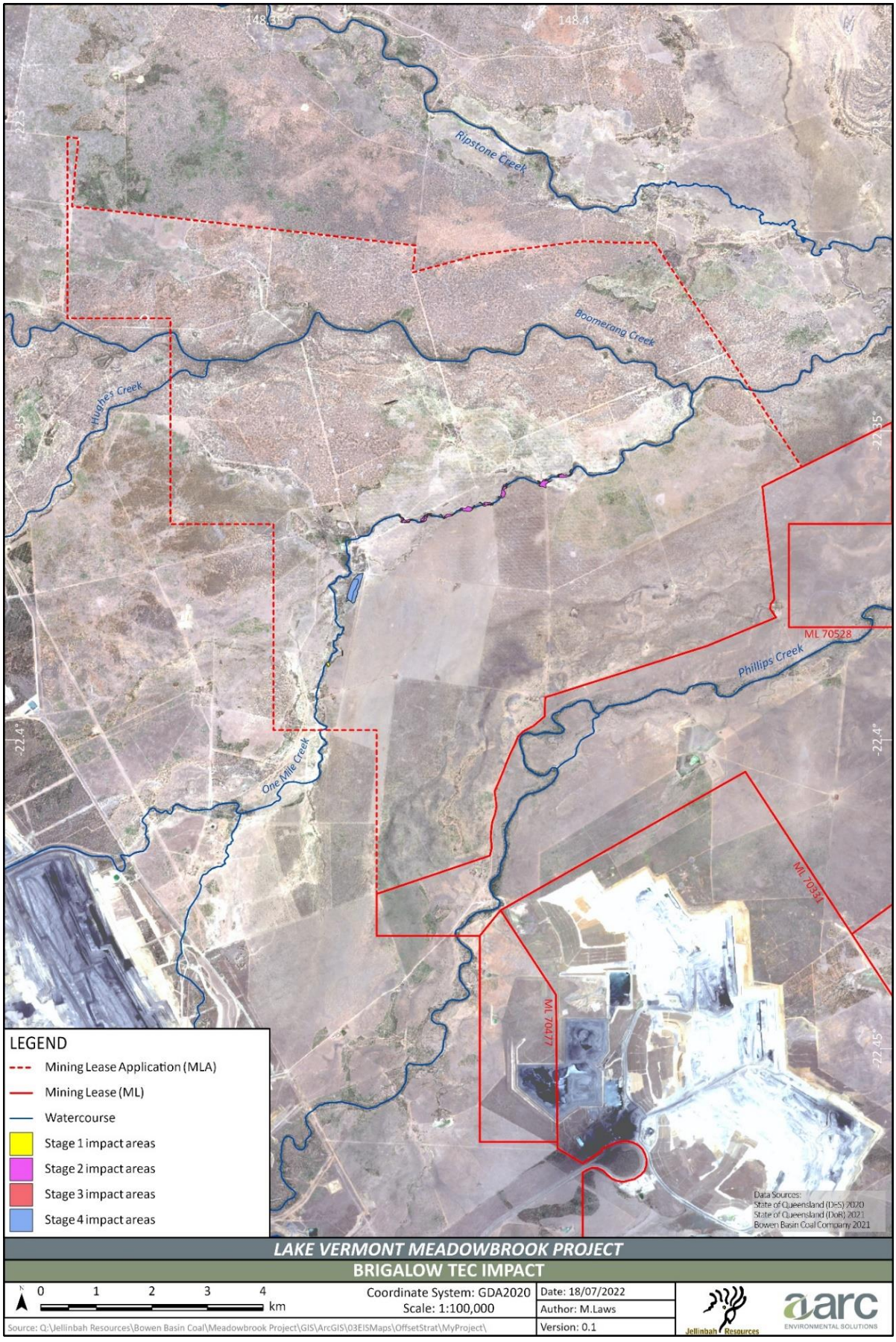

Figure 10.14: Brigalow TEC significant impact areas

10.6.2 Poplar Box Grassy Woodland on Alluvial Plains TEC

Description

The Poplar Box TEC was listed as Endangered under the EPBC Act on 4 July 2019.

This ecological community occurs west of the Great Dividing Range, typically at less than 300 m above sea level and between latitudes 20°S to 34°S within the Brigalow Belt North, Brigalow Belt South, South East Queensland, Cobar Peneplain, Darling Riverine Plains, NSW South Western Slopes and Riverina IBRA bioregions (DAWE 2021a).

The Poplar Box TEC is typically a grassy woodland with a canopy dominated by *Eucalyptus populnea* and understorey mostly of grasses and other herbs. The ecological community mostly occurs in gently undulating to flat landscapes and occasionally on gentle slopes on a wide range of soil types of alluvial and depositional origin (DoEE 2019b). Within Queensland, five REs have the potential to represent the Poplar Box TEC, namely, RE: 11.3.2, RE 11.3.17, RE 11.4.7, RE 11.4.12 and RE 12.3.10.

Survey effort

Vegetation communities within the study area have been mapped and described in accordance with the 'Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland (V5.0)' (Neldner *et al.* 2019). This includes 245 quaternary sites, 54 secondary survey sites and approximately 500 rapid observation sites. Vegetation community boundaries have been validated in the field using a Global Positioning System and refined using the latest aerial imagery available for the study area to produce a ground verified vegetation map.

Poplar Box vegetation within the study area has been assessed against the key diagnostic characteristics and condition thresholds described in the Commonwealth approved conservation advice (DoEE 2019b) to determine whether the vegetation community meets the Poplar Box TEC status.

Survey outcomes

Within the study area, one vegetation community has been found to contain areas consistent with the key diagnostic characteristics (DoEE 2019b) of the Poplar Box TEC; namely, the remnant Poplar Box woodland on alluvial plains vegetation community (VC 2a) (Figure 10.5). The majority of this vegetation community meet the structure requirements for this TEC and its condition has been assessed as Class B, good quality.

Habitat assessment

A total of 656.6 ha of the Poplar Box TEC (Class B, good quality) has been mapped within the study area. The distribution of Poplar Box TEC within the study area is shown on Figure 10.6.

Impact assessment

The Poplar Box TEC occurs within eight patches within the study area to the north and south of Boomerang Creek (Table 10.9 and Figure 10.6). The Project will not directly disturb the Poplar Box TEC, as no vegetation clearance or habitat disturbance will be undertaken within this community for Project infrastructure.

Above the underground mining area, ventilation shafts, ponding mitigation works, and a gas drainage access track will be located to avoid impacts to patches of the Poplar Box TEC.

Table 10.9: Poplar Box TEC extent of disturbance to each patch

Patch	Description	Current extent (ha)	Extent of disturbance (ha)		
			Stages 1, 2, 3 clearing (ha)	Stages 2 and 3 residual ponding (ha)	Stage 4 clearing (ha)
P1	Patch north of Boomerang Creek, in the west of the study area	52.7	0.0	0.0	0.0
P2	Patch south of Boomerang Creek in the west of study area	49.5	0.0	0.0	0.0
P3	Patch north of Boomerang Creek	18.6	0.0	1.6	0.0
P4	Patch south of Boomerang Creek extending through the central portion of the study area	395.2	0.0	42.0	0.0
P5	Patch north of Boomerang Creek	67.7	0.0	0.8	0.0
P6	Patch north of Boomerang Creek extending from the eastern boundary of the study area	12.4	0.0	0.0	0.0
P7	Patch south of Boomerang Creek extending from the eastern boundary of the study area	54.7	0.0	0.0	0.0
P8	Isolated patch south of Boomerang Creek in the east of study area	5.8	0.0	0.0	0.0

Areas of potential ponding are expected to occur adjacent to Boomerang Creek, and these ponding areas are considered likely to impact Poplar Box TEC patches in this area. The predicted residual ponding will impact 44.4 ha over three patches of Poplar Box TEC. The ponding areas are predicted to be inundated periodically for several months every few years (WRM 2022) and affected areas are conservatively considered to experience conditions deleterious to the Poplar Box TEC (refer Section 10.5.2.1). The troughs predicted to form adjacent to streams are not predicted to impact Poplar Box TEC vegetation.

For patch P3, ponding is predicted to impact 1.6 ha of the 18.6 ha patch. The patch will not be fragmented by the ponding, and all remaining sections of the patch will retain existing connectivity. No substantial increase in edge effects is expected.

Patch P4 intersects the predicted ponding footprint, and five separate ponding areas are predicted to potentially occur within the patch. This will reduce the 395 ha (maximum predicted ponding) patch size by approximately 42 ha. The potential ponding is predicted to fragment the patch into three patches of 14.3 ha and 17.3 ha and 196.13 ha.

For patch P5, ponding is predicted to impact 0.8 ha of the 67.7 ha patch. The patch will not be fragmented by the ponding, and all remaining sections of the patch will retain connectivity. No substantial increase in edge effects is expected.

The increased patch edges around the ponded areas may increase the edge effects on affected Poplar Box patches. The predicted ponding areas are expected to undergo changes to suitability of plant species, but since no active soil disturbance or movement will be undertaken within the residual ponding areas, the ponding is not expected to generate conditions likely to cause weed incursion in the Poplar Box patches. Furthermore, the monitoring and maintenance of weeds in accordance with the Weed and Pest Management Plan will effectively manage the occurrence and abundance of feral pests.

Subsidence is considered unlikely to represent a significant impact to the Poplar Box TEC. Woodland vegetation, including Poplar Box vegetation, is expected to retain viability after surface subsidence. Discussion of the expected impact of subsidence to open woodland vegetation is presented in section 10.5.2.

Given the lack of direct disturbance to patches of the Poplar Box TEC and that the patches affected by residual ponding will not be fragmented by the intermittent ponding, all patches of Poplar Box TEC are expected to remain viable post the mining impact.

The proposed impact is equivalent to 5% of the Poplar Box TEC in the study area. The impacts are predominantly due to hydrological change affecting the resilience of the Poplar Box TEC ecosystem, and the modelling for these changes has incorporated the cumulative effects of nearby projects and climate change (WRM 2022). The impacts identified to Poplar Box TEC are unlikely to contribute to cumulative impacts in the subregion. Further discussion of cumulative impacts is provided in section 10.5.4.

The identified Poplar Box TEC vegetation was within the groundwater dependent ecosystem assessment and no Poplar Box TEC patches were identified as groundwater dependent (refer Section 10.5.2.3). Impacts of subsidence related cracking and erosion are assessed in Section 10.5.2.11, Section 5.4.1 and Section 5.4.3. Given the proposed monitoring and management measures for erosion, it is considered unlikely that erosion will impact Poplar Box TEC vegetation. The Project also has the potential to increase weed and animal pest populations if they are not appropriately managed. However, as described in section 10.5.2, weed and pest management measures will be implemented for the Project. Indirect impacts associated with bushfire risk are considered unlikely given the bushfire prevention and management measures to be implemented (Section 10.5.2).

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Poplar Box TEC. The proposed avoidance and mitigation measures for the Poplar Box TEC have been outlined in section 10.8, and the proposed measures are detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.2), including a description of the timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis of each proposed measure.

Statutory requirements

Conservation, recovery and threat abatement plans relevant to the Poplar Box TEC have been considered in the survey effort for assessment of the TEC, the development of avoidance, mitigation and management measures and/or assessment of significant impact on the Poplar Box TEC:

- The ‘Approved Conservation Advice for Poplar Box Grassy Woodland on Alluvial Plains’ (DoEE 2019b), developed at the time of EPBC Act listing, outlines the key diagnostic criteria and condition thresholds for the TEC and the priority conservation actions for the community. The conservation advice also describes areas considered critical to the survival of the community.
- The ‘Poplar Box Grassy Woodland on Alluvial Plains’ ecological community’ SPRAT profile provides information about the indicative distribution of the Poplar Box TEC.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this ecological community, as the listing and the implementation of actions in the Approved Conservation Advice (DoEE 2019b) provides sufficient protection and guidance on the recovery of the ecological community.
- No Threat Abatement Plan has been identified as being relevant the Poplar Box TEC.
- ‘Australia’s Strategy for Nature 2019–2020’ (Commonwealth of Australia 2019) and Australia’s actions for nature including the ‘Threatened Species Strategy 2021–2031’ (Commonwealth of Australia 2021), ‘Australian Weeds Strategy 2017–2027’ (Commonwealth of Australia 2017a) and ‘Australian Pest Animal Strategy 2017–2027’ (Commonwealth of Australia 2017b) outline relevant actions to recover Australia’s threatened plants, animals and ecological communities.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific.

Key threats to the Poplar Box TEC include (DoEE 2019b):

- clearance and fragmentation;
- invasive weeds and pests;
- inappropriate fire and grazing regimes;
- dieback;
- chemical impact and spray drift;
- invasive fauna;
- hydrological changes and salinisation;
- nutrient enrichment; and
- climate change.

Significant impact assessment

An assessment of the likelihood of significant impacts on the Poplar Box TEC in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a) is provided through Table 10.10.

Table 10.10: Poplar Box TEC significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:	
Reduce the extent of an ecological community	The Project avoids the direct clearance of Poplar Box TEC. Surface subsidence will result in the creation of areas of predicted ponding that is expected to modify the factors necessary for the Poplar Box TECs. Ponding mitigation measures will be employed. However, residual ponding is predicted to impact 44.4 ha of Poplar Box TEC, such that the conditions necessary for the TECs survival will potentially be destroyed by the potential ponding.
Fragment or increase fragmentation of an ecological community	The Poplar Box TEC vegetation in the study area has been subject to past disturbance related to grazing land use. Three patches of Poplar Box TEC will be impacted by residual ponding (patches P3, P4, P5), and this will reduce the Poplar Box TEC vegetation by 44.4 ha across these three patches. One patch (P4) will be fragmented by the residual ponding.
Adversely affect habitat critical to the survival of an ecological community	Habitat critical to the survival of the Poplar Box TEC is 'Class A, High quality' patches (DoEE 2019b). The patches of Poplar Box TEC present in the study area are 'Class B Good quality' and, therefore, are considered not to form habitat critical to the survival of the TEC. The Project is unlikely to affect habitat critical to the survival for the TEC.

Significance criteria	Assessment of significance
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels or substantial alteration of surface water drainage patterns	The impacts of areas of periodic ponding due to surface subsidence, which modify conditions necessary for Poplar Box TEC survival, are considered as a reduction in the extent of the TEC. Management measures will be applied to prevent erosion and sedimentation resulting from Project activities within the Poplar Box TEC habitat. Given these controls, the Project is not predicted to cause erosion-related impacts that will modify or destroy factors necessary for the survival of the Poplar Box TEC. The Poplar Box TEC in the study area has not been identified as a GDE, and modifications to groundwater levels are unlikely to affect the TEC's survival (3D Environmental 2022).
Cause a substantial change in the species composition of an ecological community, including causing a decline or loss of a functionally important species	Parts of three Poplar Box TEC patches will be impacted by the Project. The partial impact on these patches may create potential for edge effects on these patches. Edge effects to remaining areas of this TEC adjacent to impact areas are unlikely to be significant, as the TEC is already subject to weed infestation of established ground cover species. Weed control measures will be implemented throughout the study area to minimise the risk of degradation of Poplar Box TEC through change in species composition. The result of the implementation of the mitigation measures proposed in this assessment will be that it is unlikely the retained TEC in the study area will experience a decline or loss of functionally important species. Bushfire prevention and management measures will be implemented in accordance with the Emergency Response Plan, which will protect the functionally important species of the Poplar Box TEC.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • assisting invasive species that are harmful to the listed ecological community to become established, or • causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community that kill or inhibit the growth of species in the ecological community	Three Poplar Box TEC patches will be partially impacted by the Project. The remaining areas of the impacted patches may be subject to edge effects. However, the Project area is within a modified rural landscape where introduced species have been recorded throughout the TEC. The proposed Project is unlikely to increase the threat of invasive species in the landscape. The Project is unlikely to result in the mobilisation of pollutants of any kind into this TEC, either within or adjacent to the Project area. The Project is not likely to use fertilisers on-site or cause regular mobilisation of herbicides that may impact the Poplar Box TEC. Control measures, such as sediment dams, will be in place to minimise the potential for pollutants to affect the Poplar Box TEC in the study area.
Interfere with the recovery of an ecological community	There is no national recovery plan for the Poplar Box TEC. The Project will result in the reduction of the extent of the Poplar Box TEC by approximately 44.4 ha.
Conclusion	The Project is considered to have a significant impact on 44.4 ha of the Poplar Box TEC. The extent of these impact areas is shown in Figure 10.15.

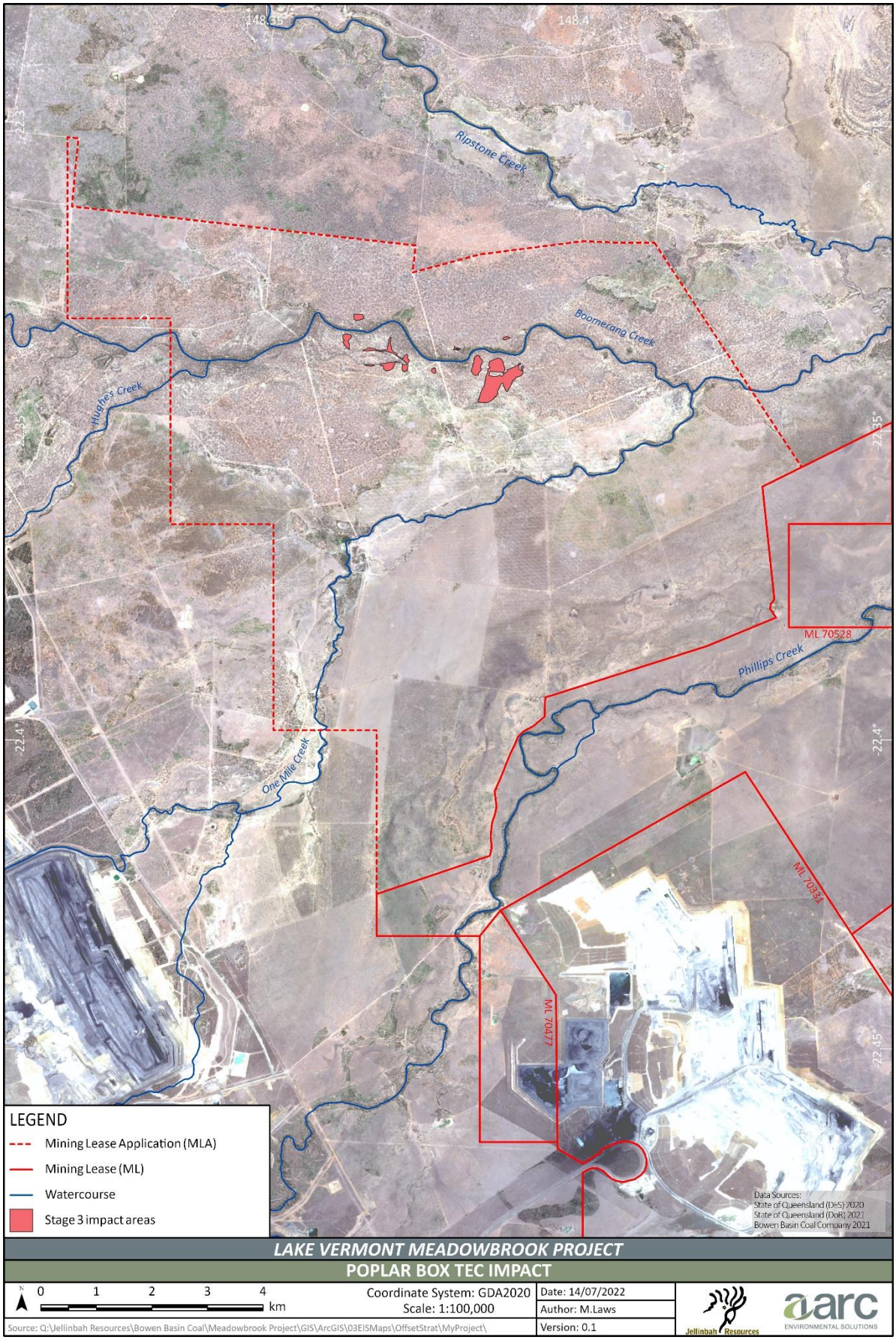

Figure 10.15: Poplar Box TEC significant impact areas

10.6.3 Ornamental Snake

Description

The Ornamental Snake (*Denisonia maculata*) is listed as Vulnerable under the EPBC Act and NC Act.

The species is known from the Brigalow Belt North and parts of the Brigalow Belt South biogeographical regions and is sparsely distributed throughout its range (DoE 2014b, DAWE 2021a). The core of the species' distribution occurs within the drainage system of the Fitzroy and Dawson Rivers (McDonald *et al.* 1991; Cogger *et al.* 1993).

The Ornamental Snake occurs within woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions in Queensland Regional Ecosystem Land Zone 4 and also lake margins and wetlands (DAWE 2021a). These habitats are favoured by frogs (the Ornamental Snake's prey) and provide suitable microhabitat features for the species, such as deep cracking clay soils, logs and vegetation debris/litter, in which the species shelters.

The Ornamental Snake has most commonly been recorded in Queensland Regional Ecosystem (RE) 11.4.3, has commonly been recorded in RE 11.4.6, RE 11.4.8 and RE 11.4.9 and has less commonly been recorded in RE 11.3.3 and RE 11.5.6 (DAWE 2021a, DSEWPaC 2011a).

The Ornamental Snake also occurs in cleared areas where the above-mentioned RE's formerly occurred, which comprise adequate ground cover to provide shelter (such as gilgai formations, logs, rocks and other debris) for the species. Gilgai formations are found where deep cracking alluvial soils with high clay contents occur.

The Ornamental Snake is nocturnally active. The diet of this species consists predominantly of frogs, and the species forages in areas where frogs are abundant (DAWE 2021a). The Ornamental Snake has been observed consuming a variety of species (DAWE 2021a). The Ornamental Snake shelters during the day in logs and under coarse, woody debris; ground litter and in deep soil cracks (DAWE 2021a). The species is thought to be active year-round, with the exception of cooler months. Peak activity occurs in early summer and through the wet season. During dry periods, *D. maculata* can remain inactive in suitable shelter sites (DAWE 2021a). The Ornamental Snake is viviparous (i.e. gives birth to young that have developed within the mother's body), and typically, a litter size ranges from three to 11 (DAWE 2021a).

Survey effort

Seasonal fauna surveys of the study area were conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April) and autumn 2021 (16–25 April) over 45 days in consideration of relevant Commonwealth and Queensland surveys guidelines. The autumn surveys were conducted during optimal climatic conditions for the Ornamental Snake.

Fourteen systematic survey sites were established during the surveys. Three systematic survey sites were established in Brigalow woodlands on clay soils, which is potential habitat for the Ornamental Snake (MF04, MF07 and MF08). Each site consisted of the recommended design and trap numbers for pitfalls and funnels consistent with the Queensland guideline (Eyre *et al.* 2018). Supplementary targeted spotlighting survey effort was conducted in autumn 2021.

Survey efforts for the Ornamental Snake at systematic and targeted sites included:

- pitfall traps: 176 trap nights;
- funnel traps: 264 trap nights;
- diurnal searches: 75 person hours; and
- spotlighting: 47 person hours in total, with 15 person hours over three nights in Brigalow and gilgai habitat.

Survey effort for active searching and spotlighting did not meet the duration requirements consistent with the Commonwealth Guideline, which requires 1.5 person hours diurnally and nocturnally per hectare over at least three days and nights. This is because it was not practicable in the area of habitat within the study area.

The Ornamental Snake is most likely to be encountered by searching in and around suitable gilgai habitats during the evening when frogs are most active. The targeted surveys conducted for the Ornamental Snake were considered the most appropriate means of survey. Despite not meeting the DAWE survey guidelines, the Ornamental Snake has been confirmed in the study area through targeted searches for this species.

For habitat assessment, amenity surveys have been conducted along 100 m transects within areas of potentially suitable habitat. The total extent of gilgai formations and maximum gilgai depths were recorded, while observations were made of dominant shrub vegetation and ground cover vegetation, woody debris and soil cracks.

Additional observations of Ornamental Snake habitat suitability were made incidentally throughout the study area.

Further details of the survey timing, effort and methodology is provided in Appendix G, Terrestrial Ecology Assessment (Section 11.1.3).

Survey outcomes

The Ornamental Snake has been recorded at three locations within the study area by the terrestrial fauna surveys. All three records were recorded within Brigalow regrowth vegetation containing well-developed gilgai (Figure 10.16).

The habitat assessment transect data and site survey/inspections informed the assessment of habitat amenity for the Ornamental Snake within the study area.

Habitat assessment

Habitat mapping for the Ornamental Snake within the study area is shown in Figure 10.16 and is informed by in-field observations and transect data, aerial photography, soils mapping and information contained in DAWEs Species Profiles and Threats (SPRAT) database, including the relevant statutory documents and published research.

Habitat amenity for the Ornamental Snake within the study area has been mapped against the criteria outlined in

Table 10.11.

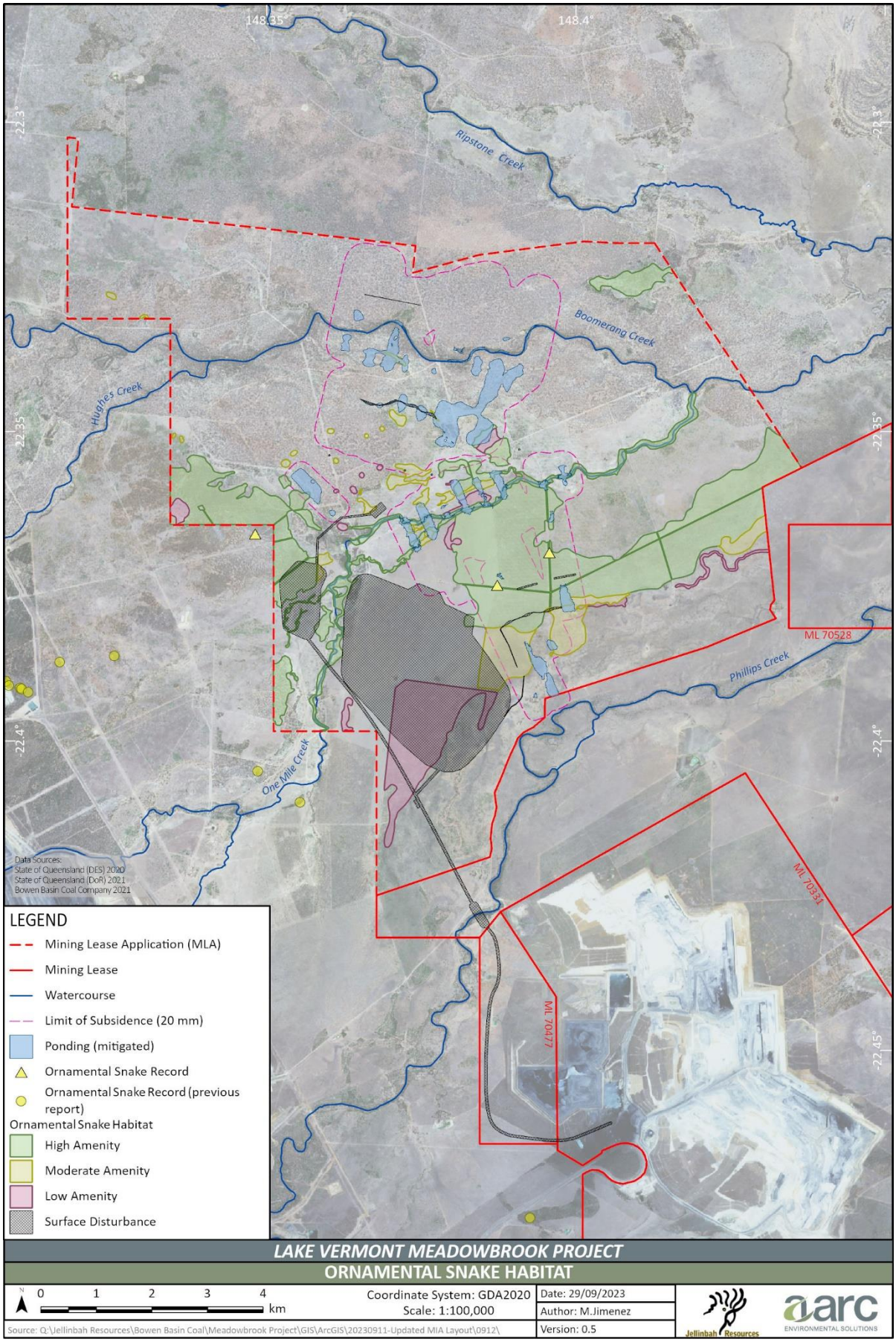

Figure 10.16: Ornamental Snake habitat mapping

Table 10.11: Ornamental Snake habitat amenity assessment criteria

Habitat amenity	Description
High	High amenity habitat is defined as areas of deep gilgai microrelief (60+ cm depth) or ephemeral creek lines (including older systems) on dark clays. Evidence of pooling surface water is common on aerial imagery. In these areas, Ornamental Snakes are known to occur (previous records) or are considered highly likely, and the area is expected to support comparatively higher densities.
Moderate	Moderate amenity habitat is areas with less pronounced gilgai microrelief (20–60 cm depth) that occurs on either dark (predominantly) or loam (uncommonly) soils. There is reduced evidence of surface water pooling on aerial imagery. On balance, these areas are more likely to be inhabited by Ornamental Snakes than not, though the species may be absent from some areas or in low abundance. These habitats may not hold water in poor rainfall conditions (i.e. droughts).
Low	Low amenity habitat are areas with slight microrelief (<20 cm) or low possibility of pooling water—often associated with sand/loam soils. Ornamental Snakes, if present, are likely to be at comparatively low density, though on balance, it is anticipated that most areas will be uninhabited. These habitats are anticipated to contain water only in high rainfall conditions (i.e. well above average) and, even then, may not hold water for lengthy periods. Despite containing water, large dams or permanent waters are not typically frequented by abundant frogs. Considering the extent of more suitable habitat, these waterbodies are generally not mapped as suitable (with some exceptions).
Unsuitable	Unsuitable habitat for the Ornamental Snake includes areas that contain less appropriate soil types (sands and sandy loams), lack suitable microhabitat features, have been subject to historic blade-ploughing that has adversely affected microrelief (unless otherwise indicated by aerial photography or in-field observations) and are characterised by dense non-native grass species. These habitats are typically not attractive to Ornamental Snakes or large aggregations of their prey (frogs).

Areas of habitat amenity have been determined based on in-field observations and aerial photography by EcoSmart Ecology and AARC. Dark clay soils, which are more likely to retain water and support abundant frog populations, have been assessed using the following hierarchy of confidence:

- direct in-field observations;
- the presence of dark shrub vegetation (Brigalow) on aerial photography and the absence of light green shrub vegetation (*Carissa ovata*); and
- soil mapping of the study area (AARC 2022).

Aerial photography of the study area (1 m resolution) was captured in May 2019 following above average rainfall (approximately 45% greater than average for June and April combined). At the provided resolution, larger, more substantial microrelief (i.e. gilgai) were visible, and the recent rainfall allowed the extent and/or likely presence of surface water to be assessed.

While the above habitats are relatively easy to define, assigning these criteria to areas within the site is problematic due to:

- gradual transitions in gilgai formations (mapping of distinct boundaries oversimplifies in-field values);
- complex patchwork of soils that can occur in some areas (e.g. to the north and west of One Mile Creek); and the
- history of ploughing to remove woody regrowth, which incrementally alters microrelief in areas that may otherwise show deep gilgai formations.

On the site, *Acacia harpophylla* is generally associated with darker clays, while Carissa sp. is generally associated with red soils. These two plant species can be differentiated using high-resolution aerial imagery.

However, in many areas there is a mix of the two. While the soil mapping by AARC (2022) is suitable for its intended purpose, it does not provide a sufficient level of detail at the scale suitable for mapping Ornamental Snake habitat. As such, it has only been used to predict soil type when required.

Impact assessment

A total of 1,672.0 ha of Ornamental Snake habitat has been identified within the study area, including 1,192.5 ha of high amenity, 213.5 ha of moderate amenity and 266.0 ha of low amenity habitat (Figure 10.16). A total of 211.1 ha of Ornamental Snake habitat is proposed to be cleared for the Project, including 41.7 ha of high amenity, 21.9 ha of moderate amenity and 147.5 ha of low amenity habitat (Table 10.12).

Table 10.12: Proposed Project footprint within Ornamental Snake habitat

Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)		Extent of subsidence impact (ha)[a]	Extent of predicted ponding impact (ha)
		Stages 1,2,3 clearing (ha)	Stage 4 clearing (ha)		
Low	266.0	4.1	143.4	19.9	4.2
Moderate	213.5	3.6	18.3	100.8	10.9
High	1192.5	38.1	3.6	393.8	27.7
Total	**1672.0**	**45.9**	**165.3**	**514.5**	**42.8**

a Excludes predicted ponding areas

The direct disturbance by clearing will impact Ornamental Snake habitat, which will add to habitat disturbance that is proposed to occur for other Projects in the region. However, it is noted that the proposed Project and other existing and approved projects are granted approval in accordance with legislation, and where significant impacts occur as a result, appropriate offsets of these impacts are provided.

Direct disturbance associated with the infrastructure corridor will intersect high amenity Ornamental Snake habitat at One Mile Creek and low amenity habitat south of the proposed open-cut pit. The clearing for the infrastructure corridor crossing at One Mile Creek will intersect the habitat adjacent to the southern portion of One Mile Creek, and these two patches will be dissected by the Project feature. However, the mobility of the species and its ability to use shallow water and mobilise through boxed culverts will likely allow the species to continue to disperse along the watercourse despite the infrastructure corridor crossing. The southern portion of the habitat adjacent to One Mile Creek will retain connectivity to habitat, continuing along the watercourse to the south of the Project boundary into an area that is not within the impact area of the adjoining, proposed Saraji East Project.

The low amenity habitat to the south of the proposed open-cut pit will also be intersected by the infrastructure corridor. The Ornamental Snake is considered likely to be able to disperse through the area despite the presence of the Project feature by mobilising over the corridor and using the culverts that will be located along the watercourse crossing. The open-cut pit will fragment the low amenity habitat to the south of the pit from the moderate and high-quality habitat in the central portion of the study area.

Ornamental Snake mobility is likely to allow the species to disperse across the areas of cleared agricultural land such that these habitat patches are unlikely to be effectively fragmented by the open-cut pit.

The areas predicted to be affected by surface subsidence, including predicted ponding areas, are shown in Figure 10.17.

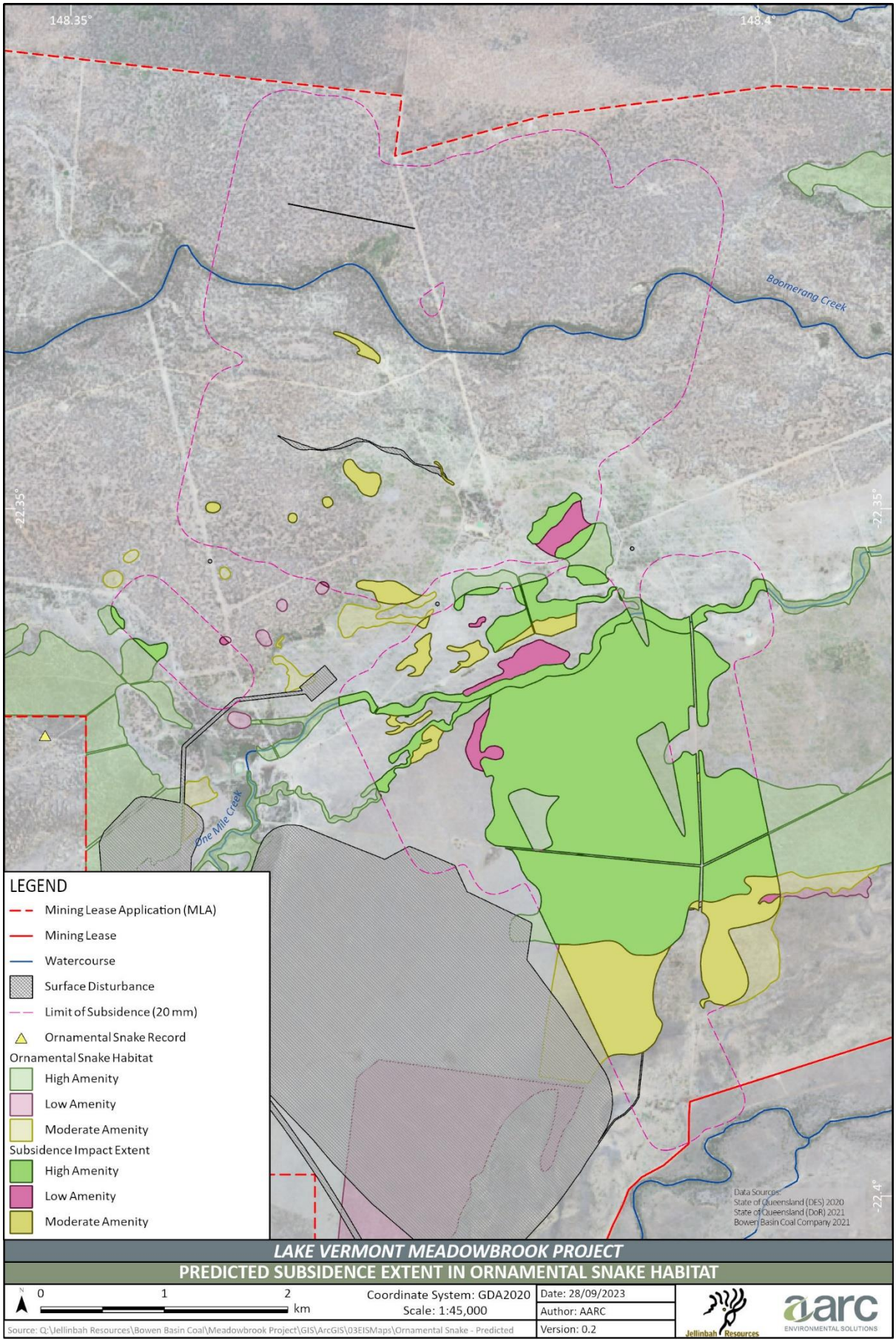

Figure 10.17: Predicted subsidence extent in Ornamental Snake habitat

The surface subsidence within the Ornamental Snake habitat area does not represent a removal of habitat, with the impact presenting as superficial geomorphological changes that will not have a deleterious effect on soil cracks or gilgai features. The subsidence within identified Ornamental Snake habitat is predicted to be to a maximum depth of 2.9 m and a tilt of typically less than 3% (Gordon Geotechniques 2022). This geomorphological change is unlikely to have a deleterious impact on the gilgai features and cracking soils that define the Ornamental Snake habitat, with indirect impacts on the Ornamental Snake habitat also considered unlikely. The predicted subsidence impacts are described in further detail in Section 10.5.2.1 and Section 5.4.1. Ornamental Snake habitat occurs within riparian vegetation adjacent to One Mile Creek, including in reaches of the Creek that will be subject to stream morphology changes from subsidence. These potential stream morphology affected areas are co-located with areas of predicted ponding, and the assessment of stream morphology change impacts and mitigation measures are detailed in Section 10.5.2.2. The vegetation forming Ornamental Snake habitat within the study area was not identified to be groundwater dependent, the groundwater dependent ecosystem assessment outcomes are described in Section 10.5.2.3.

The predicted areas of residual ponding within Ornamental Snake habitat represent a change in habitat with additional ponds arising. The quality and availability of habitat required for foraging, shelter and breeding and mobility will be retained in the residual ponding areas, although the period of inundation of gilgai features may be increased. The areas of residual ponding are predicted to be inundated for a maximum period of several months every few years depending on inflow volumes and soil permeability (Appendix W, Geomorphological Assessment Report, Section 3.3.3), which is considered comparable to the pattern of seasonal inundation required for habitat for the species. Soil types are not expected to change as a result of the surface subsidence and where cracking clay soils provide Ornamental Snake habitat, these soils are still expected to behave as cracking clay soils after surface subsidence. It is also noted that Ornamental Snake diet is predominantly frogs, for which temporary and permanent ponds provide foraging and breeding habitat, with the predicted subsidence ponding areas considered to be analogous to the temporary ponding areas suitable for the Ornamental Snake prey breeding areas. The impacts of subsidence and predicted ponding is therefore considered to represent a change in Ornamental Snake foraging habitat, with no deleterious impact to suitability for Ornamental Snake foraging.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels; however, the changes to flood levels and extent are not considered significant (Appendix W, Geomorphological Assessment Report, Section 4.2). The impacts of changes to flooding regimes on Ornamental Snake habitat are, therefore, not expected to be significant.

Gas drainage activities in the proposed southern underground mining area will occur with Ornamental Snake habitat. The gas drainage activities are unlikely to create any significant impacts to this species, as access will be largely achieved using existing tracks, and drainage sites will be remediated as mining progresses. The potential for indirect impacts on the Ornamental Snake from noise and vibration, dust, lighting and vehicle strike is considered to be minimal, given the measures that will be implemented to manage these impacts.

The identification of impacts on Ornamental Snake habitat in the study area includes consideration of potential impacts from climate change and adjoining projects that have been incorporated into hydrological modelling (Appendix Z, Flood Modelling Assessment Report, section 1.3.12). Therefore, it is considered that the assessment has taken into account cumulative sources of impact, and no further cumulative impacts on Ornamental Snake habitat will occur. Further discussion of cumulative impacts is provided in Section 10.5.4.

Impacts of erosion and subsidence related cracking and erosion are assessed in Section 10.5.2.11 and Chapter 5, Land Resources, Section 5.4.1 and Section 5.4.3. Given the proposed monitoring and management measures for erosion, it is considered unlikely that erosion will impact Ornamental Snake habitat. The Project also has the potential to increase weed and animal pest populations if they are not appropriately managed. However, as described in Section 10.5.2.5, weed and pest management measures will be implemented for the Project.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts on the Ornamental Snake. The proposed avoidance and mitigation measures for the Ornamental Snake have been outlined in section 10.7, and the proposed measures are detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.3), including

descriptions of timing, predicted effectiveness, monitoring, adaptive management and relevant statutory or policy basis of each proposed measure.

Statutory requirements

A number of conservation, recovery and threat abatement plans are relevant to the Ornamental Snake and have been considered in the development of avoidance, mitigation and management measures and assessment of significant impact on the Ornamental Snake:

- The 'Approved Conservation Advice for *Denisonia maculata* (Ornamental Snake)' (DoE 2014b), developed at the time of EPBC Act listing, provides guidance on recovery and threat abatement activities that can be undertaken to ensure the conservation of the species.
- The '*Denisonia maculata*–Ornamental Snake' SPRAT profile provides information about the Ornamental Snake, including relevant regulatory considerations and information in relation to its population and distribution, habitat, movements, feeding and reproduction.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this species, as the approved conservation advice (DoE 2014b) provides sufficient direction to implement priority actions and mitigate against key threats.
- The 'EPBC Act Draft Referral Guidelines for the nationally listed Brigalow Belt reptiles' (DSEWPaC 2011c) includes information on Ornamental Snake habitats, survey considerations, primary threats, impacts and potential mitigation measures. The Draft Referral Guidelines considers 'important habitat' to be a surrogate for 'important populations' of Brigalow Belt reptiles and lists gilgai depressions and mounds as known important habitat for the Ornamental Snake.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019) and Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

Threats to the Ornamental Snake include (DAWE 2021a):

- habitat loss through clearing;
- habitat fragmentation;
- habitat degradation by overgrazing by stock, especially cattle or grazing of gilgais during the wet season leading to soil compaction and compromised soil structure;
- alteration of landscape hydrology in and around gilgai environments;
- alteration of water quality through chemical and sediment pollution of wet areas;
- contact with the Cane Toad;
- predation by feral species; and
- invasive weeds.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific. As detailed in Appendix G, Terrestrial Ecology Assessment (Section, 11.1.1.8), the assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;

- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its habitat; and
- assessed the significance of the impacts in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Significant impact assessment

An assessment of the likelihood of significant impacts on the Ornamental Snake in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a) is provided through Table 10.13.

The Ornamental Snake population occurring at the study area has been assessed against the definition of 'important population' of a vulnerable species (DoE 2013a). The study area is near the centre of the Ornamental Snake range within the Brigalow Belt. Dispersal and genetic exchange is likely to occur between the population occupying the study area and the population occupying the broader region. Therefore, it is considered that the population occupying the study area is not likely to be:

- a key source population for breeding or dispersal;
- a population necessary for maintaining genetic diversity; or
- a population near the limit of the species range.

The high amenity habitat with pronounced gilgai relief identified within the study area corresponds with the definition of known important habitat described in SEWPaC (2011c). Therefore, the population occupying this area of potentially important habitat may be considered an important population.

Table 10.13: Ornamental Snake significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species	The population of Ornamental Snake in the Project area is considered to be an important population. The Project will involve the clearing of 211.1 ha of habitat including 147.5 ha of low amenity habitat. The Project may lead to a decrease in the size of an important population. However, 903.4 ha of habitat will be retained in the study area, and 557.5 ha will be affected by subsidence but is expected to retain or increase its habitat viability.
Reduce the area of occupancy of an important population	The Project will result in the removal of a total of 211.1 ha of habitat. This removal of habitat may reduce the area of occupancy within the study area. Habitat for the species will be retained in the study area through retention of 903.4 ha of habitat that will be unaffected by the Project, as well as the 557.5 ha that will be affected by subsidence but is expected to retain or increase its habitat viability.

Significance criteria	Assessment of significance
Fragment an existing important population into two or more populations	The Project will result in the removal of 211.1 ha of habitat. The removal of habitat for the construction of the infrastructure corridor will impact connectivity of habitat located along One Mile Creek and in the habitat patch to the south of the open-cut pit. The open-cut pit will fragment a portion of low amenity habitat to the south of the pit from the habitat in the central portion of the study area. However, the connectivity to habitat outside of the study area will be retained. The mobility of the species is expected to allow it to disperse past Project features, including over or under the infrastructure corridor and *via* surrounding cleared areas. Therefore, the population is considered unlikely to be fragmented into two or more populations.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Ornamental Snake listed on the Register of Critical Habitat (DAWE 2021Ac). While the habitat is used by a local population of the species, the areas are unlikely to be necessary for the species as a whole for activities such as: • foraging; • breeding; • roosting; • dispersal; • the long-term maintenance of the species; and • maintaining genetic diversity for the reintroduction or recovery of the species. The high amenity habitat identified in the study area is considered likely to be important habitat for the species. This habitat may be considered to represent habitat critical to the survival of the species despite not being listed on the Register of Critical Habitat, and the Project, therefore, has potential to impact this critical habitat.
Disrupt the breeding cycle of an important population	The Project will result in the removal of a total of 211.1 ha of habitat, and these areas of habitat will not support breeding of the species after clearing. The undisturbed areas are expected to continue to provide for breeding. The areas affected by subsidence are expected to maintain habitat viability for breeding, as key habitat requirements are not expected to be degraded by the process of subsidence, including; gilgai depressions and wetland features, soil cracks, debris and leaf litter. The retained habitat throughout the study area is unlikely to be indirectly impacted by the Project. Indirect impacts, such as weeds and pests, noise and vibration, dust, artificial lighting, vehicle strike and bushfire, will be managed as outlined in section 10.5.2 and are considered not to have potential to disrupt the breeding cycle of the Ornamental Snake in retained habitat within the study area. The breeding cycle of Ornamental Snake outside the area of habitat to be removed is unlikely to be impacted by the Project.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project requires the removal of 211.1 ha of Ornamental Snake habitat. The removal of this extent of habitat is considered likely to decrease the availability of habitat and cause a decline of the species within the area local to the Project. The habitat retained within the study area is unlikely to undergo any process that is likely to cause the species to decline. The habitat within the subsidence areas will undergo some modification; however, the general habitat requirements of the species will be retained with the addition of increased areas of ponding in wet conditions. Areas of inundated depressions and wetland areas are predicted to be increased within subsidence areas, and therefore, the subsidence areas are considered likely to retain or exceed the availability and quality of habitat present in these areas.

Significance criteria	Assessment of significance
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The study area is in a modified rural landscape, and invasive species that may be harmful to the Ornamental Snake exist in the broader region. Predatory species, including feral cats, have been recorded in the study area. The Project is unlikely to result in the introduction and establishment of any invasive species that may predate on the Ornamental Snake in the habitat present within the study area. Feral pigs and cane toads have been recorded and are established in the Ornamental Snake habitat within the study area and are the likely cause of degradation of the habitat. The Project is unlikely to result in the introduction or establishment of any other species likely to be harmful to the Ornamental Snake. Monitoring and management of pests, including corrective actions, will be implemented in accordance with a Weed and Pest Management Plan (Section 10.5.2).
Introduce disease that may cause the species to decline	There are no diseases listed as a threat to the Ornamental Snake. The Project is unlikely to introduce a disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no adopted or made Recovery Plan for this species. Priority recovery actions identified by the TSSC (2014) include the identification of populations of high conservation priority, the use of conservation arrangements or management agreements on private land, inclusion in reserve tenure, minimisation of adverse impacts and controlling of introduced pests. The Project is unlikely to substantially interfere with the recovery of the species.
Conclusion	The Project will result in the removal of 211.1 ha of Ornamental Snake habitat. This clearing is identified as likely to reduce the area of habitat availability within the study area and may be critical to the survival of the species in the local area. Therefore, the Project is likely to have a significant impact to the Ornamental Snake. The extent of these impact areas is shown in Figure 10.18.

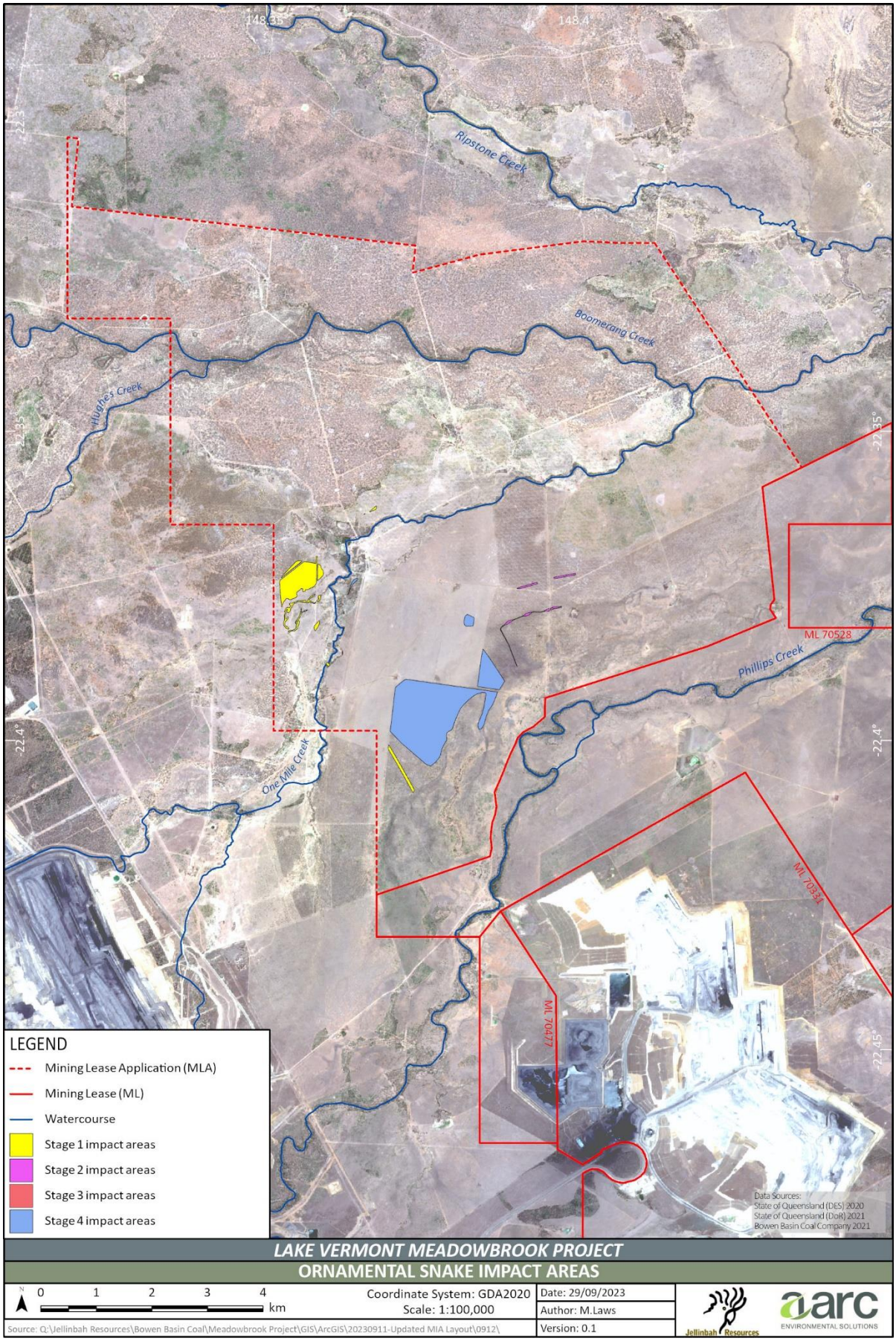

Figure 10.18: Ornamental Snake significant impact areas

10.6.4 White-throated Needletail

Description

The White-throated Needletail (*Hirundapus caudacutus*) is listed as Vulnerable under the EPBC Act and NC Act and is a listed migratory and marine species under the EPBC Act.

The White-throated Needletail is a large migratory swift that is widespread across eastern and south-eastern Australia during its non-breeding season in September/October (DAWE 2021a, TSSC 2019). In eastern Australia, it has been recorded in all coastal regions of Queensland, extending inland to the western slopes of the Great Divide and occasionally onto adjacent inland plains (DAWE 2021a). The species is considered to be widespread in eastern and south-eastern Australia, from the islands in Torres Strait south to Tasmania. One of two subspecies of White-throated Needletail occurs in Australia, although both occur in the northern hemisphere. (DAWE 2021a).

Primarily an aerial species, this species is known to occur across a variety of habitats, including wooded areas, open forests and rainforests (DAWE 2021a). Large tracts of native vegetation, particularly forest, is considered likely to be a key habitat requirement for this species (DoE 2015). It has been observed flying over farmland, typically over partially cleared pasture or within remnant vegetation at the edge of paddocks where it predominantly forages at cloud level along the edges of low-pressure systems (DAWE 2021a).

This species also forages in open habitats or recently disturbed areas (TSSC 2019), feeding on a wide variety of insects (DAWE 2021a) occasionally near ground level.

White-throated Needletails seldom alight on the ground or other substrates to catch insects and have very occasionally been seen foraging by launching into the air from trees in pursuit of flying insects or clinging to flowers on Eucalypts, searching for insects (DAWE 2021a).

It prefers to roost in forests and woodlands among dense foliage in canopies or in tree hollows, as well as on bark or rock faces, and occasionally roosts aerially (DAWE 2021a, DoE 2015a).

Survey effort

Seasonal fauna surveys of the study area were conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April) and autumn 2021 (16–25 April) over 45 days in consideration of relevant Commonwealth and Queensland surveys guidelines. The surveys were conducted within the survey windows for northern and eastern Australia (DAWE 2021a).

Fourteen systematic survey sites were established during the surveys. All systematic sites were established in habitat considered to provide potential foraging habitat to the White-throated Needletail.

Survey effort for the White-throated Needletail at systematic and supplementary sites included:

- diurnal searches: 75 person hours;
- bird surveys: 83 hours; and
- opportunistic observations.

The survey effort and timing meet the Commonwealth Guideline (DoEE 2019c) and the Queensland Guideline (Eyre *et al.* 2018). Further details of the survey timing, effort and methodology is provided in Appendix G, Terrestrial Ecology Assessment (Section 11.1.4).

Survey outcomes

An individual White-throated Needletail was recorded during the spring 2019 terrestrial ecology survey within the remnant Poplar Box woodland on alluvial plains (VC 2a) vegetation community.

Habitat assessment

The White-throated Needletail does not breed in Australia (Higgins 1996). During the non-breeding season in Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1,000 m above the ground (DAWE 2021a). The species forages above most habitat types and is predominantly recorded above wooded areas (TSSC 2019). The Project area contains areas of wooded and cleared areas that may provide foraging habitat for the species.

Impact assessment

Approximately 3371.7 ha of remnant vegetation (woodland habitat) has been identified within the study area (Figure 10.5).

A total of 12.2 ha of remnant vegetation is proposed to be cleared for the Project, and 96.9 ha is predicted to be impacted by potential ponding. The impacts to White-throated Needletail habitat will add to habitat disturbance that has, or is, proposed to occur for other Projects in the region. The clearance of remnant vegetation/habitat for the Project will not fragment habitat for this highly mobile species.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the White-throated Needletail. The proposed avoidance and mitigation measures for the White-throated Needletail have been outlined in section 10.8, and the proposed measures are detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.4), including descriptions of timing, predicted effectiveness, monitoring, adaptive management and relevant statutory or policy basis of each proposed measure.

Statutory requirements

The following conservation, recovery and threat abatement information has been considered for assessment of the White-throated Needletail:

- The 'Approved Conservation Advice for *Hirundapus caudacatus* (White-throated Needletail)' (TSSC 2019), developed at the time of the EPBC Act listing and the '*Hirundapus caudacutus*–White-throated Needletail' SPRAT profile, provides information about the White-throated Needletail, including its distribution, biology/ecology, threats and conservation actions and priorities.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this species, as the approved conservation advice (TSSC 2019) provides sufficient direction to implement priority actions and mitigate against key threats and enable recovery.
- The 'Draft Referral guideline for 14 birds listed as migratory species under the EPBC Act' (DoE 2015) provides information on 14 migratory species, including the White-throated Needletail. The referral guideline describes important non-breeding habitat for the White-throated Needletail.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019) and Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

Potential threats to the White-throated Needletail include (DAWE 2021a):

- collision with wind turbines and overhead wires;
- use of insecticides; and
- habitat loss and fragmentation (breeding habitat or non-breeding habitat).

The Project is not inconsistent with the objectives of the:

- EPBC Act or Australia's obligations under the Convention on Biological Diversity;
- Convention on International Trade in Endangered Species of Wild Fauna and Flora;
- Convention on Conservation of Nature in the South Pacific;
- China–Australia Migratory Bird Agreement (CAMBA);
- Japan–Australia Migratory Bird Agreement (JAMBA);
- Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA); or
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

As detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.4) the assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its habitat; and
- assessed the significance of the impacts in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance'.

Significant impact assessment

An assessment of the likelihood of significant impacts on the White-throated Needletail in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a) is provided through Table 10.14.

Table 10.14: White-throated Needletail significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species	Although two subspecies of White-throated Needletails breed in separate populations in the northern hemisphere, only one occurs in Australia where they do not occur as smaller populations (DAWE 2021a). The clearing of 12.2 ha of remnant vegetation for the Project and potential modification through occasional residual ponding of up to 96.9 ha of remnant vegetation is unlikely to decrease the size of the population, given the extent of habitat available to this species across eastern and south-eastern Australia.
Reduce the area of occupancy of an important population	The population of the White-throated Needletail that may use habitat within the study area is considered not to be an important population. The extent of vegetation clearance required for the Project is unlikely to reduce the area of occupancy of this species. Tracts of native vegetation which can provide roosting habitat will remain within the Project area and is widespread in the region. The study area habitat will continue to provide aerial foraging habitat.
Fragment an existing important population into two or more populations	The White-throated Needletail migrates to Australia during the non-breeding season and is widespread across eastern and south-eastern Australia. The Project will not fragment the population into two of more populations.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the White-throated Needletail listed on the Register of Critical Habitat. Habitat within the Project area does not represent habitat critical to the survival of the White-throated Needletail.
Disrupt the breeding cycle of an important population	The White-throated Needletail does not breed in Australia. The Project will not disrupt the breeding cycle.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Primarily an aerial species, the White-throated Needletail predominantly forages aerially, feeding on a wide variety of insects. They roost in forest and woodlands. While the Project will include some vegetation clearance, it will not reduce the quality or availability of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	Invasive species are not a serious threat to the White-throated Needletail. The Project is unlikely to result in invasive species that are harmful to the White-throated Needletail.
Introduce disease that may cause the species to decline	Disease is not a known threat to the White-throated Needletail. The Project is unlikely to introduce a disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. Priority conservation actions identified for this species include working with governments in East Asia to minimise disturbance to breeding habitats and identifying and protecting important habitats in Australia (TSSC 2019). The Project is unlikely to substantially interfere with the recovery of the species.
Conclusion	The area of habitat proposed to be cleared and the importance of the habitat present indicate the Project is unlikely to have a significant impact on the White-throated Needletail.

10.6.5 Squatter Pigeon

Description

The Squatter Pigeon (*Geophaps scripta scripta*) is listed as Vulnerable under the EPBC Act and NC Act.

The Squatter Pigeon occurs along the inland slopes of the Great Dividing Range, with a distribution from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coastline between Proserpine and Gladstone and south to scattered sites throughout south-eastern Queensland (Cooper *et al.* 2014).

The Squatter Pigeon is known to occur in remnant or regrowth open forest to sparse, open woodland or scrub dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species, with grassy understories within 3 km of a suitable waterbody (DAWE 2021a). Habitat for the species consists of ground covering vegetation rarely not exceeding 33%, and the species requires bare patches of gravelly or dusty soil for foraging.

Breeding habitat occurs in areas of similar vegetation on stony rises on sandy or gravelly soils within 1 km of a suitable waterbody. This is typically associated with Queensland RE land zones 3, 5 or 7 (DAWE 2021a).

The Squatter Pigeon is known to access suitable waterbodies to drink on a daily basis. Waterbodies suitable for the subspecies include:

- permanent or seasonal rivers;
- creeks;
- lakes;
- ponds and waterholes; and
- artificial dams, where there is gently sloping, bare ground on which to approach and stand at the water's edge (DAWE 2021a; Kerswell *et al.* 2020).

The subspecies also prefers to forage and dust-bathe on bare ground under an open canopy of trees (DAWE 2021a). The subspecies is considered unlikely to move far from woodland trees, which provide protection from predatory birds. Where scattered trees still occur, and the distance of cleared land between remnant trees or patches of habitat does not exceed 100 m, individuals may be found foraging in, or moving across modified or degraded environments (DAWE 2021a).

The Squatter Pigeon's diet consists of seeds, and the species mainly forages on seeds that have fallen to the ground from low vegetation, such as grasses, herbs and shrubs (DAWE 2021a).

The Squatter Pigeon scrapes a depression into the ground beneath tussock grass, a bush or a fallen log to create a nest. Females typically lay two eggs that are incubated for 17 days, and once hatched, chicks remain within the nest for two to three weeks and continue to be dependent upon their parents for around four weeks once leaving the nest (Kerswell *et al.* 2020).

Survey effort

Fauna surveys of the study area were conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April), winter 2021 (16–20 August June) and spring 2021 (6–10 September 2021) over 50 days in consideration of relevant Commonwealth and Queensland survey guidelines. The surveys extended over both Brigalow Belt Bioregion survey timing windows (i.e. spring to early summer and autumn) (Eyre *et al.* 2018).

Fourteen systematic survey sites were established during the surveys, with at least two sites established in each habitat type. Survey effort for the Squatter Pigeon included:

- active searching: 75 hours;
- diurnal bird surveys: 83 hours;
- camera trapping: 56 trap nights; and
- incidental recordings obtained from opportunistic observations while travelling within the general study.

Survey timing, methodology and effort meet the requirements of the Commonwealth and Queensland guidelines. The Project area is greater than 50 ha, ruling out the need for flushing surveys, which are required under Commonwealth guidelines for small survey areas (less than 50 ha).

Further details of the survey timing, effort and methodology are provided in Appendix G, Terrestrial Ecology Assessment (Section 11.1.5).

Survey outcomes

The Squatter Pigeon has been recorded within the study area during the spring 2019, autumn 2020 and autumn 2021 surveys. A total of 13 individuals were spotted during incidental recordings from opportunistic observations while travelling within the general study area (Appendix G, Terrestrial Ecology Assessment, appendix J). In winter 2021, opportunistic observations by 3D Environmental recorded the Squatter Pigeon to the east of the study area near the Isaac River. Squatter Pigeons were located at six locations in the study area and the locations at which the Squatter Pigeon has been recorded in the study area are shown on Figure 10.19.

Based on field survey data (i.e. secondary site assessment; Neldner *et al.* [2020]), remnant vegetation and high-value regrowth within the study area typically have a ground cover of less than 33%. While some locations include a high percentage of exotic Buffel Grass, native grass cover is common. Ground cover is not heterogeneous, and open areas were often encountered. Furthermore, grazing pressure was altered in April to June 2021 when cattle were removed from the property and this, accompanied by drought breaking rains in the following months, may have resulted in increased ground cover. Under these conditions, the local population may have shifted into surrounding lands where continued grazing ensured ground cover remained suitable. These changing conditions may explain their sporadic presence at the site and that, under different climatic conditions and grazing regime, it could play an important role for the location population.

Habitat assessment

Habitat mapping for the Squatter Pigeon within the study area is based on the habitat descriptions outlined in Table 10.15 and shown in Figure 10.19. The habitat descriptions in Table 10.15 are based on the information contained in DAWEs SPRAT database, including relevant statutory documents and published research specific to the distribution of habitat for the Squatter Pigeon within the study area.

Potential permanent, semi-permanent and seasonal water sources (watercourses, farm dams and wetlands) within the study area have been inspected by EcoSmart Ecology and AARC to determine their suitability as a water source for Squatter Pigeon breeding and foraging. The habitat assessment involved observations of the characteristics of the potential water source and the ground cover and other microhabitat features in areas surrounding the water source.

Table 10.15: Squatter Pigeon habitat description and occurrence

Habitat description	Relevant features present within the study area
Potential for breeding	
Remnant or regrowth open forest, woodland, open woodland or scrub with relatively sparse (<33%) groundcover vegetation. Typically an overstorey dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species within 1 km of suitable permanent or semi-permanent water bodies (DAWE 2021a).	Available literature suggests Squatter Pigeons have the potential to nest in areas of suitable habitat within 1 km of a permanent or semi-permanent water source. All areas of remnant and high-value regrowth within the site have been identified as suitable (subject to weather and grazing conditions). Permanent or semi-permanent water bodies identified within the study area include One Mile Creek, all farm dams and a selection of natural wetlands, which have been assessed as providing a reliable source of water for breeding under most climatic conditions. Applying the 1 km buffer around these sources suggests breeding opportunity is possible within the areas shown in Figure 10.19. The ephemeral watercourses, Hughes Creek, Boomerang Creek and Phillips Creek are characterised by sandy substrates. While water can be present in these streams following large rainfall events/flooding, the water quickly disappears within days or, at most, a few weeks. These streams do not provide a semi-permanent or permanent water source for the Squatter Pigeon.
Potential for climatic dependant breeding	
Remnant or regrowth open forest, woodland, open woodland or scrub with relatively sparse (<33%) groundcover vegetation. Typically an overstorey dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species within 1 km of suitable seasonal water bodies.	A number of natural wetlands occur within the study area that do not provide a permanent or semi-permanent source of water. However, these natural wetlands may provide a suitable source of water under certain climatic conditions (e.g. in above average wet years). Remnant and high-value regrowth vegetation within 1 km of these natural wetlands may provide breeding habitat for the Squatter Pigeon under certain climatic conditions and have been mapped as 'opportunity for climatic-dependent breeding'.
Suitable foraging habitat	
Remnant or regrowth open forest, woodland, open woodland or scrub with relatively sparse (<33%) groundcover vegetation. Typically an overstorey dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species within 3 km of suitable permanent, semi-permanent, or seasonal water bodies.	The areas mapped as remnant vegetation and high-value regrowth vegetation within the study area provide suitable groundcover for the Squatter Pigeon (subject to climatic conditions and grazing pressure). Therefore, they have been mapped as suitable habitat where the vegetation occurs within 3 km of suitable permanent, semi-permanent or seasonal water sources. The suitable water sources include those described above in 'potential for breeding' and 'opportunity for climatic breeding'. The ephemeral streams, Hughes Creek, Boomerang Creek and Phillips Creek are considered not to provide a suitable seasonal source of water. Grass cover in the cleared agricultural areas is typically much greater than 33% and unsuitable foraging habitat for the Squatter Pigeon. There is some opportunity for the Squatter Pigeon to forage in the immediate vicinity of farm dams, where cattle grazing prohibits grass growth, and along property access tracks. However, these areas are considered unlikely to provide extensive foraging opportunities for the species.
Dispersal habitat	
Any forest or woodland occurring between patches of foraging or breeding habitat and suitable waterbodies—includes areas of cleared land less than 100 m wide linking areas of suitable breeding or foraging habitat.	Dispersal habitat has been defined to include any remnant and regrowth open forest or woodland occurring between patches of foraging and breeding habitat and areas of cleared land (<100 m wide) that link areas of suitable habitat.

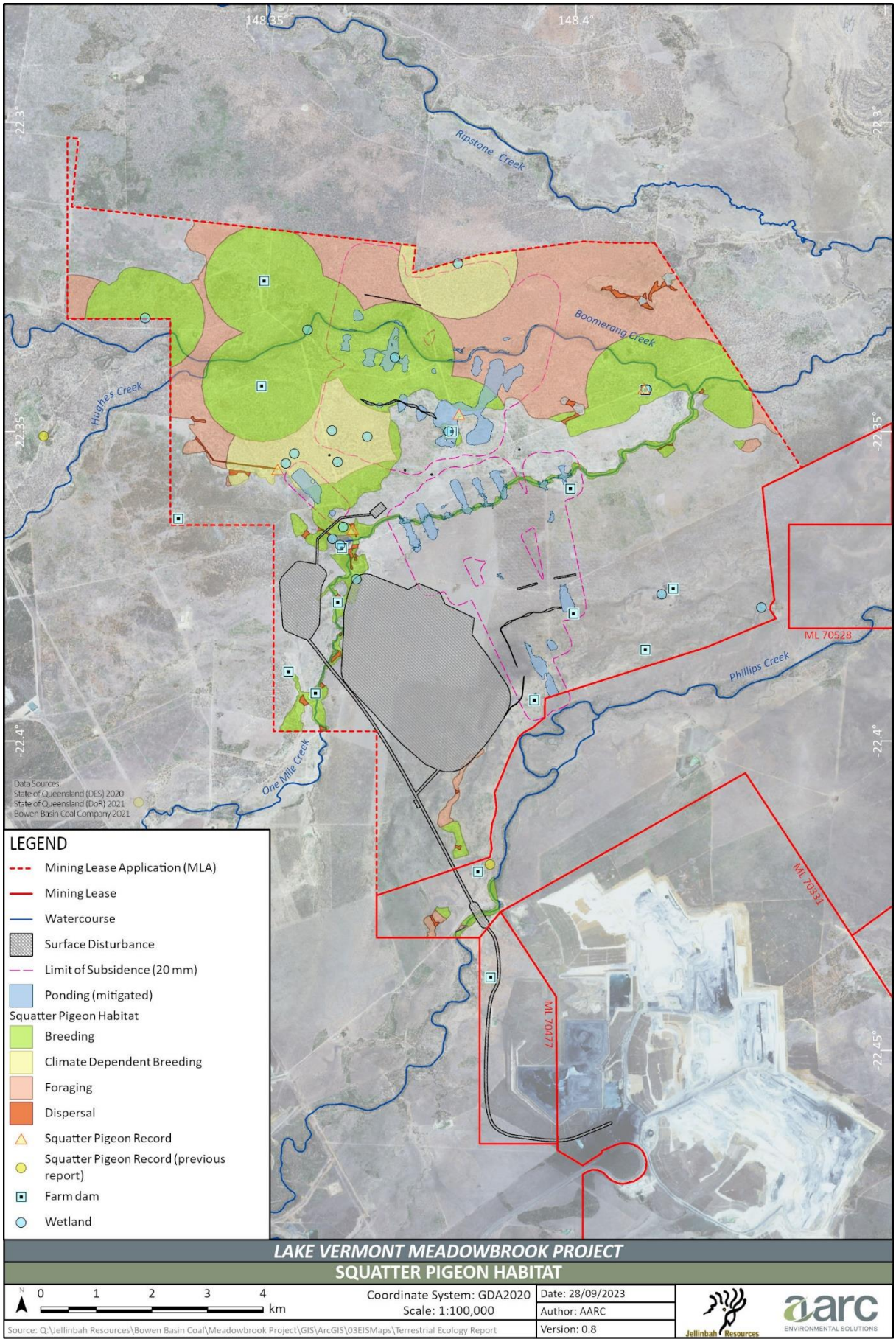

Figure 10.19: Squatter Pigeon habitat mapping

Impact assessment

A total of 3,539.2 ha of Squatter Pigeon habitat has been identified within the study area, as shown in Table 10.16 and Figure 10.19, including:

- 1,869.7 ha of potential breeding habitat;
- 459.4 ha of potential climate-dependent breeding habitat;
- 1,181.1 ha of additional foraging habitat (i.e. additional to the foraging habitat provided by the potential breeding areas); and
- 29 ha of dispersal habitat.

A total of 15.5 ha of Squatter Pigeon habitat is proposed to be cleared for the direct surface disturbance of stages 1, 2, 3 and 4 of the Project, including:

- 12.6 ha of potential breeding habitat;
- 0.3 ha of potential climate-dependent breeding habitat; and
- 2.7 ha of additional foraging habitat.

The Project will result in impacts on Squatter Pigeon habitat, which will add to habitat disturbance that is proposed to occur for other Projects in the region.

The land disturbance associated with the Project (e.g. infrastructure corridor and MIA) will result in some fragmentation of Squatter Pigeon habitat; however, this is unlikely to be significant given the mobility of this species.

A total of 990.3 ha of Squatter Pigeon habitat is within the proposed subsidence footprint and a further 103.6 ha of habitat is within the subsidence footprint predicted to undergo periodic ponding. The potential indirect impacts of subsidence are discussed in Section 10.5.2.1. No direct impacts to vegetation are expected to result from subsidence and the Squatter Pigeon habitat characteristics within the subsidence area are expected to be maintained. Soil cracks are predicted to develop in the subsidence area, however given the monitoring and management of potential soil cracks which will be detailed within the Subsidence Management Plan (refer Chapter 5, Land Resources) the quality or availability of Squatter Pigeon habitat within the subsidence footprint is considered unlikely to be impacted.

The expected impacts in areas predicted to undergo periodic ponding are described in Section 10.5.2.1. Squatter Pigeon habitat in areas of predicted ponding is expected to retain vegetation characteristics required for provide suitable habitat of open forest, woodland, open woodland or scrub with relatively sparse (<33%) groundcover vegetation. The areas of predicted residual ponding are expected to represent a potential change of habitat, not a removal of habitat. These areas are predicted to experience inundation every few years and retain water for several months. The predicted ponding of water in these areas will create an expansion of the potential climatic-dependent breeding habitat into areas that currently provide foraging habitat but do not support breeding habitat because of their distance to water. The availability of Squatter Pigeon habitat is expected to be retained in predicted ponding areas and the quality of habitat is expected to change through the expansion of breeding and climatic dependent breeding areas.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels; the changes to flood levels and extent are not considered significant (Appendix W, Geomorphological Assessment Report, Section 4.2). The impacts therefore, of changes to flooding regimes are not expected to significantly impact Squatter Pigeon habitat. Potential or likely GDEs were identified within the study area, however were assessed to be unlikely to be significantly impacted by the Project (refer Section 10.5.2.3). Therefore, groundwater impacts are considered unlikely to impact Squatter Pigeon habitat.

The potential for indirect impacts on the Squatter Pigeon from noise and vibration, dust, lighting and vehicle strike are considered to be minimal, given the measures that will be implemented to manage these impacts.

Impacts of erosion and subsidence related cracking and erosion are assessed in Section 10.5.2.11 and Chapter 5, Land Resources, Section 5.4.1 and Section 5.4.3. Given the proposed monitoring and management measures for erosion, no substantial erosion is expected to occur and it is considered unlikely that erosion will impact Squatter Pigeon habitat. The Project also has the potential to increase weed and animal pest populations if they are not appropriately managed. However, as described in section 10.5.2, weed and pest management measures will be implemented for the Project.

The identification of impacts to Squatter Pigeon habitat in the study area includes consideration of potential impacts from climate change and adjoining projects that have been incorporated into hydrological modelling (Appendix Z, Flood Modelling Assessment Report, Section 1.3.12). It is considered that the assessment has, therefore, taken into account cumulative sources of impact, and no further cumulative impacts to Squatter Pigeon habitat will occur. Further discussion of cumulative impacts is provided in section 10.5.4.

Table 10.16: Proposed Project footprint within Squatter Pigeon habitat

Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)		Extent of subsidence impact (ha)[a]	Extent of predicted ponding impact (ha)
		Stages 1, 2, 3 clearing (ha)	Stage 4 clearing (ha)		
Breeding	1,869.7	5.5	7.1	373.5	62.6
Climate-dependent breeding	459.4	0.3	0.0	273.1	8.9
Foraging	1,181.1	0.5	2.2	343.7	31.5
Dispersal	29.0	<0.1	0	0	0.6
Total	**3,510.2**	**6.3**	**9.3**	**990.3**	**103.6**

a Excludes predicted ponding areas

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Squatter Pigeon. The proposed avoidance and mitigation measures for the Squatter Pigeon have been outlined in section 10.8, and the proposed measures are detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.5), including descriptions of timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis of each proposed measure.

Statutory requirements

A number of conservation, recovery and threat abatement plans are relevant to the Squatter Pigeon and have been considered in assessment of the Squatter Pigeon:

- The 'Conservation Advice for *Geophaps scripta scripta* (Squatter Pigeon [southern])' (TSSC 2015b), developed at the time of EPBC Act listing, and '*Geophaps scripta scripta*–Squatter Pigeon (southern)' SPRAT profile provide information about the species, including its distribution, biology/ecology, threats and conservation actions and priorities.
- The SPRAT profile for this species indicates that there is no adopted or made Recovery Plan for this species, as the approved conservation advice (TSSC 2015b) provides sufficient direction to implement priority actions and mitigate against key threats.
- The 'Survey guidelines for Australia's threatened birds' (DEWHA 2010a) includes information on Squatter Pigeon and recommended methods for survey.

- Three threat abatement plans are listed in the SPRAT profile (DAWE 2021a) as being relevant to the Squatter Pigeon, namely:
    - Department of the Environment (Commonwealth of Australia 2015b) Threat Abatement Plan for predation by feral cat;
    - Department of the Environment and Energy (2016b) Threat Abatement Plan for competition and land degradation by rabbits; and
    - Department of the Environment, Water, Heritage and the Arts (DEWHA 2008b) Threat Abatement Plan for predation by the European red fox.

Note: A threat abatement plan is a plan made or adopted under section 270B of the EPBC Act that establishes a national framework to guide and coordinate Australia's response to the impacts of a key threatening process.

'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019), Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

Threats to the Squatter Pigeon (southern) include (DAWE 2021a):

- habitat loss and fragmentation;
- habitat degradation by overgrazing by stock, especially cattle;
- habitat degradation by the establishment of invasive pasture species, including Buffel Grass *(Cenchrus ciliaris)*; and
- predation by species, including the Fox *(Vulpes vulpes)*, Dingo *(Canis familiaris dingo)*, and Feral Cat *(Felis catus)*.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific. The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitat;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its habitat; and
- assessed the significance of the impacts in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Significant impact assessment

Table 10.17 provides an assessment of the likelihood of significant impacts on the Squatter Pigeon in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

The Squatter Pigeon population occurring in the study area is not part of the sub-population occurring south of the Carnarvon Ranges, which is an important sub-population (DAWE 2021a). The species occurs regularly north of the Carnarvon Ranges and is considered one population occurring commonly throughout the northern range. The population occurring at the study area is part of this northern population that has connectivity across a large area for dispersal and breeding. Therefore, the Squatter Pigeon occurring in the study area is neither:

- a key source population for breeding or dispersal; nor
- a population that is necessary for maintaining genetic diversity.

The Squatter Pigeon range extends south to northern NSW, north to Mackay and west to near Longreach. Therefore, the population occurring in the study area is not located near the limit of the species range.

The population of Squatter Pigeon that uses the study area is considered unlikely to be an important population according to the criteria of the Significant Impact Guidelines (DoE 2013a).

Table 10.17: Squatter Pigeon significant impact assessment

Significance criteria	**Assessment of significance**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species	The population of Squatter Pigeon that uses habitat within the study area is considered not to be an important population. It is considered that the removal of 15.5 ha of Squatter Pigeon habitat will not lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	The population of Squatter Pigeon that uses habitat within the study area is considered not to be an important population. The removal of 15.5 ha of Squatter Pigeon habitat is considered unlikely to reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	The population of Squatter Pigeon that uses the habitat within the study area is considered not to be an important population. The removal of 15.5 ha of Squatter Pigeon habitat is considered unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Squatter Pigeon listed on the Register of Critical Habitat (DAWE 2021a). The Squatter Pigeon habitat to be impacted by the Project is considered not critical to the survival of the species as, while the habitat is used by a local population of the species, the areas are unlikely to be necessary for the species as a whole for activities such as: • foraging; • breeding; • roosting; • dispersal; • long-term maintenance of the species; • maintaining genetic diversity; and • the reintroduction or recovery of the species.
Disrupt the breeding cycle of an important population	The population of Squatter Pigeon that uses habitat within the study area is considered not to be an important population. The removal of 15.5 ha of Squatter Pigeon habitat is considered unlikely to disrupt the breeding cycle of an important population.

Significance criteria	Assessment of significance
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project requires the removal of 15.5 ha of Squatter Pigeon habitat, including 12.6 ha of potential breeding habitat, 0.3 ha of potential climate-dependent breeding habitat and 2.7 ha of foraging habitat. The removal of this extent of habitat is unlikely to lead to a long-term decline in the species population, given the wider extent of habitat for this species.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The study area is in a modified rural landscape, and invasive species that are harmful to the Squatter Pigeon exist in the broader region. Predatory species, including feral cat and feral fox, have been recorded and are established in the study area and are recognised threats to the Squatter Pigeon. Buffel Grass, which can change understory cover, is already established throughout the study area. The Project is unlikely to result in the introduction and establishment of any invasive species that are harmful to the Squatter Pigeon in the habitat present in the study area. Monitoring and management of pests, including corrective actions, will be implemented in accordance with a Weed and Pest Management Plan (Section 10.5.2).
Introduce disease that may cause the species to decline	No diseases are listed as a threat to the Squatter Pigeon. The Project is unlikely to introduce a disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no adopted or made Recovery Plan for this species. The approved conservation advice provides direction to implement priority actions for this species and mitigate against key threats (TSSC 2015b). Priority conservation and management actions include the identification of sub-populations of high conservation priority, development of conservation agreements and control of feral herbivores. The Project is unlikely to substantially interfere with the recovery of the species.
Conclusion	The Project is considered unlikely to result in a significant impact to the Squatter Pigeon. The area of habitat to be disturbed by the Project is a very small proportion of the mapped habitat for the species, both within the study area and the wider region. The impacted habitat is considered not to be utilised by an important population. The predicted subsidence will also provide areas of intermittent ponding that may support the expansion of breeding habitat within the study area through the provision of seasonal water sources.

10.6.6 Australian Painted Snipe

Description

The Australian Painted Snipe (*Rostratula australis*) is listed as Endangered under the EPBC Act and NC Act. It is also listed as a migratory species and marine species under the EPBC Act.

The Australian Painted Snipe is known to occur within wetlands within all states of Australia (DAWE 2021a). This species is most common in eastern Australia, where it has been recorded throughout much of Queensland, New South Wales, Victoria and south-eastern South Australia at scattered locations (DAWE 2021a). The species is widespread and is considered not to have a limited geographic distribution (DSEWPaC 2013a). The species is considered to occur in Australia as a single contiguous breeding population (DAWE 2021a).

Habitat for the Australian Painted Snipe includes a variety of shallow wetlands, including temporary and permanent lakes, swamps and claypans (DAWE 2021a). The Australian Painted Snipe forages at the waters' edge and on mudflats (Garnett and Crowley 2000) and eats vegetation, seeds, insects, worms and molluscs, crustaceans and other invertebrates (Marchant & Higgins 1993).

Nesting nearly always occurs on small islands or wetlands with complex shorelines, shallow water, exposed mud, with patchy to continuous vegetation surrounding the wetland (Rogers *et al.* 2005). Although the species can utilise modified habitats for foraging, they do not breed within areas that lack suitable cover. This species is mainly crepuscular (active at dawn and dusk) and highly cryptic.

The species requires wetland areas and will move to suitable habitat when the habitat becomes unavailable in an area (DAWE 2021a). Dispersive movements have been attributed to local conditions (i.e. moving to flooded areas, moving from drying to permanent wetlands and moving away from areas affected by drought). (DAWE 2021a).

Survey effort

Fauna surveys of the study area were conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April) and spring 2021 (6–10 September) over 50 days in consideration of relevant Commonwealth and Queensland survey guidelines. The surveys extended over both Brigalow Belt Bioregion survey timing windows (i.e. spring to early summer and autumn) (Eyre *et al.* 2018).

Fourteen systematic survey sites were established during the surveys, with at least two sites established in each habitat type. Survey effort for the Australian Painted Snipe included:

- active searching: 75 hours;
- diurnal bird surveys: 83 hours;
- spotlighting: 47 hours; and
- opportunistic observations in suitable habitat.

Survey timing, methodology and effort meet the requirements of the Commonwealth and Queensland guidelines.

Survey outcomes

The Australian Painted Snipe was not detected by the seasonal fauna surveys. Most water bodies within the site are not considered suitable as they lack a complex mosaic of shallow water, open mudflats and clumping vegetation. This includes almost all farm dams. Where habitat is present, it is minor in extent and low in amenity. The species might only occur as a rare vagrant.

Habitat assessment

Habitat mapping for the Australian Painted Snipe within the study area is shown in Figure 10.20 and is based on the habitat descriptions outlined in

Table 10.18. It should be noted that the extent of the low amenity is likely to be less than indicated due to thick exotic grass growth in some areas. The habitat descriptions in

Table 10.18 are based on the information contained in DAWEs SPRAT database, including relevant statutory documents and published research specific to the distribution of potential habitat for the Australian Painted Snipe within the study area.

Habitat assessment for the Australian Painted Snipe has involved inspection of permanent, semi-permanent and seasonal water sources by EcoSmart Ecology and AARC to assess their suitability for Australian Painted Snipe breeding and/or foraging in relation to:

- water body size;
- water retention;
- presence of mudflats; and
- structure of aquatic and fringing vegetation.

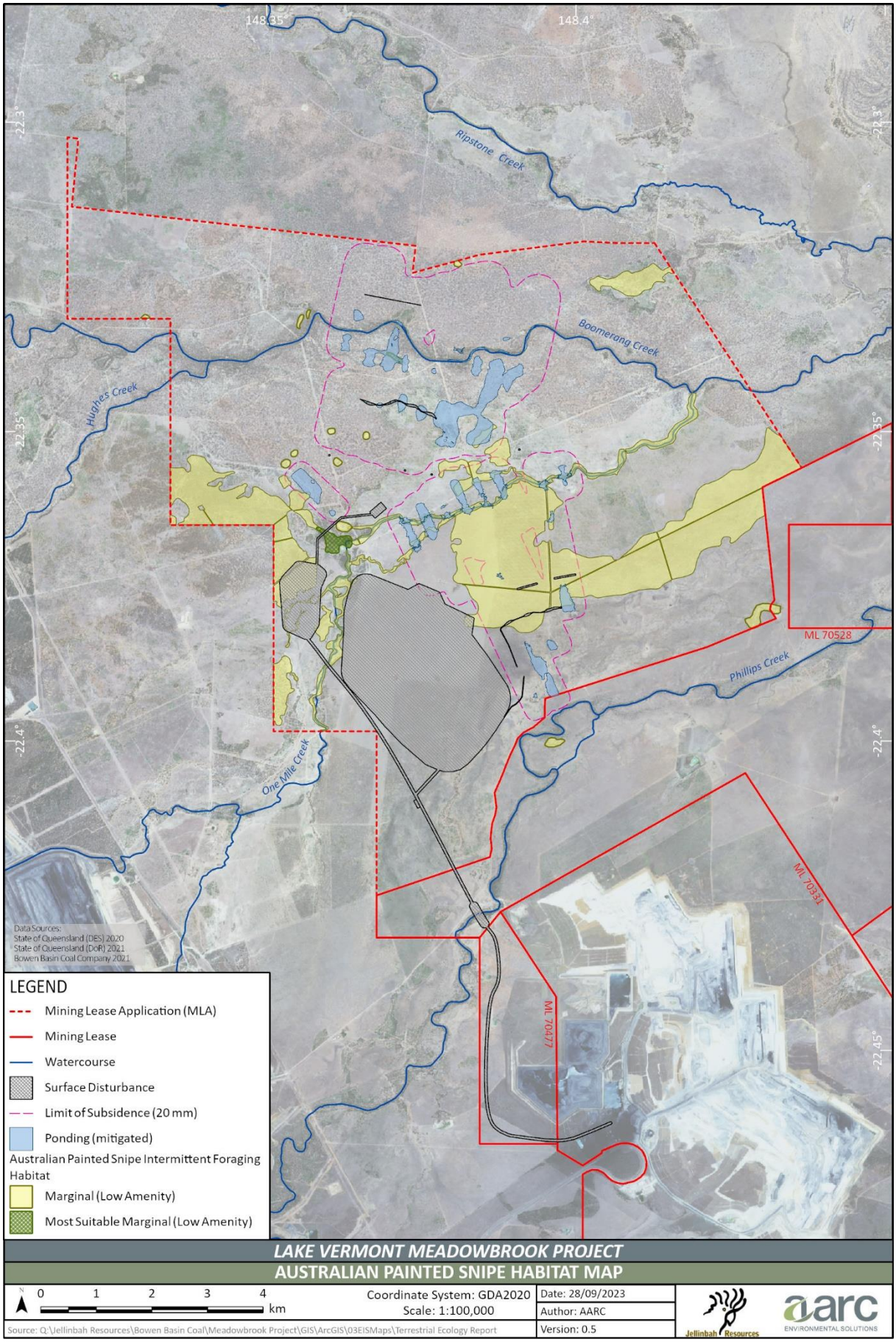

Figure 10.20: Australian Painted Snipe habitat mapping

Table 10.18: Australian Painted Snipe habitat description

Habitat description	Features present within the study area relevant to habitat category
Breeding habitat	
Wetlands with a complex shoreline with a mosaic of open mud areas, shallow waters (<5cm) and surrounding groundcover vegetation—clumping vegetation, such as tufted grasses, sedges, small woody plants and continuous reed beds or stands of reed-like vegetation (not including tall dense reed beds such as Cumbungi) Nests are built on small islands.	Not present within the study area; wetlands within the study area are minor in extent and lack the complex microhabitat features required for this species breeding.
Intermittent foraging habitat	
Shallow permanent or ephemeral freshwater or brackish wetlands and other inundated/waterlogged areas with a variable ground cover (e.g. grasses, shrubs and rushes)	Site habitat assessments indicate the wetland and gilgai habitats within the study area provide the most suitable marginal (low amenity), intermittent foraging habitat for the Australian Painted Snipe. This includes one natural palustrine wetland and two modified wetlands (palustrine and lacustrine). Less suitable marginal (low amenity) habitat is provided by wetted gilgai habitat is only available for a short period after rainfall when the gilgai are full. Inspections of farm dams within the study area indicate they do not provide suitable foraging habitat for the Australian Painted Snipe.

Impact assessment

A total of 1242.2 ha of Australian Painted Snipe marginal (low amenity) foraging habitat has been identified within the study area including 14.2 ha of the most suitable (palustrine and lacustrine wetland area) and 1228 ha of low amenity foraging habitat (Figure 10.20). A total of 36.5 ha of Australian Painted Snipe habitat is proposed to be disturbed by stage 1 of the Project, and 4.2 ha is proposed to be disturbed by stage 4 (Table 10.19). The Project will result in impacts on Australian Painted Snipe which, while low in habitat amenity, will add to habitat disturbance that is proposed to occur for other Projects in the region.

The areas of residual ponding occur over a 29.5-ha portion of the identified Australian Painted Snipe habitat. These areas are expected to represent a change of habitat; the ponded areas are likely to hold water for a maximum period of several months every few years depending on inflow volumes and soil permeability conditions at the time (Appendix W, Geomorphological Assessment Report, Section 3.3.3), which is likely longer than the habitat currently holds water. This would potentially provide an increase in habitat suitability in these areas. The residual ponding areas also extend outside the mapped Australian Painted Snipe foraging habitat, and the ponding in these areas may allow these previously unsuitable areas to provide some low amenity foraging habitat to the Australian Painted Snipe.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels; however, the changes to flood levels and extent are considered not significant (Appendix W, Geomorphological Assessment Report, Section 4.2). The impacts of changes to flooding regimes on Australian Painted Snipe habitat are, therefore, not expected to be significant.

The potential for indirect impacts to the Australian Painted Snipe from noise and vibration, dust, lighting and vehicle strike is considered to be minimal, given the measures that will be implemented to manage these impacts and the low likelihood of its occurrence given more suitable habitats exist in the surrounds and in the wider region. The Project also has the potential to increase weed and animal pest populations if they are not appropriately managed. However, as described in section 10.5.2, weed and pest management measures will be implemented for the Project.

Table 10.19: Proposed disturbance of Australian Painted Snipe habitat

Habitat	Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)	
			Stages 1, 2, 3 clearing (ha)	Stage 4 clearing (ha)
Intermittent foraging habitat	Most suitable marginal (low amenity)	14.2	0.3	0.0
	Marginal (low amenity)	1228.0	36.2	4.2
	Total	**1242.2**	**36.5**	**4.2**

Avoidance

The Project has been designed to avoid and mitigate impacts on the Australian Painted Snipe. The proposed avoidance and mitigation measures for the Australian Painted Snipe have been outlined in section 10.8, and the proposed measures are detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.6), including descriptions of timing, predicted effectiveness, monitoring, adaptive management and relevant statutory or policy basis of each proposed measure.

Statutory requirements

The following conservation, recovery and threat abatement information has been considered for assessment of the Australian Painted Snipe:

- The 'Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe)' (DSEWPaC 2013a), 'Commonwealth Listing Advice on *Rostratula australis* (Australian Painted Snipe)' (TSSC 2013b) and 'Rostratula australias–Australian Painted Snipe' SPRAT profile provides information in relation to its population and distribution, habitat, movements and feeding and provides guidance on threat abatement and recovery actions that can be undertaken for the species.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this species; however, a Recovery Plan is required. A 'Draft National Recovery Plan for the Australian Painted Snipe–Rostratula australis' (DoEE 2019d) provides information on current threats and recovery actions.
- The 'Survey guidelines for Australia's threatened birds' (DEWHA 2010a) includes information on the Australian Painted Snipe and recommended methods for survey.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019) and Australia's actions for nature, including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

Threats to the Australian Painted Snipe include (DAWE 2021a, DoEE 2019d):

- loss and degradation of wetland habitat, including:
  - drainage of wetlands and diversion of water to agriculture and reservoirs;
  - deterioration of water quality;
  - grazing and associated trampling of wetland vegetation by cattle and/or sheep;
  - the replacement of endemic wetland vegetation by invasive weeds;
  - climate variability and change; and

  - degradation of habitat by invasive herbivores such as the Feral Pig, Goat and Deer;
- predation by feral species, such as the European Red Fox and Feral Cat;
- inappropriate fire regimes; and
- low genetic diversity.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention on Conservation of Nature in the South Pacific, the China–Australia Migratory Bird Agreement, the Japan–Australia Migratory Bird Agreement, the Republic of Korea–Australia Migratory Bird Agreement or the Convention on the Conservation of Migratory Species of Wild Animals. As detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.6), the assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its habitat; and
- assessed the significance of the impacts in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Significant impact assessment

An assessment of the likelihood of significant impacts on the Australian Painted Snipe in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a) is provided in Table 10.20.

Table 10.20: Australian Painted Snipe significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	The Australian Painted Snipe is considered to occur in a single, contiguous breeding population (Garnett & Crowley 2000). As the Project will not disturb breeding habitat, it is unlikely to disrupt the breeding cycle of the Australian Painted Snipe. The extent of Project disturbance to low amenity intermittent foraging habitat is unlikely to lead to a long-term decrease in the size of the population, given the extent of foraging habitat available in the wider region. The Project is highly unlikely to decrease the size of a population.
Reduce the area of occupancy of the species	The Australian Painted Snipe has not been recorded by the Project surveys. While the Project will disturb potential intermittent foraging habitat for the Australian Painted Snipe, it is unlikely to reduce the area of occupancy of the species, given similar (and higher amenity) wetland and floodplain habitats occur within the local area and wider region.

Significance criteria	Assessment of significance
Fragment an existing population into two or more populations	The Australian Painted Snipe has been recorded at wetlands in all states of Australia. However, it is most common in eastern Australia where it has been recorded throughout much of Queensland, New South Wales, Victoria and south-eastern South Australia at scattered locations (DoEE 2019c and DoEE 2019d). Connectivity of habitat will not be compromised by the Project for this mobile species. The Project will not fragment the population into two of more populations.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Australian Painted Snipe listed on the Register of Critical Habitat (DAWE 2021a). The habitat to be disturbed by the Project is considered not critical to the survival of the species, as it is unlikely to be necessary for activities such as foraging, breeding, roosting, dispersal, long-term maintenance of the species, maintaining genetic diversity or recovery of the species.
Disrupt the breeding cycle of a population	The Project will not disturb breeding habitat for the Australian Painted Snipe and is unlikely to disrupt the breeding cycle of the population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No potential breeding habitat will be disturbed by the Project. Up to 40.7 ha of potential intermittent marginal foraging habitat for the Australian Painted Snipe may be directly disturbed by the Project. However, this is unlikely to cause the species to decline given the availability of foraging resources in the local and wider area. As described in section 10-33, changes to the flooding regime within the study area and surrounds are predicted to be minor and are unlikely to affect the availability of habitat for this species. Potential indirect impacts associated with the Project, such as weeds and pest animals, will be managed so they do not degrade retained habitat within the study area. The Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Land within the study area is currently used for low intensity cattle grazing. Grazing, and associated trampling of wetland vegetation by cattle is recognised as a potential threat to this species' habitat. Predation by feral species, such as the European Red Fox and Feral Cat, is also a recognised threat; both have been recorded in the study area. Invasive herbivores, including the Feral Pig and Red Deer, have also been recorded in the study area. The Project is unlikely to increase these threats or result in invasive species becoming established in the species' habitat.
Introduce disease that may cause the species to decline	Disease is not a known threat to this species. There are no indications of disease threatening the population of the Australian Painted Snipe. The Project is unlikely to introduce a disease that may cause the species to decline.

Significance criteria	Assessment of significance
Interfere with the recovery of the species	While there is currently no adopted Recovery Plan for this species, the 'Draft National Recovery Plan for the Australian Painted Snipe –Rostratula australis' (DoEE 2019d) outlines recovery objectives and strategies to improve the conservation status of the species. The six key strategies identified to achieve the Draft Recovery Plan objectives are: 1. Manage and protect known Australian Painted Snipe breeding habitats at the landscape scale. 2. Develop and apply techniques to measure changes in population trajectory in order to measure the success of recovery actions. 3. Reduce or eliminate threats at breeding and non-breeding habitats. 4. Improve knowledge of the habitat requirements, biology and behaviour of Australian Painted Snipe. 5. Engage community stakeholders to improve awareness of the conservation of Australian Painted Snipe. 6. Coordinate, review and report on recovery process. The Project is unlikely to interfere with the recovery of the species.
Conclusion	The Project is considered unlikely to significantly impact the Australian Painted Snipe.

10.6.7 Koala

Description

The Koala (*Phascolarctos cinereus*) was listed as vulnerable under the NC Act and the EPBC Act at the time of the Section 75 EPBC Act controlled action decision for the Project). The Koala listing status under the EPBC Act was subsequently updated to endangered in 2022 (after the controlled action decision was made and significant survey effort was completed). The impact on this species has therefore been assessed using the criteria that applied at the time of the controlled action decision (consistent with legal expectations).

The Koala is known to occur in temperate to tropical forest, woodland and semi-arid communities in areas that contain known Koala food trees or shrubland with emergent food trees (DoE 2014a). The Koala is a leaf-eating specialist that feeds primarily during dawn, dusk or at night (DoE 2014a). Diet is restricted mainly to *Eucalyptus* species; however, it may also consume foliage of related genera, including *Corymbia, Angophora* and *Lophostemon*. The Koala is also known to supplement its diet with other genera at times, including *Leptospermum* and *Melaleuca* (DoE 2014a).

Koalas tend to move little under most conditions, changing trees only a few times each day (Ellis *et al.* 2009). Dispersing individuals, mostly young males, may occasionally cover distances of several kilometres over land with little vegetation (DAWE 2021a).

Shelter trees play an essential role in thermoregulation and are likely to be selected based on height, canopy cover and elevation (i.e. trees occurring in gullies are preferable) (Crowther *et al.* 2013). A growing body of evidence suggests that shelter trees are equally important as food trees and should be weighted as such when assessing habitat suitability (Crowther *et al.* 2013).

Preferred food and shelter trees are naturally abundant on fertile clay soils, and the highest densities of Koalas are likely to occur along creek lines (DoEE 2019c, TSSC 2012a, DSEWPaC 2012a). A potential Koala habitat tree is considered to be a tree of the *Corymbia, Melaleuca, Lophostemon, Eucalyptus* genera that is edible by Koalas or *Angophora* genus with a trunk diameter greater than 10 cm at 1.3 m above ground (State of Queensland 2020).

This species has established home ranges within revegetated Eucalypt Woodlands (TSSC 2012a). Areas of relatively lower quality habitat that enable movement between higher quality areas also constitute important habitat for the Koala (DEWHA 2009).

Survey effort

Fauna surveys of the study area were conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April) and spring 2021 (6–10 September) over 50 days in consideration of relevant Commonwealth and Queensland surveys guidelines. The spring 2019 survey was conducted during the recommended direct observation period (TSSC 2012a).

Fourteen systematic survey sites were established during the surveys, all habitat types surveyed systematically were considered to provide potential Koala habitat.

Survey effort for the Koala at systematic and targeted sites included:

- diurnal searches for Koalas and scats: 75 person hours;
- call playback: 11 person hours;
- spotlighting: 58.6 person hours in total;
- camera trapping: 56 trap nights.

Survey timing, effort and methodology are consistent with the Commonwealth and Queensland guidelines, and the survey methods used were included in the recommendations of both guidelines.

The habitat assessment survey comprised 20 x 100 m x 50 m transects used to assess the availability of suitable *Myrtaceae* 'Eucalypt' trees (species of *Eucalyptus, Angophora* and *Corymbia*) within remnant vegetation and high-value regrowth vegetation within the study area. The number of *Myrtaceae Eucalypts* with a diameter at breast height of more than 10 cm were counted along each transect. Further details of the survey timing, effort and methodology are provided in Appendix G, Terrestrial Ecology Assessment (Section 11.1.7).

Survey outcomes

The Koala is present within the study area. Six Koala individuals and three scats were recorded during the autumn 2019, spring 2019 fauna surveys and the spring 2021 habitat assessment survey. The species has been observed at systematic trap sites in Eucalypt Dry Woodlands and freshwater wetland habitats and incidentally in remnant vegetation as shown in Figure 10.21.

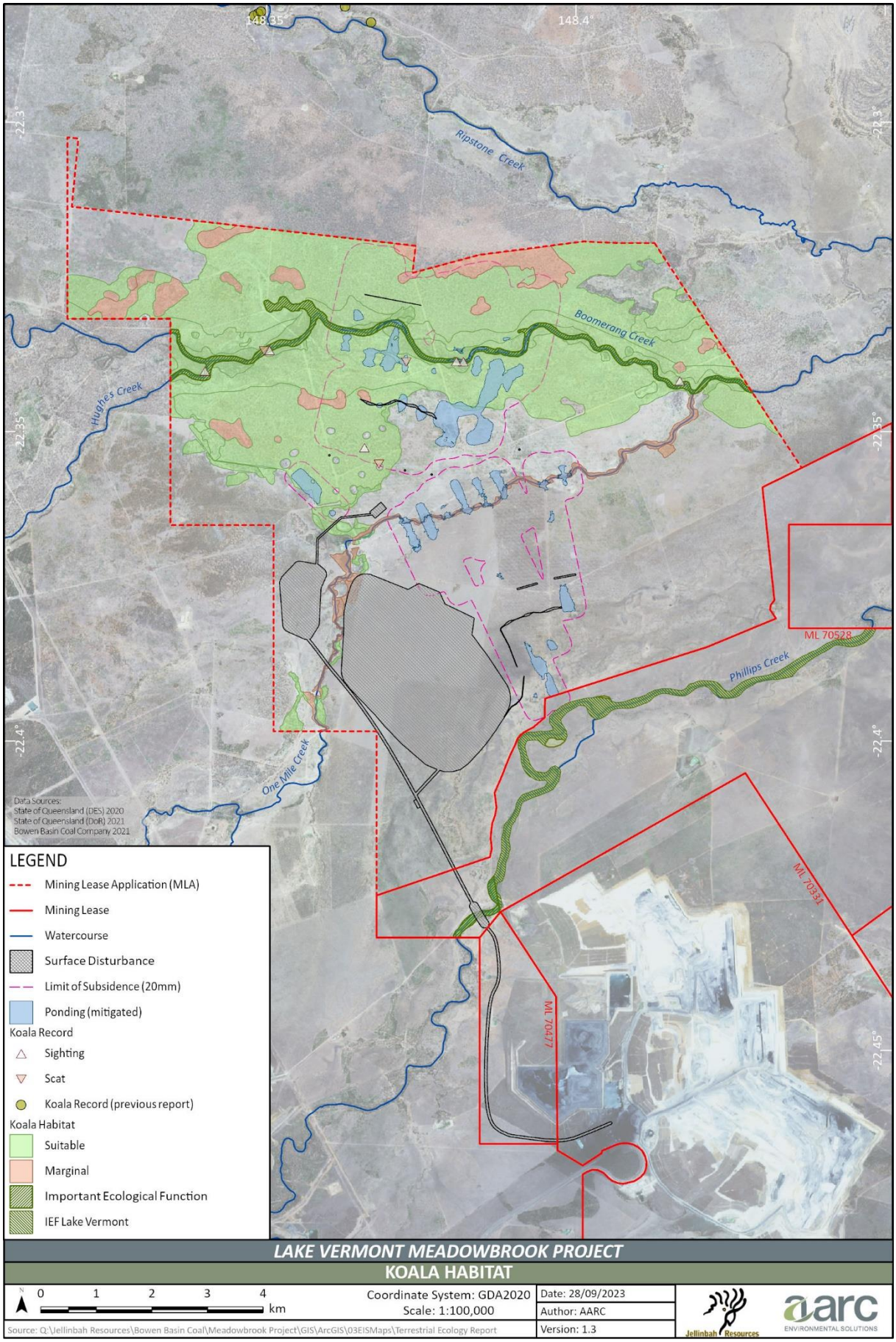

Figure 10.21: Koala habitat mapping

Habitat assessment

Habitat mapping for the Koala within the study area is shown in Figure 10.21 and is based on the habitat descriptions provided in Table 10.21, which have been derived from field habitat assessments conducted by EcoSmart Ecology and AARC. The habitat description in Table 10.21 is based on the information contained in DAWEs SPRAT database, including the relevant statutory documents and published research specific to the distribution of habitat for the Koala within the study area.

Table 10.21: Koala habitat description and occurrence

Habitat Description	Relevant features present within the study area
Suitable habitat	
Koala habitat is any forest or woodland that contains known Koala food tree species or shrubland with emergent food trees (TSSC 2012a). A Koala food tree includes species from the *Eucalyptus*, *Corymbia, Angophora, Lophostemon* and *Melaleuca* genera (DoE 2014a). In inland areas, Koalas are also known to inhabit *Acacia* woodlands (with emergent food trees) in both riparian and non-riparian environments. Non-food trees such as Brigalow (*Acacia harpophylla)* and Sally wattle (*Acacia salicina*) have been utilised by this species for daytime roosting (Ellis *et al.* 2002). A potential Koala habitat tree is considered to be a tree with a trunk diameter greater than 10 cm at 1.3m above ground (State of Queensland 2020).	Within the study area, areas mapped as remnant vegetation communities with food tree species density greater that 20 per ha are considered to provide potential suitable habitat for the Koala. The communities include: • Eucalypt Grassy Woodlands (VC 2a [RE 11.3.2], VC 2b [RE 11.3.3], VC 2c [RE 11.3.4] and VC 2e [RE 11.5.3]); • Eucalypt open forest to woodlands fringing drainage lines (VC 3a [RE 11.3.25]); and • Eucalypt freshwater wetlands (VC 4a [RE 11.3.27b], VC 4b [RE 11.3.27f], VC 4c [RE 11.5.17, noting the palustrine wetlands themselves have not been mapped]). A patch of RE 11.3.2 to the south of Boomerang Creek in the far east of the study area is small in extent and separated (~200 m) from nearby habitats. While Koalas can move over open areas of this distance, it seems unlikely the area will be utilised with regularity, considering nearby available habitat. It has, therefore, been mapped here as 'marginal' habitat.
Marginal habitat	
Koala marginal habitat includes sub-suitable food tree species density. A potential Koala habitat tree is considered to be a tree with a trunk diameter greater than 10 cm at 1.3 m above ground (State of Queensland 2020).	Within the study area, areas mapped as remnant vegetation communities with food tree species density lower than 20 per ha are considered to provide potential marginal habitat for the Koala. The communities include: • Brigalow Woodlands on clay soils (VC 1a [RE 11.3.1], VC 1b [RE 11.4.8], and VC 1c [RE 11.4.9]); and • Poplar Gum and Clarkson Bloodwood Woodland on alluvial plains (VC 2d [RE 11.3.9], VC 2h [RE 11.5.12]).
Important ecological function habitat	
Koala habitat that may provide: • refugial habitat features, such as food trees on more fertile soils with higher leaf nutrient status, higher leaf moisture or with thicker canopies; these characteristics are especially important during periods of drought or heat stress; • connective function between otherwise discontinuous areas of suitable habitat.	Within the study area, areas mapped as Eucalypt Grassy Woodlands (VC 3a [RE 11.3.25]) have been identified as potential important ecological function habitat.

With the exception of RE 11.3.1, transect data indicates remnant vegetation within the study area (with the minor exceptions noted in Table 11 21) provides abundant Myrtaceae Eucalypts (Table 10.22). In many Res, this includes a high density of trees preferentially used for foraging *(E. tereticornis, E. melanophloia* and *E. populnea)* (Kerswell *et al.* 2020). Exceptions include RE 11.3.1, 11.3.9, 11.5.8b, 11.5.8c and 11.5.12, which have lower preferred tree densities (less than 15/ha). Based on these results, some areas of vegetation within the site are likely to support lower Koala densities and can be assessed as having 'marginal' habitat amenity (as per the definition in Kerswell *et al.* 2020).

While all areas of vegetation with dense preferred feed trees have the potential to support comparatively high Koala numbers, given the vegetation structure and occurrence within the landscape, RE 11.3.25 may play a particularly important ecological role for the local population. Koalas show a preference for tree species on more fertile soils with higher leaf nutrient status and possibly high leaf moisture, especially during times of drought or heat stress (Clifton *et al.* 2007; Ellis *et al.* 2010; Davies *et al.* 2014; DAWE 2021b).

Koalas are also susceptible to extreme temperatures (DAWE 2021b) and will select trees which provide better thermal regulation (Lunney *et al.* 2014; Briscoe *et al.* 2015). Such trees are often in gullies and/or have thicker canopies (Crowther *et al.* 2013). It is likely vegetation within RE 11.3.25 fulfils these roles, as it is within close proximity to creek lines (increasing the likelihood of high leaf moisture) and has a comparatively tall, dense canopy. Furthermore, this vegetation is linear, following major creek lines (Boomerang Creek and Phillips Creek) and may, therefore, also play an important dispersal/movement role.

Vegetation Community VC 1d (Brigalow high-value regrowth) and the adjacent patch of RE 11.4.8 contains few Eucalypts/habitat trees and are considered unsuitable for the Koala. While Eucalypt regrowth can be suitable for the Koala, the cleared agricultural areas within the study area contains low Brigalow regrowth, which is unsuitable for the Koala.

Table 10.22: Estimated tree density per hectare for dominant RE's within the study area

RE	Number of sites	Estimated Eucalypt* density/ha	Important food species density/ha[#]
11.3.1	2	24	8
11.3.2	3	82	79
11.3.9	2	101	11
11.3.25/27	5	85	52
11.3.4	1	62	54
11.5.3	5	86	79
11.5.8	2	65	12

* including all Eucalypt, Angophora and Corymbia species

[#] for the assessed important food tree species included *E. tereticornis, E. melanophloia* and *E. populnea*

Impact assessment

Approximately 3319.5 ha of Koala habitat has been identified within the study area (Table 10.23 and Figure 10.21) of which approximately 12.2 ha of Koala habitat is proposed to be cleared for the Project, and 96.9 ha is predicted to be impacted by residual ponding.

Table 10.23: Proposed disturbance of Koala habitat

Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)		Extent of indirect disturbance (ha)
		All stages 1, 2, 3 direct clearing	Stage 4, open-cut pit	Predicted periodic ponding
Suitable (important ecological function)	2,963.0	4.6 (1.6)	<0.1 (0.0)	88.7 (5.2)
Marginal	356.6	0.6	7.0	8.2
Total	**3,319.6**	**5.2**	**7.1**	**96.9**

Areas of residual ponding are predicted to be inundated for a maximum period of several months every few years depending on inflow volumes and soil permeability conditions (WRM 2022). This inundation is expected to negatively impact the Koala's staple forage tree species and is, therefore, considered to constitute the removal of the habitat, further detail of ponding impacts to vegetation is provided in Section 10.5.2.1. Koala habitat occurs within riparian vegetation adjacent to Boomerang Creek and One Mile Creek, including in reaches that will be subject to stream morphology changes from subsidence. These potential stream morphology affected areas are co-located with areas of predicted ponding, and the assessment of stream morphology change impacts and mitigation measures are detailed in Section 10.5.2.2.

The subsidence footprint outside of the residual ponding areas is predicted to retain its Koala habitat suitability. Open woodland vegetation subject to comparable surface subsidence conditions has retained its vegetation condition post-subsidence (Section 10.5.2). Therefore, the predicted impacts are not likely to substantially impact the Koala forage and breeding trees, and the vegetation that provides Koala habitat within the subsidence footprint is expected to maintain its habitat quality post-subsidence. Canopy trees within the subsidence footprint will be avoided while surface activities for gas drainage are conducted, so gas drainage activities are, therefore, considered unlikely to impact Koala habitat.

The Project will result in impacts on Koala habitat, which will add to habitat disturbance that is proposed to occur for other Projects in the region.

The vegetation clearance associated with the infrastructure corridor will fragment the riparian corridors of One Mile Creek and Phillips Creek.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels. The changes to flood levels and extent are considered not significant (Appendix W, Geomorphological Assessment Report, Section 4.2). The impacts of changes to flooding regimes on Koala habitat are, therefore, not expected to be significant. Potential or likely GDEs were identified within the study area, however all areas assessed to be unlikely to be significantly impacted by the Project (refer Section 10.5.2.3). Therefore, groundwater impacts are considered unlikely to impact Koala habitat.

The potential for indirect Impacts to the Koala from noise and vibration, dust, lighting and vehicle strike is considered to be minimal, given the measures that will be implemented to manage these impacts. Subsidence impacts related to cracking and erosion are assessed in Section 10.5.2.11 and Chapter 5, Land Resources, Section 5.4.1 and Section 5.4.3. Given the proposed monitoring and management measures for erosion, no substantial erosion is expected to occur and it is considered unlikely that erosion will impact Koala habitat. The Project also has the potential to increase animal pest populations if they are not appropriately managed. However, as described in section 10.5.2, pest management measures will be implemented for the Project.

The proposed impact is equivalent to 3% of the Koala habitat in the study area. The impacts are predominantly due to hydrological change affecting the resilience of Koala habitat, and the modelling for these changes has incorporated the cumulative effects of nearby projects and climate change (WRM 2022). The impacts identified

to Koala habitat are unlikely to contribute to cumulative impacts in the subregion. Further discussion of cumulative impacts is provided in section 10.5.4.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Koala. The proposed avoidance and mitigation measures for the Koala have been outlined in section 10.8, and the proposed measures are detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.7), including descriptions of timing, predicted effectiveness, monitoring, adaptive management and relevant statutory or policy basis of each proposed measure.

Statutory requirements

Conservation and recovery plans relevant to the Koala and have been considered in assessment of the Koala:

- The 'Listing advice for *Phascolarctos cinereus* (Koala)' (TSSC 2012a), which outlines the reason for the conservation assessment of the Koala, and the 'Approved Conservation Advice for *Phascolartos cinerus* (combined populations in Queensland, New South Wales and the Australian Capital Territory)' (DSEWPaC 2012a), developed at the time of EPBC Act listing, provides information about the species, including its distribution and habitat, threats and priority management actions.
- The '*Phascolarctos cinereus* combined populations of Qld, NSW and the ACT–Koala' SPRAT profile provides information about the Koala, including relevant regulatory considerations and information in relation to its population and distribution, habitat, life cycle, feeding, movement patterns and threats, abatement and recovery.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this species; however, a Recovery Plan is required. The 'Draft National Recovery Plan for the Koala (combined populations in Queensland, New South Wales and the Australian Capital Territory)' (DAWE 2021b) provides information, including cultural significance, ecology, current threats, guidance on recovery and further conservation of the species.
- The 'Draft National Recovery Plan for the Koala' considers habitat critical to the survival of a species to be the area that the species relies on to halt decline and promote the recovery of the species, which can be unambiguously identified. Under the EPBC Act, the following factors and any other relevant factors may be considered when identifying habitat that is critical to the survival of a species:

  a) whether the habitat is used during periods of stress (examples flood, drought or fire);

  b) whether the habitat is used to meet essential life cycle requirements (examples foraging, breeding, nesting, roosting, social behaviour patterns or seed dispersal processes);

  c) the extent to which the habitat is used by important populations;

  d) whether the habitat is necessary to maintain genetic diversity and long-term evolutionary development;

  e) whether the habitat is necessary for use as corridors to allow the species to move freely between sites used to meet essential life cycle requirements;

  f) whether the habitat is necessary to ensure the long-term future of the species or ecological community through reintroduction or re-colonisation;

  g) any other way in which habitat may be critical to the survival of a listed threatened species or a listed threatened ecological community.

- The 'EPBC Act referral guidelines for the vulnerable Koala' (DoE 2014a) includes information on Koala habitat, modelled distribution, geographic context, threats, interim recovery objectives and survey

methods. The Draft Referral Guideline includes a Koala Habitat Assessment Tool to assist in determining habitat quality and whether the habitat constitutes critical habitat.

- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019) and Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

The SPRAT profile for this species indicates no threat abatement plan has been identified as being relevant to this species. However, threats to the Koala include (DAWE 2021a):

- habitat loss and habitat fragmentation;
- vehicle strike;
- predation by the domestic or feral dogs;
- climate change induced impacts, including drought, fire and heatwaves; and
- disease.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific. As detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.7), the assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its habitat; and
- assessed the significance of the impacts in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Significant impact assessment

Table 10.24 provides an assessment of the likelihood of significant impacts on the Koala in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 10.24: Koala significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species	The population of Koala that uses the habitat within the study area can be considered an important population. The removal of 12.3 ha of habitat and potential ponding impact of 96.9 ha on the habitat may lead to a long-term decrease in the size of an important population.

Significance criteria	Assessment of significance
Reduce the area of occupancy of an important population	The population of Koala that uses the habitat within the study area can be considered an important population. The removal of 12.3 ha habitat and potential ponding impact of 96.9 ha on habitat may reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	The population of Koala that uses the habitat within the study area can be considered an important population. The removal of 12.3 ha habitat and potential ponding impact of 96.9 ha on habitat is considered unlikely to fragment an existing important population into two or more populations. The remaining vegetation will retain connectivity to the broader region of Koala habitat.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Koala listed on the Register of Critical Habitat (DAWE 2021c). However, the Koala habitat in the study area is considered likely to meet the EPBC Act Referral Guidelines (DoE 2014a) definition of habitat critical to the Koala. Approximately 109.2 ha of Koala habitat will be disturbed by the Project through direct clearing and impact by ponding from subsidence. This action is considered likely to adversely affect habitat critical to the survival of the species. Approximately 2232.8 ha will remain undisturbed by clearing or subsidence within the study area for the local population. A further 977.6 ha of habitat will be retained within the subsidence footprint, which is predicted not to be substantially impacted and expected to continue to provide its current habitat function.
Disrupt the breeding cycle of an important population	The population of Koala that uses the habitat within the study area may be considered an important population. The removal of 12.3 ha of habitat and potential ponding impact of 96.9 ha on habitat is considered unlikely to disrupt the breeding cycle of an important population. The Koala habitat retained is expected to remain suitable for breeding for the species. Indirect impacts will be managed such that the breeding cycle will not be disrupted of the population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project requires the removal of 12.3 ha of habitat, which will result in geomorphological changes creating ponding impacts on 96.9 ha of habitat. This includes 93.3 ha of suitable habitat and 15.8 ha of marginal habitat. The removal of this extent of habitat is unlikely to lead to a long-term decline in the species population, given the availability of habitat for the species in the broader region. The study area is connected to areas of remnant vegetation habitat along the northern, north-east and north-west boundaries, including connectivity to the Isaac River in the east of the study area, which represents an area of habitat to support mobility for the species throughout the broader region. The retained habitat throughout the study area is unlikely to be indirectly impacted by the Project. Indirect impacts, such as weeds and pests, noise and vibration, dust, artificial lighting, vehicle strike and bushfire, will be managed as outlined in section 10.5.2 and are considered not to have potential to impact the availability or quality of habitat to the extent that the Koala is likely to decline. The GDE Assessment (3D Environmental 2022) has identified that the risk of impact to GDEs (which form a portion of Koala habitat in the Project area) is 'low to insignificant'. The impact of groundwater drawdown is, therefore, unlikely to impact the availability or quality of habitat to the extent that the Koala is likely to decline.

Significance criteria	Assessment of significance
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The study area is in a modified rural landscape, and invasive species that are harmful to the Koala exist in the broader region. While predatory species, including wild dogs, are recorded to be established in the study area, the Project is unlikely to result in the introduction and establishment of any invasive species that are harmful to the Koala within the study area. Monitoring and management of pests, including corrective actions, will be implemented in accordance with a Weed and Pest Management Plan (Section 10.8.3).
Introduce disease that may cause the species to decline	Koala populations are affected by three known viral diseases that are widespread throughout the wild population. These diseases are likely to be present in the population in the study area. However, the proposed Project is unlikely to cause the introduction of these diseases or other diseases to the study area. The Koala population in the study area will retain connectivity to the surrounding Koala habitat and will, therefore, remain exposed to infections from the broader region.
Interfere substantially with the recovery of the species	The Project will result in the clearing of 12.3 ha and impact on 96.9 ha of potential ponding in Koala habitat. The Draft Recovery Plan for the Koala (DAWE 2021b) identifies that direct threats to the Koala include climate change, land use changes and natural system modifications, while ecological threatening processes include habitat loss and fragmentation, habitat degradation and genetic effects. There is currently no habitat for the Koala listed on the Register of Critical Habitat (DAWE 2021c). However, the Koala habitat in the study area is considered likely to meet the EPBC Act Referral Guidelines (DoE 2014a) definition of habitat critical to the Koala. Therefore, the impact of the Project on the Koala habitat in the study area may amount to impacts equivalent to the direct threats identified in the Draft Recovery Plan for the Koala, and the Project may interfere with the recovery of the species.
Conclusion	The Project will result in the clearing or disturbance of 109.2 ha of Koala habitat. This habitat is identified as likely to be critical habitat and, therefore, the Project is likely to have a significant impact to the Koala. The extent of these significant impact areas is shown in Figure 10.22

The Koala population occurring in the study area has been assessed against the definition of 'important population' of a vulnerable species (DoE 2013a). The population is determined to be part of a large population that is distributed throughout the broader region and maintains connectivity for breeding and dispersal throughout this area. Breeding is considered to occur among the population of the broader region and, therefore, the population occurring in the study area is not likely to be necessary for maintaining species genetic diversity. The Koala range extends throughout the coast and inland areas of eastern Australia, and the study area is not near the limits of the species range.

It is unlikely the Koala population in the study area is necessary for the species' long-term survival and recovery, and therefore, it is not an important population as per the Significant Impact Guidelines for a vulnerable listed species (refer Section 10.6.5). However, considering the species' recent EPBC Act listing change to endangered, it is considered justified to determine all populations as important for the purpose of impact assessment.

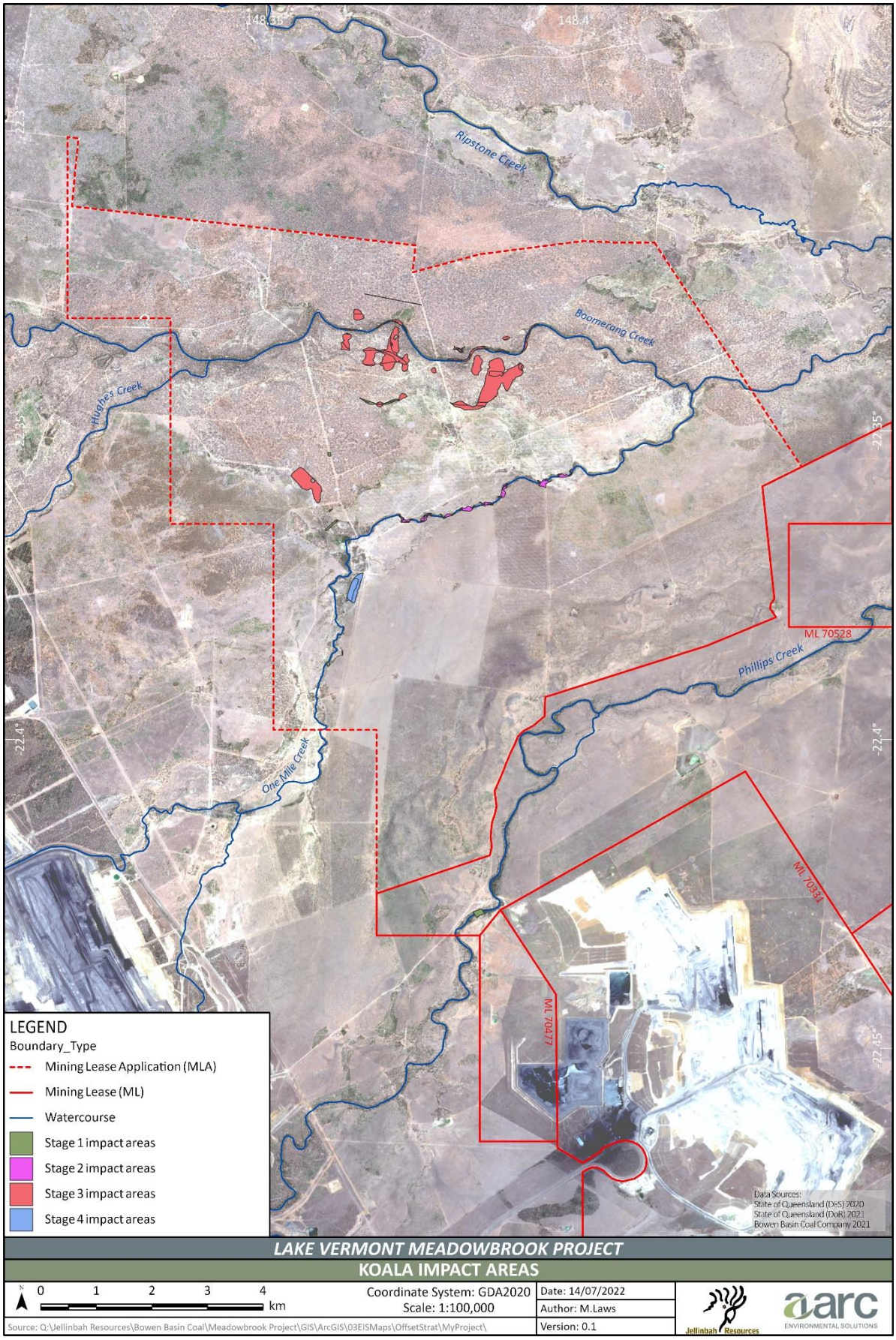

Figure 10.22: Koala significant impact areas

10.6.8 Greater Glider

Description

The Greater Glider (*Petauroides volans*) was listed as vulnerable under the NC Act and the EPBC Act at the time of the controlled action decision for the Project. Since this time, it is acknowledged that the listing status for the Greater Glider has been upgraded to endangered under the NC Act and the EPBC Act. While the updated conservation advice for this species has been considered, ecological surveys and impact assessment have been undertaken using the criteria that applied at the time of the controlled action decision (not applied retrospectively).

The taxonomy of this species may be subject to revision in the near future (McGregor *et al.* 2020); however, this assessment is applicable to the Greater Glider (*Petauroides volans sensu lato*) as referred to on the DAWE Species Profiles and Threats database (DAWE 2021a). The species is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria, with an elevational range from sea level to 1,200 m above sea level.

The Greater Glider is an arboreal, nocturnal marsupial known to occur in Eucalypt-dominated habitats, ranging from low, open forests on the coast to tall forests in the ranges and low woodland westwards of the Dividing Range (TSSC 2016b, DCCEEW 2022). It is primarily folivorous, with a diet mostly comprising Eucalypt leaves and occasionally flowers. Preferred habitat consists of taller, montane, moist Eucalypt forests with relatively old trees and abundant hollows. It also favours forests with a diversity of Eucalypt species due to seasonal variation in its preferred tree species (TSSC 2016b, DCCEEW 2022). During the day, this species shelters in tree hollows, with a particular selection for large hollows in large, old trees (TSSC 2016b, DCCEEW 2022) and requires at least two hollow-bearing trees for every 2 ha of suitable forest habitat (Kerswell *et al.* 2020).

The species is absent from cleared areas and has little dispersal ability to move between fragments through cleared areas. Greater Gliders have been recorded in habitat patches <10 ha however, modelling suggests that in QLD the species requires native forest patches of at least 160 km^2 to maintain viable populations, and low reproductive output and susceptibility to disturbance ensures low viability in small remnants (TSSC 2016b, DCCEEW 2022).

Survey effort

Fauna surveys of the study area were conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April) and spring 2021 (6–10 September) over 50 days in consideration of relevant Commonwealth and Queensland survey guidelines. All surveys fell within the Brigalow Belt Bioregion recommended survey timing (Eyre *et al*. 2018).

Fourteen systematic survey sites were established during the surveys. Four systematic sites were established in Eucalypt Dry Woodlands on inland depositional plains (sites MF01, MF05, MF09, MF13) and two systematic sites on Poplar Gum and *Corymbia* spp. woodlands on alluvial plains (sites MF10 and MF14).

For habitat assessment, amenity surveys have been conducted along transects of 100 m x 50 m within areas of potentially suitable vegetation. The canopy cover of Myrtaceae Eucalypt species (*Eucalyptus, Angophora* and *Corymbia*) has been recorded using the intercept method (Neldner *et al.* 2020), and the number of trees with suitable hollows (diameter more than 20 cm, alive or dead) has been recorded. Spotlighting along a 500 m transect has been undertaken at a subset of these sites to record the number of observed Greater Glider individuals.

Survey effort for the Greater Glider at systematic and supplementary sites included:

- active searches: 75 person hours;
- spotlighting: 58.6 person hours; and
- call playback: 11 person hours.

The survey timing, methodology and effort are consistent with the Commonwealth guidelines. Stag watch surveys have not been applied, as spotlighting and call playback at potential den tree areas sufficiently surveyed these areas.

Further details of the survey timing, effort and methodology are provided in Appendix G, Terrestrial Ecology Assessment (Section 11.1.8).

Survey outcomes

The Greater Glider was recorded at the Project area in woodland and riparian habitats during the autumn 2019, spring 2019, autumn 2020 and spring 2021 surveys. Targeted spotlighting for the Greater Glider conducted during the site habitat assessments also recorded the species. There were 24 records of Greater Gliders within the study area and the location of Greater Glider records is shown on Figure 10.23.

The habitat assessment transect and spotlight data has been used to assess habitat amenity for the Greater Glider within the study area (Table 10.25)[2]. High counts of tree hollows and *Eucalyptus* spp. canopy cover are associated with higher Greater Glider abundance (DCCEEW 2022), and these characteristics have been used as indicators of Greater Glider habitat amenity. Transects have not been conducted within RE 11.3.3, 11.4.8 or 11.4.9 due to their small extent within the study area and have been assessed for habitat amenity on the basis of other survey experience conducted within these REs.

Table 10.25: Greater Glider habitat amenity assessment criteria

Habitat amenity	**Hollows per ha**	***Eucalyptus* spp. canopy cover**	**Greater Glider transect abundance per km**
High	>10	>40 %	>3
Moderate	>10	<40 %	1
Low	2-9	<40 %	0.25
Unsuitable	<2	Not applicable	NA

Habitat assessment

Habitat mapping for the Greater Glider within the study area is shown on Figure 10.23 and is informed by the assessment of the habitat available at the Project area, information contained in DAWEs SPRAT database, including the relevant statutory documents and published research.

The habitat requirements of the Greater Glider are described in the species description in Section 10.6.8. The key habitat features are:

- presence of suitable fodder trees (Eucalyptus species);
- presence and abundance of hollow-bearing trees with suitably sized and aged hollows; and
- sufficient canopy cover of Eucalyptus species.

The habitat amenity surveys conducted by EcoSmart Ecology and AARC resulted in:

- three REs assessed as providing high habitat amenity—RE 11.3.25/RE11.3.27, 11.3.3, 11.3.4.

2 Assessment of habitat amenity for the Greater Glider is only applicable to the study area and is not an assessment of habitats throughout the species range or within the region.

- three REs assessed as providing moderate habitat amenity—RE 11.3.9, 11.5.8c, 11.5.3 (with the exception noted below).
- four REs assessed as providing low habitat amenity—RE 11.3.2 (with the exception noted below), 11.3.1 (with the exception noted below), 11.4.8 (with the exception noted below) and 11.4.9.
- REs or specific areas considered unsuitable for the Greater Glider are:
    - RE 11.5.17 (palustrine wetland component containing no Eucalypts);
    - the high-value regrowth Brigalow vegetation in the north-east of the study area and the small patch of RE 11.4.8 situated adjacent to the high-value regrowth Brigalow vegetation (both of which do not contain enough hollows or Eucalypts for the Greater Glider);
    - riparian vegetation (RE 11.3.1) along the western section of One Mile Creek due to the low density of Eucalyptus species, low number of hollow-bearing trees, its more open canopy and narrow linear nature;
    - a portion of RE 11.5.3 in the south near Phillips Creek, as it is small in extent and isolated from other suitable habitat; and
    - a portion of RE 11.3.2 to the south of Boomerang Creek near the eastern boundary of the study area (identified to be too small and isolated to provide suitable habitat).

Impact assessment

Approximately 3194.4 ha of Greater Glider habitat has been identified within the study area, including 332.2 ha of high amenity, 1874.0 ha of moderate amenity and 988.1 ha of low amenity habitat (and Table 10.26 and Figure 10.23). A total of 11.9 ha of Greater Glider habitat is proposed to be directly disturbed through clearing for the Project and 88.7 ha indirectly impacted by predicted periodic ponding.

Table 10.26: Proposed disturbance of Greater Glider habitat

Habitat amenity	**Extent within study area (ha)**	**Extent of direct disturbance (ha)**		**Extent of indirect disturbance (ha)**
		Stages 1, 2, 3 clearing	**Stage 4 clearing**	**Stages 2 and 3 residual ponding**
High	332.2	1.6	0.0	12.6
Moderate	1874.0	2.9	0.0	17.8
Low	988.1	0.3	7.0	58.3
Total	3194.3	4.8	7.0	88.7

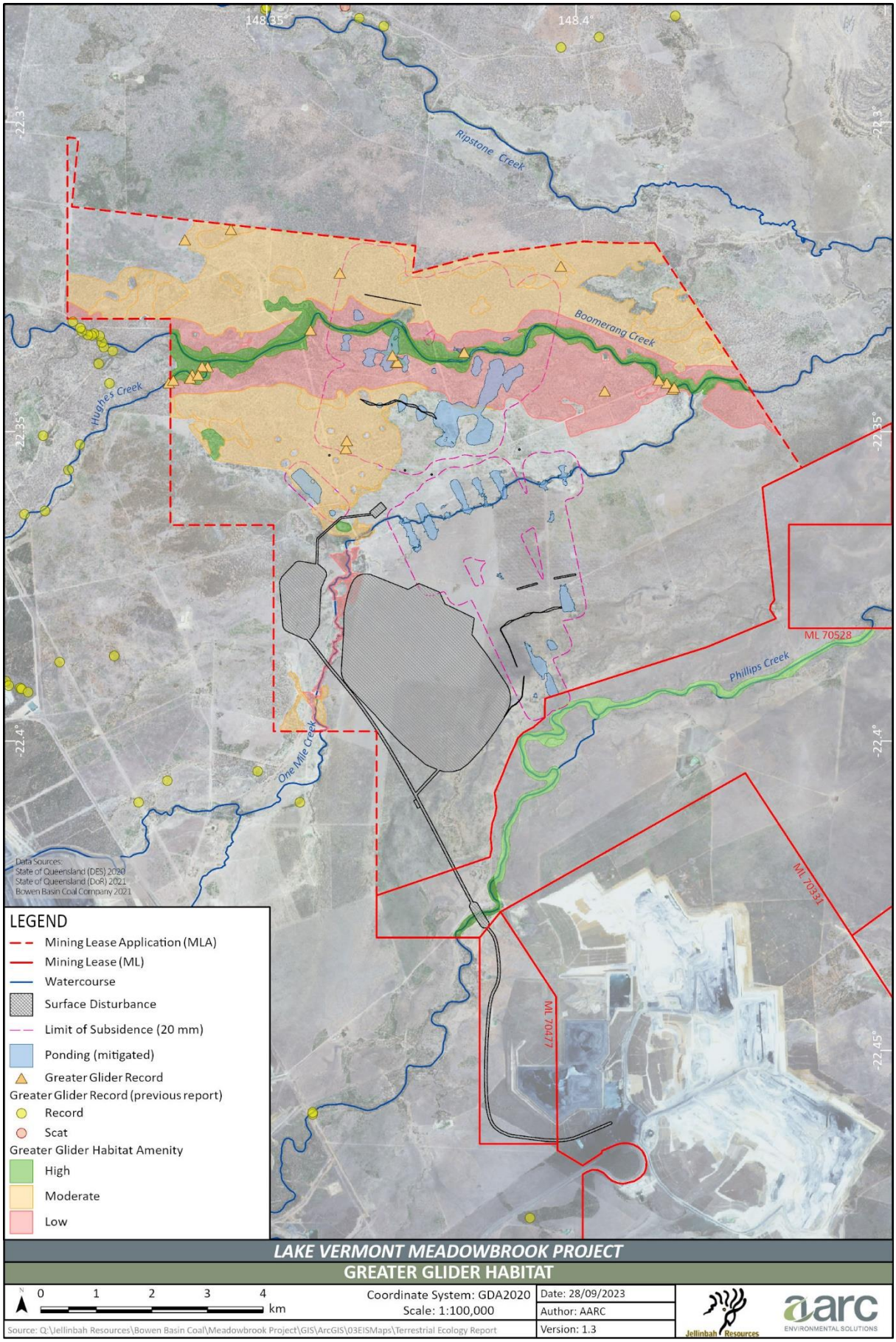

Figure 10.23: Greater Glider habitat mapping

Areas of residual ponding are predicted to be inundated for a maximum period of several months every few years depending on inflow volumes and soil permeability conditions (WRM 2022). This is expected to be sufficient to disturb the Greater Gliders' staple forage tree species and is, therefore, considered sufficient disturbance to cause the removal of the habitat. Further detail of ponding impacts to vegetation is provided in Section 10.5.2.1. Greater Glider habitat occurs within riparian vegetation adjacent to Boomerang Creek and One Mile Creek, including in reaches that will be subject to stream morphology changes from subsidence with subsidence troughs forming within the stream channels. The areas are co-located with areas of predicted ponding, and the assessment of hydrology change impacts and mitigation measures are detailed in Section 10.5.2.2.

The subsidence footprint outside of the residual ponding areas is predicted to retain its Greater Glider habitat suitability. Open woodland vegetation subject to comparable surface subsidence conditions at other underground mining projects in the Bowen Basin has retained its vegetation condition post-subsidence (Section 10-31). Therefore, the predicted impacts are not likely to substantially impact the Greater Glider foraging and breeding trees, and the vegetation that provides Greater Glider habitat within the subsidence footprint is expected to maintain its habitat quality post-subsidence. Canopy trees within the subsidence footprint will be avoided while surface activities for gas drainage are conducted. Therefore, the gas drainage activities within the subsidence footprint are not expected to amount to a significant impact on Greater Glider habitat.

The Project will result in impacts on Greater Glider habitat, which will add to habitat disturbance that is proposed to occur for other Projects in the region.

The direct disturbance associated with the Project (e.g. infrastructure corridor and MIA) will result in some fragmentation of Greater Glider low and moderate amenity habitat.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels; however, the changes to flood levels and extent are considered not significant (Appendix W, Geomorphological Assessment Report, Section 4.2). The impacts of changes to flooding regimes on Greater Glider habitat are, therefore, not expected to be significant. Potential or likely GDEs were identified within the study area, however all areas were assessed to be unlikely to be significantly impacted by the Project (refer Section 10.5.2.3). Therefore, groundwater impacts are considered unlikely to impact Koala habitat.

The potential for indirect impacts to the Greater Glider from noise and vibration, dust, lighting and vehicle strike is considered to be minimal, given the measures that will be implemented to manage these impacts. Impacts of erosion and subsidence related cracking are assessed in Section 10.5.2.11 and in Chapter 5, Land Resources, Section 5.4.1 and Section 5.4.3. Given the proposed monitoring and management measures for erosion, no substantial erosion is expected to occur and it is considered unlikely that erosion will impact Greater Glider habitat. The Project also has the potential to increase animal pest populations if they are not appropriately managed. However, as described in section 10.8, pest management measures will be implemented for the Project.

The proposed impact is equivalent to 3% of the Greater Glider habitat in the study area. The impacts are predominantly due to hydrological change affecting the resilience of Greater Glider habitat, and the modelling for these changes has incorporated the cumulative effects of nearby projects and climate change (WRM 2022). The impacts identified on Greater Glider habitat are unlikely to contribute to cumulative impacts on the subregion. Further discussion of cumulative impacts is provided in section 10.5.4.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Greater Glider. The proposed avoidance and mitigation measures for the Greater Glider have been outlined in section 10.7, and the proposed measures are detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.8), including descriptions of timing, predicted effectiveness, monitoring, adaptive management and relevant statutory or policy basis of each proposed measure.

Statutory requirements

Conservation information relevant to the Greater Glider has been considered in this assessment as follows:

- The 'Conservation Advice for *Petauroides volans* (greater glider) (southern and central)' (DCCEEW 2022) outlines the reasons for the conservation assessment of the species with regard to the 2022 up listing of the species and provides information about the Greater Glider, including information in relation to its distribution, biology/ecology, threats and conservation and management actions.
- The Conservation Advice for *Petauroides volans* (greater glider) (TSSC 2016b) outlines the conservation assessment of the species according to the listing relevant to the assessment and approval process for the species.
- The '*Petauroides volans*–Greater Glider' SPRAT profile provides information about the relevant regulatory considerations and links to information available in relation to its listing under the EPBC Act. The SPRAT profile indicates there is no adopted or made Recovery Plan for this species; however, a Recovery Plan is required.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019), Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

Threats to the Greater Glider include (TSSC 2016b, DCCEEW 2022):

- inappropriate fire regimes;
- habitat clearing and fragmentation;
- timber harvesting;
- barbed wire fencing (entanglement);
- increased temperatures and changes to rainfall patterns;
- hyper-predation by owls;
- competition from Sulphur-crested Cockatoos;
- predation by Feral Cats; and
- predation by European Red Foxes.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific. The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its habitat; and
- assessed the significance of the impacts in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance'.

Significant impact assessment

Table 10.27 provides an assessment of the likelihood of significant impacts on the Greater Glider in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

The Greater Glider population occurring at the study area has been assessed against the definition of 'important population' of a vulnerable species (DoE 2013a). The population is determined to be part of a large population, which is distributed throughout the broader region and maintains connectivity for breeding and dispersal throughout this area. Breeding is considered to occur among the population of the broader region and, therefore, the population occurring in the study area is not likely to be necessary for maintaining species genetic diversity. The Greater Glider range extends throughout the coast and inland areas of eastern Australia, and the study area is not near the limits of the species range.

It is unlikely the Greater Glider population in the study area is necessary for the species' long-term survival and recovery and, therefore, is not an important population as per the Significant Impact Guidelines for a Vulnerable listed species(refer Section 11.1.8.1). However, considering the species' recent EPBC Act listing change to Endangered, it is considered justified to determine all populations as important for the purpose of impact assessment.

Table 10.27: Greater Glider significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species	The population of Greater Glider using the study area can be considered an important population. The impacts to all Greater Glider habitat amenity categories includes the removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered unlikely to lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	The population of Greater Glider using the study area can be considered an important population. The impacts to all Greater Glider habitat amenity categories includes the removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered unlikely to reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	The population of Greater Glider using the study area can be considered an important population. The impacts to all Greater Glider habitat amenity categories includes the removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Greater Glider listed on the Register of Critical Habitat (DAWE 2021c). However, according to the latest conservation advice (DCCEEW 2022), all suitable habitat identified in the study area is considered likely to be habitat critical to the survival of the species due to being a large contiguous area of eucalypt forestwith of hollow-bearing trees and forage species canopy cover. As such, impacts on all identified habitat for the Greater Glider within the study area is considered likely to adversely affect habitat critical to the survival of the species. The Project involves clearing and direct impacts on approximately 100.6 ha of Greater Glider habitat.
Disrupt the breeding cycle of an important population	The population of Greater Glider using the study area can be considered an important population.

Significance criteria	Assessment of significance
	The impacts to all Greater Glider habitat amenity categories includes the removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered unlikely to disrupt the breeding cycle of an important population
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project requires the removal of 11.9 ha of habitat and will result in geomorphological changes causing potential ponding impacts on 88.7 ha of habitat. The removal of this extent of habitat is unlikely to lead to a long-term decline in the species population, given the wide extent of habitat for this species. The study area is connected to areas of remnant vegetation habitat along the northern, north-east and north-west boundaries. The study area will maintain connectivity to corridors of high amenity riparian Eucalypt Woodland vegetation, including vegetation adjoining the Isaac River, which represents areas of habitat to support mobility for the species throughout the broader region. The retained habitat throughout the study area is unlikely to be indirectly impacted by the Project. Indirect impacts, such as weeds and pests, noise and vibration, dust, artificial lighting, vehicle strike and bushfire, will be managed, as outlined in section 10.5.2 and are considered not to have potential to impact the availability or quality of habitat to the extent that the Greater Glider is likely to decline. The Groundwater Dependent Ecosystem Assessment (3D Environmental 2022) identified that the risk of impact on GDEs (which form a portion of Koala habitat in the Project area) is 'low to insignificant'. The impact on groundwater drawdown is, therefore, unlikely to impact the availability or quality of habitat to the extent that the Greater Glider is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The study area is in a modified rural landscape and invasive species exist in the broader region. Invasive species (Feral Cats and European Red Foxes) and native species (owls and Sulphur Crested Cockatoos) are recognised as a threat to the Greater Glider (DCCEEW 2022). Feral Cat and European Red Fox were recorded in surveys. Given the proposed monitoring and management of pests including corrective actions in accordance with a Weed and Pest Management Plan (Section 10.5.2.5) the Project is unlikely to result in the increase of invasive species likely to be harmful to the Greater Glider. The confidence in the threat posed by native species threats is considered low and these threats are considered applicable for small parts of the Greater Glider range (DCCEEW 2022). The numbers of native owls and Sulphur-crested Cockatoos are considered unlikely to present a threat to the Greater Glider in the study area, and the Project is therefore unlikely to impact/increase these threats. The study area is in a modified rural landscape, and invasive species exist in the broader region. No non-native invasive species are recognised as a threat to the Greater Glider (TSSC 2016b). However, hyper-predation of Greater Gliders by large forest owls (resulting from increases in owl density due to impacts of other invasive predators) is listed as a threatening process to the species. The Project is unlikely to result in the increase of invasive species likely to be harmful to the Greater Glider through hyper predation of the species.
Introduce disease that may cause the species to decline	There are no diseases of the Greater Glider listed as a threat to the species (DCCEEW 2022). The Project is unlikely to introduce a disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no adopted or made Recovery Plan for this species; however, a Recovery Plan is considered to be required (DCCEEW 2022). Priority conservation actions identified by the Conservation Advice (DCCEEW 2022) include: • management of habitat loss, disturbance and modification (including fire) including protection of unburnt habitat, revision of prescribed burning prescriptions, protection of habitat trees, avoidance of habitat fragmentation and avoidance of the use of barbed wire; • protection of climate change refuge habitat and improve micro-climate conditions in at risk areas;

Significance criteria	Assessment of significance
	• manage invasive species threats; and • investigate the feasibility of reintroductions to areas the species was extirpated. The Project is unlikely to substantially interfere with the recovery of the species. The removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered not to substantially interfere with the recovery of the species.
Conclusion	The Project will result in the clearing or disturbance of 100.6 ha of Greater Glider habitat, including 14.2 ha of high amenity habitat, 20.7 moderate amenity habitat and 65.6 ha of low amenity habitat. All Greater Glider habitat identified within the study area is considered likely to be critical to the survival of the species, and the clearing and ponding impact on 100.6 ha of habitat is considered to be a significant impact. The extent of these impact areas is shown in Figure 10.24

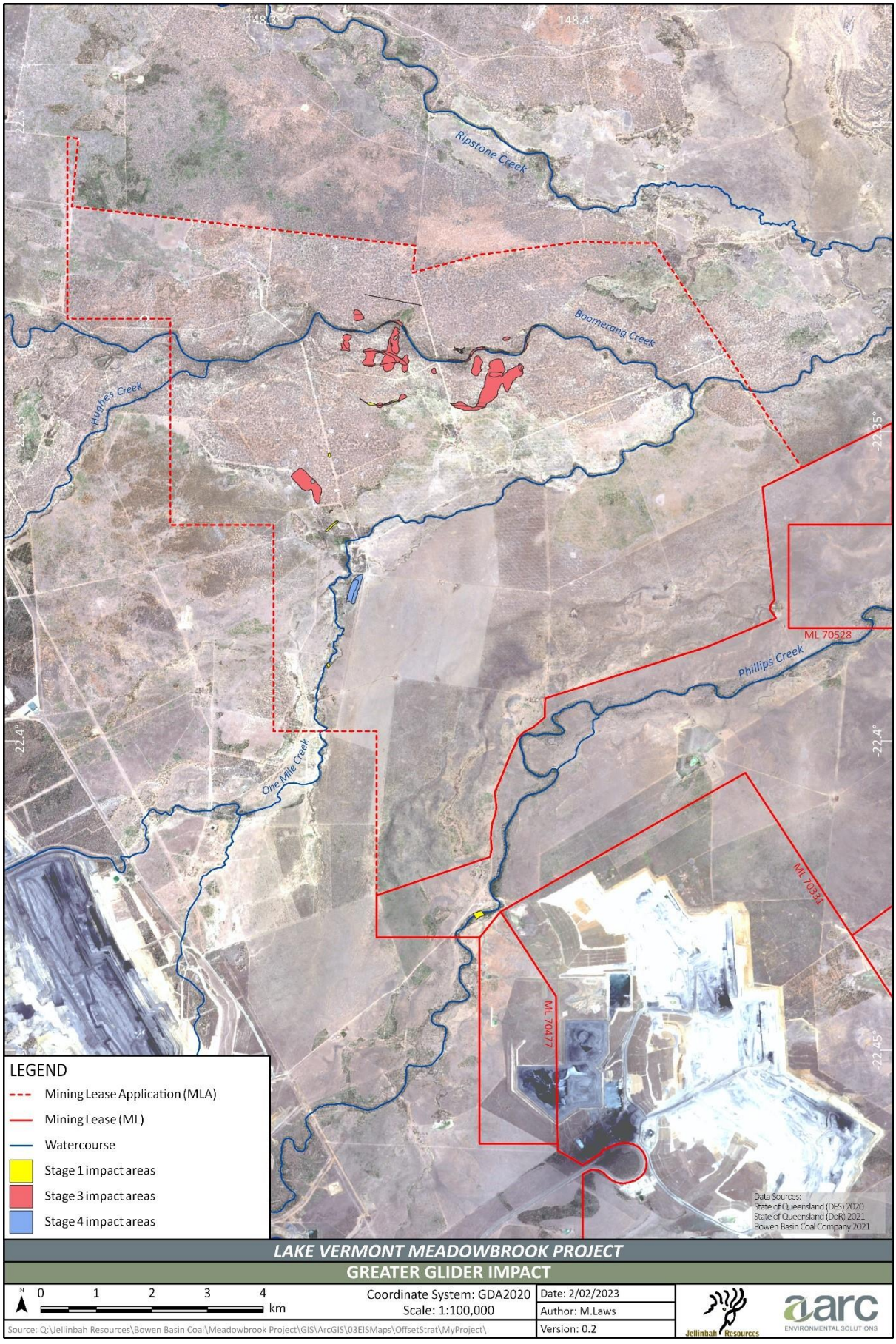

Figure 10.24: Greater Glider significant impact areas

10.6.9 Migratory Birds

Description

Desktop analysis has been conducted of relevant databases to determine records of migratory species within the vicinity of the Project, including Wildlife Online, Queensland Museum, Wildnet and Atlas of Living Australia occurrence records. The desktop assessment also includes a review of ecological survey and assessments for nearby developments for information/records relating to migratory species.

Sixteen species listed as migratory under the EPBC Act have been identified by the desktop assessment as having known records within the wider region (50 km search area). While not having known records within 50 km of the study area, an additional four species listed in the ToR for the Project (Oriental Cuckoo, Yellow Wagtail, Curlew Sandpiper[3] and Pectoral Sandpiper) have also been considered in the survey and assessment of migratory species.

A description of each migratory species, including its distribution, habitat and ecology and assessment of likelihood of occurrence is provided in Appendix G, Terrestrial Ecology Assessment (Section 11.1.9).

Thirteen migratory species have been identified as having the potential to occur within the study area:

1) Fork-tailed Swift;
2) Gull-billed Tern;
3) Caspian Tern;
4) Black-faced Monarch;
5) Satin Flycatcher;
6) Rufous Fantail;
7) Common Sandpiper;
8) Sharp-tailed Sandpiper;
9) Red-necked Stint;
10) Latham's Snipe;
11) Greenshank;
12) Marsh Sandpiper; and
13) Glossy Ibis.

Migratory species considered to have a higher likelihood of occurring within the study area are the:

- Fork-tailed Swift;
- Satin Flycatcher;
- Caspian Tern;
- Latham's Snipe; and
- Glossy Ibis.

Five migratory species are considered unlikely to occur in the study area (Osprey, Oriental Cuckoo, Spectacled Monarch, Yellow Wagtail and Pectoral Sandpiper), although they have still been targeted by the field surveys as described in Appendix G, Terrestrial Ecology Assessment (Section 11.1.9).

3 The Curlew Sandpiper is also listed as threatened under the EPBC Act and has been considered in the assessment of threatened species

Survey effort

Seasonal fauna surveys were undertaken in autumn 2019 (11–21 March 2019), spring 2019 (6–19 November 2019), autumn 2020 (23–25 March 2020; 1–8 April 2020), autumn 2021 (14–22 April 2021) and spring 2021 (6–10 September 2021), consistent with Commonwealth and Queensland survey guidelines.

Appendix G, Terrestrial Ecology Assessment (section 11.1.9) describes the survey effort undertaken and how the survey effort compares to relevant Commonwealth, State guidelines or best practice survey guidelines for each migratory species. In summary, survey methods and effort generally complies with survey guidelines and includes, but is not limited to:

- 14 systematic survey sites;
- 75 person hours of active searching;
- 83 person hours of diurnal bird surveys;
- opportunistic observations; and
- survey and inspection of farm dams and wetlands.

While other survey methods have been employed during the terrestrial ecology surveys, those mentioned above are the most relevant for the detection of the migratory birds potentially occurring within the study area.

Survey outcomes

Two migratory species listed under the EPBC Act have been recorded within the study area during the field surveys: the White-throated Needletail and the Caspian Tern.

The survey outcomes and assessment for the White-throated Needletail are provided in section 10.6.4. One Crested Tern was recorded opportunistically during the autumn 2021 field survey at a lacustrine wetland (farm dam) within the cleared agricultural area.

Habitat assessment

The wetland areas, farm dams and/or inundated paddocks within the study area provide potential foraging habitat for occasional migratory species that utilise wetland habitats, particularly when climatic conditions are suitable. These include species such as the:

- Gull-billed Tern;
- Caspian Tern;
- Common Sandpiper;
- Sharp-tailed Sandpiper;
- Marsh Sandpiper;
- Red-necked Stint;
- Latham's Snipe; and
- Greenshank and Glossy Ibis.

The wetland and gilgai habitats mapped as providing potential intermittent foraging habitat for the Australian Painted Snipe (Figure 10.20) within the study area provide potential habitat for the migratory wetland species. For the Australian Painted Snipe, wetted gilgai habitat is only available for a short period after rainfall when the gilgai are full. While inspections of farm dams within the study area indicate they do not provide suitable

foraging habitat for the Australian Painted Snipe, they may provide potential foraging habitat for migratory wetland bird species. The location of farm dams within the study area is shown on Figure 10.19.

Remnant vegetation within the study area provides potential habitat for occasional migratory species such as the:

- Fork-tailed Swift;
- Black-faced Monarch; and
- Satin Flycatcher and the Rufous Fantail.

The areas of remnant vegetation within the study area providing potential or known habitat for the Koala (Figure 10.21) provides potential habitat for the migratory woodland bird species.

The study area does not provide potential breeding habitat for migratory species, with many being non-breeding visitors to Australia.

Impact assessment

Wetland areas, farm dams and/or inundated paddocks within the study area provide potential intermittent foraging habitat for occasional migratory species that utilise wetland habitats. Approximately 38.4 ha of this habitat will be cleared by the Project. A further 29.5 ha of this habitat will be impacted by residual ponding, which represents a change in this habitat rather than a removal of this habitat.

A total of 213.9 ha is modelled to undergo increased ponding as a result of changed hydrology due to surface subsidence (Appendix W, Geomorphological Assessment Report, Section 3.3.1) These areas are likely to result in increased suitability for migratory species that use wetland habitats.

Remnant vegetation within the study provides potential habitat for occasional migratory species that utilise woodland habitats. A total of 12.2 ha of remnant vegetation is proposed to be cleared for the Project, and a further 96.9 ha of remnant vegetation is predicted to be substantially impacted by residual ponding.

The impacts to migratory species' habitat will add to habitat disturbance that is proposed to occur for other Projects in the region. The Project will not fragment habitat for mobile migratory species.

The extent of flooding is predicted to increase along the margins of subsided panels; however, the changes to flood levels are considered not significant (Appendix W, Geomorphological Assessment Report, Section 4.2). Therefore, the impact of changes to flooding regimes on migratory species are not expected to be significant.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the migratory species. The proposed avoidance and mitigation measures for the migratory species have been outlined in section 10.8, and the proposed measures are detailed in Appendix G, Terrestrial Ecology Assessment (Section 11.1.9), including description of timing, predicted effectiveness, monitoring, adaptive management and relevant statutory or policy basis of each proposed measure.

Statutory requirements

Australia is party to international conventions and agreements to protect migratory species. These include the:

- China–Australia Migratory Bird Agreement;
- Japan–Australia Migratory Bird Agreement;
- Republic of Korea–Australia Migratory Bird Agreement; and

- Convention on the Conservation of Migratory Species of Wild Animals.

Each of these agreements provides for the protection and conservation of migratory birds and their important habitats, protection from take or trade except under limited circumstances, the exchange of information, and building cooperative relationships (DAWE 2020a). Bird species listed within the appendices/annexes of these agreements/conventions are subsequently listed as migratory species under the EPBC Act.

The EPBC Act provides the domestic legal framework for implementing Australia's obligations under a number of international conventions related to the environment, including, but not limited to, the Bonn Convention. The EPBC Act also includes provisions relating to migratory bird conservation bilateral agreements, including CAMBA, JAMBA and ROKAMBA.

Threats to migratory species include (DoE 2015, DAWE 2021a):

- loss, modification or fragmentation of habitat;
- invasive species that are harmful to the migratory species;
- actions that result in mortality (e.g. collisions with wind turbines, windows, light houses); and
- human activities at international breeding sites.

The Project is not inconsistent with Australia's obligations under the China–Australia Migratory Bird Agreement, the Japan–Australia Migratory Bird Agreement, the Republic of Korea–Australia Migratory Bird Agreement or the Convention on the Conservation of Migratory Species of Wild Animals. As detailed in Appendix G, Terrestrial Ecology Assessment (section 11.1.4.8) the assessment has:

- conducted a thorough desktop assessment to identify migratory species with the potential to be impacted by the Project;
- identified the habitat and lifecycle requirements of migratory species and considered their likelihood of occurrence;
- undertaken field surveys to target migratory species within the study area in consideration of Commonwealth and Queensland survey guidelines);
- identified potential habitat for migratory species within the study area;
- identified potential impacts of the Project on migratory species and their habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on migratory species and their habitat; and
- assessed the significance of the impacts in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a), which has indicated the Project will not result in a significant impact to migratory species.

Significant impact assessment

Table 10.28 provides an assessment of the likelihood of significant impacts on migratory species that have the potential to occur in the study area in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

An area of 'important habitat' for a migratory species is (DoE 2013a):

1) habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or

2) habitat that is of critical importance to the species at particular lifecycle stages, and/or

3) habitat utilised by a migratory species which is at the limit of the species range, and/or

4) habitat within an area where the species is declining.

The potential habitat available to migratory species in the study area is unlikely to provide important habitat for any migratory species.

Table 10.28: Migratory species significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	The study area is unlikely to represent an area of important habitat for any migratory species, including the Crested Tern. The Project will not substantially modify, destroy or isolate an area of important habitat for a migratory species.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The study area is unlikely to represent an area of important habitat for a migratory species. Predation by feral species, such as the European Red Fox and Feral Cat, is a recognised threat to species such as Latham's Snipe; both pests have been recorded in the study area. The Project is unlikely to increase these threats or result in invasive species becoming established in potential habitat for migratory species.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	The Project is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of a population of a migratory species.
Conclusion	The Project will not result in a significant impact to migratory species listed under the EPBC Act.

Important habitats in Australia for migratory shorebirds under the EPBC Act include those recognised as nationally or internationally important (DAWE 2021a):

- Wetland habitat is considered *internationally important* if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird or a total abundance of at least 20,000 waterbirds.
- *Nationally important habitat* for migratory shorebirds regularly supports 0.1% of the flyway population of a single species of migratory shorebird, or 2,000 migratory shorebirds or 15 migratory shorebird species.

The 'Revision of the East Asian–Australasian Flyway Population Estimates for 37 Listed Migratory Shorebird Species' (Hansen *et al.* 2016) provides population estimates for 37 migratory shorebirds to help define 'important habitat' for these species. As an example, important habitat for Latham's Snipe is described as areas that have previously been identified as internationally important for the species or areas that support at least 18 individuals of the species (Hansen *et al.* 2016). The 'Referral Guideline for 14 birds Listed as Migratory' (DoE 2015) also outlines ecologically significant proportions of 14 migratory species, including the Fork-tailed Swift, Rufous Fantail, Black-faced Monarch and Satin Flycatcher.

One Crested Tern was recorded at one time during surveys conducted over several seasons. Similarly, extensive field surveys conducted for nearby studies and in the wider region also recorded migratory species in low

numbers. The area is unlikely to support an ecologically significant proportion of the population of a migratory species.

10.7 Potential impacts to MSES

The potential for the Project to impact MSES has been considered. Terrestrial ecology MSES prescribed under the *Environmental Offsets Regulation 2014* of relevance to the Project are provided in Table 10.29.

MSES values identified within the Project have been assessed under the 'Queensland Environmental Offsets Policy Significant Residual Impact Guideline' (DEHP 2014). As the EO Act does not apply to impacts on EPBC Act MNES that are being assessed by the Commonwealth Government, the matters assessed under the Significant Residual Impacts Guideline only include MSES that are not already assessed as MNES.

The assessments undertaken in Appendix G, Terrestrial Ecology Assessment (Section 11.2) include the following:

- regulated vegetation;
- connectivity areas; and
- protected wildlife habitat (Short-beaked Echidna).

The impact assessments consider the potential impacts of the Project and the avoidance, mitigation and management measures described in section 10.8.

The impacts to wetlands and watercourses under the Significant Residual Impact Guideline' are assessed separately within Chapter 11, Aquatic Ecology Assessment.

Significant residual impacts have been identified to occur as a result of the Project on MSES regulated vegetation.

Table 10.29: Summary of impacts to MSES

Matter of State Ecological Significance			**Applicability to Project**
Regulated Vegetation	Endangered REs	RE 11.3.1	RE occurs in Project area
		RE 11.4.8	
		RE 11.4.9	
		RE 11.5.17	
	Of Concern REs	RE 11.3.2	
		RE 11.3.3	
		RE 11.3.4	
	REs within mapped vegetation management wetlands		Mapped vegetation management wetlands occur in the Project area
	REs within the defined distance of a vegetation management watercourse		REs within the defined distance of a vegetation management watercourse occur within the Project area
Connectivity areas			Vegetation in the Project area has connectivity values
Wetlands and watercourses			High Ecological Significance wetlands are within the vicinity of the Project area. Impacts to wetlands and watercourses are assessed in Chapter 11, Aquatic Ecology

Matter of State Ecological Significance			Applicability to Project
Protected Wildlife Habitat	Essential habitat		Ornamental Snake Essential Habitat occurs in the Project area
	Flora survey trigger map high risk area		Not applicable
	Area containing plants that are Endangered or Vulnerable wildlife		Not applicable
	Habitat for Endangered, Vulnerable or Special Least Concern Animal	Ornamental Snake	The Project area contains habitat for the species. Refer to Section 10.9 of this report.
		White-throated Needletail	
		Squatter Pigeon	
		Australian Painted Snipe	
		Koala	
		Greater Glider	
		Short-beaked Echidna	
Designated Precinct in a Strategic Environmental Area			Not applicable
Protected Areas			Not applicable
Highly protected zones of State marine parks			Not applicable
Fish habitat areas			Not applicable
Waterway providing for fish passage			Impacts to waterway providing for fish passage assessed in Chapter 11, Aquatic Ecology
Marine plants			Not applicable
Legally secured offset areas			Not applicable

10.7.1 Regulated vegetation

Endangered and Of Concern REs

A total of 12.2 ha of remnant vegetation is proposed to be cleared for the Project, and a further 96.9 ha of remnant vegetation is predicted to be substantially impacted by residual ponding, including Endangered and Of Concern REs defined under the VM Act. The Significant Residual Impact Guideline (DEHP 2014) provides thresholds for clearing in Endangered and Of Concern vegetation that will constitute a significant residual impact and trigger the requirement of environmental offset. The proposed clearing, thresholds and assessments for clearing Endangered and Of Concern REs is provided in Table 10.30.

Areas of Endangered and Of Concern REs to be cleared meet the criteria for TECs and these impacts have been assessed under the Commonwealth Significant Impact Guidelines (DoE 2013a) in sections 10.6.1 and 10.6.2. Only the portions of REs which did not trigger assessment as MNES require assessment as a MSES.

Offsets will be required for the significant residual impacts to:

- 4.8 ha of Endangered RE 11.3.1 which is not subject to offset conditions for the Brigalow TEC;
- 3.3 ha of Endangered RE 11.4.8 which are not subject to offset conditions for the Brigalow TEC;
- 13.9 ha of Of Concern RE 11.3.2; and
- 4.9 ha of Of Concern RE 11.3.4.

The remainder of impacted remnant vegetation is listed as least concern under the VM Act.

Areas of vegetation within the subsidence footprint, but outside of predicted residual ponding areas are not expected to be deleteriously impacted (refer Section 10.5.2.1). Subsidence impacts related cracking and erosion are assessed in Section 10.5.2.11 and Chapter 5, Land Resources, Section 5.4.1 and Section 5.4.3. Given the proposed monitoring and management measures for erosion, no substantial erosion is expected to occur, and it is considered unlikely that erosion will impact regulated vegetation.

Table 10.30: Endangered and Of Concern Regional Ecosystems impact summary

Regional Ecosystem	Extent within study area (ha)	Structural category	Assessment criteria	Assessment against criteria	Stage 1,2,3 direct disturbance (ha)	Stage 4 (ha)	Predicted periodic ponding (ha)
Endangered RE							
11.3.1	106.2	Mid-dense	Clearing exceeds 0.5 ha	Yes, the Project will result in the removal of 12.1 ha of this community, 4.8 ha of which does not represent the Brigalow TEC[1]	0.3 (0.0 not TEC)	3.6 (3.6 not TEC)	8.2 (1.2 not TEC)
11.4.8	51.4	Sparse	Clearing exceeds 2 ha	Yes, the Project will result in the removal of 3.9 ha of this community, 3.3 ha of which does not represent the Brigalow TEC[1]	0.3 (0.0 not TEC)	3.5 (3.3 not TEC)	0.1 (0.0 not TEC)
11.4.9	19.4	Sparse	Clearing exceeds 2 ha	No, the Project will not clear vegetation within this vegetation community.	0.0	0.0	0.0
11.5.17	21.3	Sparse	Clearing exceeds 2 ha	No, the Project will not clear vegetation within this vegetation community.	0.0	0.0	0.0
Of Concern RE							
11.3.2	960.2	Sparse	Clearing exceeds 2 ha	Yes, the Project will result in the removal of 58.3 ha of this community, all of which represents the Poplar Box TEC[1].	0.0	0.0	58.3 (13.9 not TEC)
11.3.3	12.2	Sparse	Clearing exceeds 2 ha	No, the Project will not clear vegetation within this vegetation community.	0.0	0.0	0.0
11.3.4	178.0	Sparse	Clearing exceeds 2 ha	Yes, the Project will result in the removal of 4.9 ha of this community.	0.0	0.0	4.9

[1] The 'Queensland Environmental Offsets Policy (Version 1.9)' (DES 2021b) states that the State Government can only impose an offset condition in relation to a prescribed activity if the same matter has not been subject to assessment under the EPBC Act.

Vegetation within a defined distance of a wetland

The Project will impact vegetation within the mapped vegetation management wetlands. Offsets are required under the EO Act for significant residual impacts on remnant REs that lie within a mapped vegetation management wetland and are within 50 m of the defining bank of a VM Act wetland. For an activity to have a significant residual impact on a RE that is within a mapped wetland, the same thresholds described for Regional and Of Concern REs must be exceeded.

Four VM Act wetlands will be impacted by the Project:

- One VM Act wetland is partially within the footprint of the ETL:
    - The area of disturbance is 0.01 ha within the wetland and 0.48 ha within 50 m of the wetland defined bank. The wetland vegetation is RE 11.3.27f, and no vegetation structure category is assigned for this RE (DES 2021d). However, the impact on this RE will not exceed the threshold for any of the structure categories and is not considered to be a significant impact.
- Three VM Act wetlands are within the stage three subsidence area, and hydraulic modelling indicates that these wetlands will experience changes hydraulic conditions post subsidence:
    - One VM Act wetland of 1.8 ha located 400 m to the south of Boomerang Creek is within the underground mining stage 3 predicted periodic ponding footprint. The predicted increase in ponding represents a change in habitat that may increase the frequency and duration of ponding in the wetland and is expected to result in a change detrimental to the vegetation fringing the current extent of the wetland. This change is considered to be a significant impact.
    - One VM Act wetland of 3.5 ha located between Boomerang Creek and One Mile Creek will be partially impacted by subsidence from stage 3 underground mining. The area of the wetland that will receive periodic inundation is predicted to be reduced as a result of the predicted surface subsidence. The lack of periodic inundation is expected to be detrimental to the vegetation of the wetland, and it is considered that the portion of the wetland that will receive reduced inundation (0.8 ha) will be significantly impacted.
    - One VM Act wetland of 2.1 ha located between Boomerang Creek and One Mile Creek will be entirely impacted by subsidence from stage 3 underground mining. A longwall pillar will be located under the wetland, and the wetland is predicted to not receive periodic inundation as a result of the predicted surface subsidence. This change is considered to be a significant impact.

A total of 4.7 ha of VM Act wetlands of RE 11.5.17 are predicted to be impacted by the Project. This exceeds the thresholds relevant to the vegetation structure categories. Therefore, a significant residual impact is expected to occur to 4.7 ha and offsets will be required.

Vegetation within a defined distance of a watercourse

Remnant REs that occur within certain distances of defined watercourses are classified as MSES. Clearing within the defined distance of these watercourse REs can trigger a significant impact under the Significant Residual Impact Guideline. For an activity to have a significant residual impact, the same thresholds described for Regional and Of Concern REs must be exceeded (i.e. clearing of greater than 0.5 ha in mid-dense REs and clearing of greater than 2 ha in sparse REs). Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek are defined watercourses under the VM Act.

Remnant vegetation of REs within the defined distance of VM Act watercourses in the study area that will be cleared or impacted by predicted periodic ponding for areas that exceed the threshold include:

- 8.0 ha of RE 11.3.1; and
- 6.1 ha of RE 11.3.25.

These impacts to vegetation within the defined distance of a watercourse meet the conditions for a significant residual impact and offsets will be required.

10.7.2 Connectivity areas

In accordance with the Significant Residual Impact Guideline, the Landscape Fragmentation and Connectivity Tool has been used to assess the significance of impact on connectivity areas.

An impact on connectivity areas is determined to be significant if:

- the change in the core remnant ecosystem extent at the local scale (post impact) is greater than a threshold determined by the level of fragmentation at the regional scale; or
- any core area that is greater than or equal to 1 ha is lost or reduced to patch fragments (core to non-core).

The assessment has determined that the Project change in the core remnant ecosystem extent at the local scale is below the threshold of regional fragmentation. The assessment has determined that the number of core remnant areas occurring on the site will not be reduced by the Project. The assessment has concluded that any impact on connectivity areas is not significant. The Landscape Fragmentation and Connectivity Tool output is provided in Appendix G, Terrestrial Ecology Assessment (Section 11.2.2).

10.7.3 Wetlands and watercourses

The impacts to wetlands and watercourses under the Significant Residual Impact Guideline are assessed in Chapter 11, Aquatic Ecology Assessment. The assessment has concluded that the Project is unlikely to cause a significant residual impact to wetlands or watercourses.

10.7.4 Protected wildlife habitat

Essential habitat

Essential habitat is shown on the regulated vegetation management map under the VM Act and is areas that contain at least three essential habitat factors for protected wildlife or is areas in which the protected wildlife is located. Essential habitat is mapped within the study area for the Ornamental Snake (Appendix G, Terrestrial Ecology Assessment Section 11.2.4). The impacts on this species and its habitat are assessed as a MNES in section 10.6.3.

Habitat for an Endangered, Vulnerable or Special Least Concern animal

Protected wildlife habitat includes an area of habitat for an Endangered, Vulnerable or Special Least Concern animals (DEHP 2014).

Five fauna species listed as Endangered or Vulnerable under the NC Act have been identified during field surveys, the:

1) Ornamental Snake;
2) Squatter Pigeon (Southern);
3) White-throated Needletail;
4) Koala; and
5) Greater Glider.

The Australian Painted Snipe, listed as Endangered under the NC Act, was not observed during field surveys. However, it has been included for assessment because, despite the likelihood of occurrence of the species being potential, the condition and extent of the potential habitat justified assessment. The NC Act listed species identified for assessment are also listed as threatened under the EPBC Act and have been assessed in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a) in section 10.6.

Two Special Least Concern (migratory) species listed under the NC Act have been recorded by the surveys, the:

1) White-throated Needletail (also listed as Vulnerable); and

2) Crested Tern (*Thalasseus bergii*).

These species are also listed as migratory under the EPBC Act and have been assessed in section 10.6.9, along with other Special Least Concern (migratory) species that are likely to have the potential to occur within the study area.

The Short-beaked Echidna *(Tachyglossus aculeatus)*, which is listed as a non-migratory Special Least Concern species under the NC Act has also been recorded during the surveys. An assessment of the likelihood of significant impacts on the Short-beaked Echidna is provided below.

10.7.5 Short-beaked Echidna

The Short-beaked Echidna is found in almost all Australian environments and is present is all Australian states (Van Dyck and Strahan 2008). This species is known from a variety of habitat types, including open forests, grasslands and heavily vegetated woodlands. Distributions in arid regions is generally sparse. The Short-beaked Echidna has no particular habitat requirements outside of the supply of ants and termites for its diet (Van Dyck and Strahan 2008). This species generally seeks shelter under thick bushes, in hollow logs, in debris and has been known to occasionally shelter in rabbit or wombat burrows (Van Dyck and Strahan 2008).

The Short-beaked Echidna is a solitary species, with overlapping home ranges and no fixed nesting sites (Van Dyck and Strahan 2008). In arid regions, the species is known to forage at night to avoid high temperatures (Van Dyck and Strahan 2008). In temperate regions, the pattern of activities varies depending on temperatures, but the species typically forages around dusk and dawn (Van Dyck and Strahan 2008). Habitat loss poses a threat to the Echidna, and the retention of habitat, such as fallen logs, branches, tree stumps, leaf litter and debris, is beneficial to this species (NSW National Parks and Wildlife Service 1999). The Short-beaked Echidna is thought to have few natural enemies; however, it may be killed by cars, dogs, foxes, cats and occasionally goannas (Australian Museum 2021).

The Short-beaked Echidna was recorded opportunistically within cleared agricultural land within the study area during the autumn 2021 and spring 2021 surveys. While the Short-beaked Echidna is known to use cleared and disturbed habitats, remnant habitats in the study area are likely to be preferred (over 3,440 ha in the study area). The Project will result in the clearing/disturbance of approximately 12.2 ha of remnant vegetation and 801.7 ha of cleared agricultural areas and high-value regrowth. Areas of indirect disturbance, such as predicted increased potential ponding and predicted subsidence, are not expected to constitute a disturbance with magnitude or intensity sufficient to impact the habitat utility for the Echidna. Subsidence areas, including the areas which may undergo intermittent ponding, are expected to retain vegetation sufficient to provide Short-beaked Echidna habitat (refer Section 10.5.2.1).

Table 10.31 provides an assessment of the likelihood of significant impacts on the Short-beaked Echidna in accordance with the Significant Residual Impact Guideline.

Table 10.31: Short-beaked Echidna significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a Special Least Concern (non-migratory) animal wildlife habitat if it is likely that it will result in:	
A long-term decrease in the size of a local population	Approximately 12.2 ha of remnant vegetation and 801.7 ha of cleared agricultural land is proposed to be cleared by the Project. The Short-beaked Echidna utilises a wide range of habitats, which are widespread in the study area and wider region. The extent of habitat disturbance proposed is unlikely to lead to a long-term decrease in the size of a local population, given the extent of habitat that remains available in the local area and wider region.
A reduced extent of occurrence of the species	While the Project will disturb potential habitat for the Short-beaked Echidna, it is unlikely to reduce the extent of occurrence of this species. The Project is not near the edge of the known distribution of the Short-beaked Echidna.
Fragmentation of an existing population	The Short-beaked Echidna is a mobile species able to move across cleared or disturbed land. Connectivity of habitats is unlikely to be significantly affected by the proposed vegetation clearance and disturbance associated with the Project. The Project is unlikely to fragment an existing population into two of more populations.
Genetically distinct populations forming as a result of habitat isolation	The Project is unlikely to isolate or fragment an existing population of the Short-beaked Echidna and is, therefore, unlikely to result in genetically distinct populations forming.
Disruption to ecologically significant locations (breeding, feeding or nesting sites) of a species	The Short-beaked Echidna is a mobile species that uses a diverse range of habitats. While direct impacts on Short-beaked Echidna generic foraging habitat and potentially breeding/nesting habitat will occur within proposed Project disturbance areas, similar and higher quality habitat occurs on adjacent and nearby lands within the study area. The habitat within the proposed disturbance areas is unlikely to be of any specific significance to the local population.
Conclusion	The Project is unlikely to result in a significant impact to the Short-beaked Echidna.

10.8 Mitigation and management measures

In order to manage potential impacts on terrestrial ecology values as a result of the Project, the following framework has been adopted, consistent with the recommended 'mitigation hierarchy' from DES:

- avoid impacts where possible;
- mitigate or minimise unavoidable impacts; and
- where necessary, offset significant residual impacts.

The avoidance, mitigation and management measures detailed in sections 10.8.1 and 10.8.2 have been developed in consideration of the 'S.M.A.R.T' principle (specific, measurable, achievable, relevant, time-bound). The proposed measures have been categorised as those relating to habitat and vegetation disturbance, subsidence and site operational impacts. Project alternatives have been considered including alternative mine plans and mining methods. The proposed plan represents a layout option which best avoids environmental impacts. Key measures incorporated into the Project plan to avoid impacts to terrestrial ecology values are detailed in Chapter 3, Project Description, Section 3.6 and include the following:

- minimising the open cut footprint and avoiding areas of remnant vegetation in the open cut footprint;
- not developing the two other potential open cut areas within the Project area;
- mitigation of subsidence areas to minimise areas that experience ponding;
- waste rock disposal design to minimise overall disturbance footprint and allowing for progressive rehabilitation of mine landforms;
- infrastructure corridor alignment to minimise disturbance to watercourses, remnant vegetation and environmentally sensitive areas; and
- MIA alignment to avoid and minimise clearing or remnant vegetation and threatened species habitat while be adequately located from underground mining area and open-cut pit.

Unavoidable impacts will be offset in accordance with Commonwealth and State legislative requirements. Commonwealth offsets are detailed in Chapter 21, MNES, and State offsets are discussed in section 10.9.

10.8.1 Habitat and vegetation disturbance

10.8.1.1 Vegetation clearing protocols

The following management measures will be implemented when vegetation clearance is necessary in order to minimise and/or mitigate impacts on vegetation communities and fauna habitats, including the risk of injury or death to native fauna. Protocols to be adopted include:

- Clearing activities will be undertaken progressively in accordance with the mine schedule and Project requirements and not before.
- Vegetation/habitat adjoining proposed clearance areas will be delineated and clearly marked to prevent accidental damage through a 'Permit to Disturb' process or similar.
- Areas to be cleared will be inspected to identify fauna at direct risk from clearing activities.
- Vegetation will be felled in the direction of the clearance zone to avoid impacts to adjoining retained vegetation and habitat.
- Clearing operations will be managed to maximise the re-use of cleared vegetative material. This will include the salvage and re-use of select habitat resources from the cleared vegetation (e.g. logs) for habitat enhancement, either in the rehabilitation program, proposed offset areas located on Bowen Basin Coal land or elsewhere on-site.
- A fauna spotter/catcher will be on-site when clearing activities occur within Ornamental Snake, Koala or Greater Glider habitat. The fauna spotter/catcher will monitor clearance activities for conservation significant species and any incidence of fauna mortality or injury will be recorded. Injured fauna will be taken to a wildlife carer or veterinarian.
- The fauna spotter/catcher will monitor the fauna encountered and the occurrence of Ornamental Snakes within trenches.
- Select habitat features (e.g. hollows, logs) will be salvaged during clearance activities for habitat enhancement in Ornamental Snake habitat that will not be disturbed by the Project.

As described in section 10.5.1, temporary vegetation/habitat disturbance above the underground mining area will be undertaken for the deployment of gas drainage wells. Surface disturbance works to support the conduct of gas drainage activities will be sited to minimise the amount of vegetation disturbance required. Management measures for areas of disturbance required above the underground mining area include:

- using existing tracks to access sites, to minimise vegetation clearing, disturbance of soils and creation of new tracks;
- restricting vegetation clearance to the slashing of vegetation (i.e. leaving the lower stem and roots in situ to maximise the potential for natural regrowth), where practicable;

- lopping of branches, rather than the removal of trees, where practicable;
- limiting the amount of soil disturbance to the minimum required for the mobilisation, placement and operation of equipment and for maintaining access to equipment; and
- implementing timely rehabilitation measures (at the completion of activities) with weed control measures implemented if/as required.

10.8.1.2 Clearing Management Program

A Clearing Management Program will be prepared for the Project by a suitably qualified ecologist, in accordance with relevant guidelines, prior to the commencement of Project clearance activities. The Clearing Management Program will include:

- measures to be implemented to minimise disturbance and salvage and re-use of select habitat features in accordance with the vegetation clearance protocols;
- protocols for handling fauna encountered prior to or during clearing activities, including their relocation as necessary to suitable habitat;
- provision for an appropriately qualified fauna spotter/catcher to be present during clearing in;
- specific measures to be implemented to minimise impacts to threatened species, including the Ornamental Snake, White-throated Needletail, Squatter Pigeon, Koala and Greater Glider; and
- protocols for injured wildlife, including emergency euthanasia.

A Species Management Program will also be developed for the Project to provide for the management of breeding areas of key conservation species potentially impacted by the Project clearing. The Species Management Program(s) will be in accordance with the NC Animals Regulation and be provided for approval by DES prior to vegetation clearance activities that would disturb animal breeding places. The Species Management Program will detail the individual responsibilities of personnel (employees and contractors) to operate in accordance with the program, such that roles would include but not be limited to:

- manager—obtain all relevant approvals and permits necessary prior to the execution of any vegetation clearing activities;
- senior executive—ensure all workers are trained and competent to perform relevant duties and maintain an acceptable level of risk under the program;
- site environmental representative—direct implementation of the plan on-site, including communications with site supervisors to confirm pre-clearing, clearing and construction activities are undertaken in accordance with the program; and
- suitably qualified and experienced person—undertake pre-clearance surveys in accordance with the program.

The plan will be reviewed for its effectiveness in the event of any:

- changes made to legislative requirements;
- direction from the Commonwealth Minister; or
- any modifications made to the EA or EPBC Act Approval.

10.8.1.3 Pre-clearing inspections

Inspection of areas to be cleared will be undertaken prior to clearing to confirm whether any animal breeding places for threatened or near threatened species are present or are likely to be present. If breeding places for threatened or near threatened species are present or are likely to be present, the Project will engage a spotter/catcher to manage the potential impacts on fauna during clearing activities.

10.8.1.4 Weed and pest management

Throughout Project construction, operation and decommissioning phases, the Proponent will limit activities that cause disturbance specifically for the purpose of avoiding impacts to terrestrial ecology values from invasive species. The Proponent will undertake consultation with the IRC, property neighbours and local land managers, when necessary, to best manage local and regional weed and pest management challenges.

The existing Lake Vermont Mine 'Pest and Weed Management Plan' will be reviewed and revised when appropriate to incorporate pest and weed management measures for the Project. The 'Pest and Weed Management Plan' for the Lake Vermont Mine complex will provide for:

- inspections within the mining lease to identify areas requiring weed management to be implemented;
- weed management measures (e.g. mechanical removal and application of approved herbicides) in consideration of weed control strategies outlined by the Department of Agriculture and Fisheries and the 'Isaac Regional Biosecurity Plan 2020–2023' (Isaac Regional Council 2020);
- requirements for follow up inspections to assess the effectiveness of the weed management measures implemented and requirement for any additional management measures;
- requirements for maintenance of a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna;
- requirements for storage of domestic waste in appropriate receptacles and locations;
- feral animal control strategies in consideration of pest control strategies outlined by the Department of Agriculture and Fisheries, 'Isaac Regional Biosecurity Plan 2020–2023' (Isaac Regional Council 2020) and Threat Abatement Plans applicable to the EPBC Act listed key threatening processes; and
- requirements for minimising the period that areas remain in disturbed and or unvegetated condition.

10.8.1.5 Site rehabilitation

Land disturbed by mining activities will be rehabilitated progressively as land becomes available. Details of the proposed rehabilitation program are provided in Chapter 6, Rehabilitation. In accordance with Queensland government policy objectives defined in the 'Mined land rehabilitation policy' (Queensland Government 2018), the general rehabilitation goals for the Project are to leave an area that is safe, stable, does not cause environmental harm and is able to sustain the post mining land use approved through the Project PRC Plan.

10.8.2 Subsidence

Residual ponding is anticipated to change vegetation structure and composition, with potential significant residual impacts to MSES and MNES; therefore, a reduction in the area of ponding will reduce the amount of terrestrial vegetation and habitat impacted by subsidence. Mitigation drains and mitigation bunds will be constructed to reduce the area of ponding created by subsidence, as outlined in Chapter 9, Flooding and Regulated Structures. These measures will be designed and constructed to minimise disturbance to conservation significant habitat and minimise ponding in areas of the habitat for Brigalow TEC, Poplar Box TEC, Ornamental Snake, Australian Painted Snipe, Koala, Greater Glider and migratory species.

A Subsidence Management Plan will be prepared prior to the commencement of the Project, which will include monitoring, management and mitigation measures for potential subsidence impacts of the Project. The

Subsidence Management Plan will provide for the collection of ongoing data to assist with the management of associated risks, validate subsidence predictions and analyse the relationship between subsidence effects and impacts on the surrounding environment. The Subsidence Management Plan will, therefore, promote adaptive management, facilitating monitoring to guide management action responses.

10.8.3 Site operations

Ongoing operation of the Project has the potential to impact terrestrial ecology values. General Project site protocols, as well as impact specific management plans in relation to water management, bushfire management and equipment management, are discussed below. In addition, the Proponent has or will develop the following management plans to mitigate impacts resulting from ongoing site operations:

- Develop an Air Quality Management Plan for the Project (outlined in Chapter 13, Air Quality).
- Update the existing Lake Vermont Mine Topsoil Management Plan for the Project (outlined in Chapter 5, Land Resources).
- Develop a Subsidence Management Plan for the Project (outlined in Chapter 5, Land Resources).
- Develop an Emergency Response Plan for the Project (outlined in Chapter 16, Hazards and Safety).
- Update the existing Lake Vermont Mine 'Water Management Plan' for the Project, including the addition of Project monitoring bores (outlined in Chapter 8, Surface Water).
- Update the existing Lake Vermont Mine 'Receiving Environment Monitoring Program' for the Project (outlined in Chapter 9, Flooding and Regulated Structures).
- Develop a Groundwater Dependent Ecosystem Monitoring and Management Plan (outlined in Chapter 7, Groundwater and Chapter 11, Aquatic Ecology).

These management plans will be developed/updated in consideration of potentially impacted fauna and flora values and will be designed using the management hierarchy.

Erosion and sediment control measures

During all phases of the Project, erosion and sediment controls to reduce the risk and impacts of erosion will be implemented in accordance with established erosion and sediment control standards. Erosion and sediment control is outlined in Chapter 5, Land Resources. Erosion control measures are identified as specifically relevant to avoiding impacts on habitat for the Ornamental Snake, Australian Painted Snipe and migratory species.

Monitoring of subsidence-affected reaches of Boomerang Creek and One Mile Creek will be undertaken, with a particular focus on identifying potential bed and bank erosion predicted by hydrological modelling. This monitoring will be provisioned for within the Subsidence Management Plan. Further details of monitoring and application of mitigation measures for erosion and sediment control are detailed in Chapter 8, Surface Water.

Water quality control measures

Water quality management measures are considered in Chapter 8, Surface Water. In addition to the proposed water quality management, implementation of measures to reduce the risk of introduction of pollutants (e.g. bunding or containment of hydrocarbon storage and the provision of spill kits) are proposed as specifically relevant to avoiding impacts on habitat for the Ornamental Snake, Australian Painted Snipe and migratory species.

Lighting

The Proponent will implement artificial lighting in consideration of AS 4282:2019 'Control of the obtrusive effects of outdoor lighting' (Standards Australia 2019). Lighting will be conducted in a way that focuses on

disturbance/work areas and minimises/avoids lighting of remnant vegetation, with particular regard to avoiding impacts to habitat for the Koala and Greater Glider.

Vehicle strike management

The Proponent will implement management measures to reduce impacts on fauna species due to vehicle strike, with particular regard to avoiding impacts to the Koala. The proposed measures are:

- Speed limits will be imposed to reduce the risk of vehicle strikes.
- Safe driving procedures will be incorporated into site inductions to increase awareness of the risk of vehicle strikes.

Waste management

The Proponent will implement waste management measures to prevent the creation of conditions likely to favour pest species. The measures will be undertaken with particular regard to avoiding pest species identified as potentially impacting Brigalow TEC, Poplar Box TEC, Squatter Pigeon, Australian Painted Snipe, Koala and migratory species. The proposed measures are:

- maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna; and
- storage of domestic waste in appropriate receptacles and locations.

Bushfire prevention and management

An Emergency Response Plan will be prepared/updated by the Proponent, as outlined in Chapter 16, Hazards and Safety. Induction for Project site personnel will include fire awareness. The bushfire prevention measures are particularly relevant to avoiding impacts to Brigalow TEC, Poplar Box TEC, Squatter Pigeon, Koala, Greater Glider, and migratory species.

GDE specific management measures

Mitigation, management and monitoring measures are proposed in Appendix I, Groundwater Dependent Ecosystem Assessment (Section 6.4) to minimise the risk of impacts to GDEs and include the following:

- The Project will operate under an updated Water Management Plan with the primary objective of minimising environmental harm. The Water Management Plan will provide erosion and sediment control measures.
- The Project will operate under an updated Receiving Environment Monitoring Program that will be implemented as applicable to the management of potential impacts to GDEs that occur within the influence of the Project.
- Project groundwater monitoring bores will continue to be monitored across the life of the Project, with this to be facilitated through an update to the existing Lake Vermont Mine Water Management Plan.
- Additional baseline data will be collected to further characterise the seasonal ecohydrological function and baseline condition of alluvial GDEs on Boomerang Creek and Philips Creek and the GDE at HES wetland 8. The collection of baseline data will be conducted in accordance with a Groundwater Dependent Ecosystem Monitoring and Management Plan, which will provide protocols for:
    - collection of baseline ecological condition data (Biocondition and Leaf Area Index) for Type 1 GDEs over areas where groundwater drawdown in the Tertiary and Quaternary sediments is predicted;

- collection of baseline ecological condition data (Biocondition and Leaf Area Index) over HES Wetland 8 (GDE Type 2) where more than 2m of groundwater drawdown is modelled in the Tertiary sediments;
- collection of baseline ecological condition data in GDE areas where limited (less than 2m) and/or no groundwater drawdown is predicted to provide an ecological control;
- prescriptive methods for GDE monitoring over the life of the mine and post mining periods which are tailored to the assessed levels of ongoing risk to GDE function; and
- mitigations and methods of adaptive management that can be implemented if impacts to GDEs are detected (which can be linked either directly or indirectly to mining operations associated with the Project).

10.9 Proposed offsets

The Biodiversity Offset Strategy provides a comprehensive assessment of offset requirements and the proposed delivery strategy (Appendix K, MNES Biodiversity Offsets Strategy).

The assessments of impacts to MNES are provided in section 10.6 and further detailed in Chapter 21, Matters of National Environmental Significance. Based on the results of the significant impact assessments, it is proposed that the Proponent will provide biodiversity offsets in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* 'Environmental Offsets Policy' (DSEWPaC 2012b) for:

- Brigalow TEC
- Poplar Box TEC
- Ornamental Snake
- Koala
- Greater Glider

Where these offset requirements overlap with MSES values, offsets will be provided under the EPBC Act. The assessment of impacts on MSES (that are not subject to an assessment under the EPBC Act) are provided in section 10.7.

The impacts on MSES and associated offset requirements for the Project are summarised in Table 10.32. In summary, residual State-based offsets will be required for the Project for significant residual impacts on regulated vegetation, in accordance with the EO Act and Queensland Environmental Offsets Policy for:

- Endangered and Of Concern REs;
- REs within mapped vegetation management wetlands; and
- REs within the defined distance of a vegetation management watercourse.

It is noted that the authorised impacts to prescribed environmental matters for Lake Vermont Mine include:

- regulated vegetation for REs within a defined distance of a relevant watercourse for;
  - RE 11.3.25 within defined distance of a relevant watercourse;
  - RE 11.3.27 within defined distance of a relevant wetland; and
- protected wildlife habitat for the Squatter Pigeon.

Therefore, under the Queensland Environmental Offsets Policy, for the purposes of the impacts to these matters, all impacts identified are considered cumulative to the approved authorised impact and require offsets. This includes direct impacts to Squatter Pigeon habitat assessed to not meet the significance assessment criteria of the Significant Impact Guideline (DoE 2013a) in Section 10.6.5.

For all prescribed environmental matters, the size and scale of an offset is that which is necessary to achieve a conservation outcome.

10.9.1 Offset management strategy

The EPBC Act Environmental Offsets Policy (DoEE 2012) outlines the Australian Government's position on the use of environmental offsets, while the Queensland Environmental Offsets Policy (Version 1.12) (DES, 2022d) is the relevant State instrument for environmental offsets in Queensland (applicable at the time of the Project ToR).

The Queensland Environmental Offsets Policy establishes an environmental offset hierarchy to avoid duplication of offset conditions between jurisdictions. State and local governments may only impose an offset condition if "the same, or substantially the same, impact and the same, or substantially the same, matter" has not been subject to assessment under the Commonwealth.

This includes if the Commonwealth could have imposed an offset condition but did not do so. However, it does not apply if the Commonwealth has decided that the activity itself is not a 'controlled action'. For example, an activity referred to the Commonwealth that could impact on MNES that receives a 'not a controlled action' or a 'not controlled action–particular manner' notice, could still be subject to an offset condition imposed by State or local government.

If the Commonwealth imposes an offset condition for a prescribed environmental matter after the State or local government has already imposed an offset condition, the Proponent can apply to the lower level of government to have the duplicate offset requirement removed, provided the condition is for the same, or substantially the same, impact and prescribed environmental matter.

Table 10.32: Summary of impacts to MSES

Matter of State Environmental Significance			**Extent of disturbance (ha)**	**Offset required**
Regulated Vegetation	Endangered REs	RE 11.3.1	12.1[1] (4.8 ha of which is assessed as not Brigalow TEC assessed under the EPBC Act)	Yes, for the 4.8 ha of RE 11.3.1 not assessed as Brigalow TEC under the EPBC Act
		RE 11.4.8	3.9[2] (3.3 ha of which is assessed as not Brigalow TEC under the EPBC Act)	Yes, for the 3.3 ha of RE 11.4.8 not assessed as Brigalow TEC under the EPBC Act
		RE 11.4.9	No clearing of this vegetation community	No
		RE 11.5.17	No clearing of this vegetation community	No
	Of Concern REs	RE 11.3.2	58.3[3] (44.4 of which represents the Poplar Box TEC assessed under the EPBC Act)	Yes, for the 13.9 ha of RE 11.3.2 not assessed as Poplar Box TEC under the EPBC Act
		RE 11.3.3	No clearing of this vegetation community	No
		RE 11.3.4	4.9	Yes, for 4.9 ha
	REs within mapped vegetation management wetlands		Significant hydrological change impacts to three wetland areas of RE 11.5.17	Yes, for 4.7 ha of RE 11.5.17 wetland areas
	REs within the defined distance of a vegetation management watercourse	RE 11.3.1	8.0	Yes, for 8.0 ha (and assessed as Brigalow TEC under the EPBC Act)
		RE 11.3.25	6.1	Yes, for 6.1 ha
Connectivity areas			No significant impact	No
Wetlands and watercourses			No direct disturbance (wetlands) Not applicable (watercourses)	No

Matter of State Environmental Significance			Extent of disturbance (ha)	Offset required
Protected Wildlife Habitat	Essential habitat	Ornamental Snake	Refer to section 10.6.3 of this report, significance assessment for the Ornamental Snake under the EPBC Act	
	Flora survey trigger map high risk area		Not applicable	
	Area containing plants that are Endangered or Vulnerable wildlife		Not applicable	No
	Habitat for Endangered, Vulnerable or Special Least Concern Animal	Ornamental Snake	Refer to section 10.6.3 of this report, significance assessment under the EPBC Act	
		White-throated Needletail	Refer to section 10.6.4 of this report, significance assessment under the EPBC Act	
		Squatter Pigeon	Direct impacts considered to be significant as cumulative to authorise impacts for Lake Vermont Mine under Queensland Environmental Offsets Policy despite significance assessment under EPBC Act (refer to section 10.6.5)	
		Australian Painted Snipe	Refer to section 0 of this report, significance assessment under the EPBC Act	
		Koala	Refer to section 0 of this report, significance assessment under the EPBC Act	
		Greater Glider	Refer to section 10.6.8 of this report, significance assessment under the EPBC Act	
		Short-beaked Echidna	809.9 ha (including 12.2 ha remnant vegetation and 801.7 ha of cleared agricultural land)	No
Designated Precinct in a Strategic Environmental Area			Not applicable	No
Protected Areas			Not applicable	No
Highly protected zones of State marine parks			Not applicable	No
Fish habitat areas			Not applicable	No
Waterway providing for fish passage			Refer to Appendix H, Aquatic Ecology Assessment (Section 10.2.2)	
Marine plants			Not applicable	No
Legally secured offset areas			Not applicable	No

[1] Of this, 4.8 ha of RE 11.3.1 represents the Brigalow TEC under the EPBC Act. [2] Of this, 3.3 ha of RE 11.4.8 represents the Brigalow TEC under the EPBC Act. [3] Of this, 44.4 ha of RE 11.3.2 represents the Poplar Box TEC under the EPBC Act.

10.9.1.1 Commonwealth offsets requirements

Stage 1 – 3 offsets

The proposed offset strategy which addresses all MNES offsets required for the stage 1 to 3 significant impacts of the Project is detailed in Appendix K, MNES Biodiversity Offsets Strategy (Section B). The extent of areas subject to significant impact for each Project stage is shown in Figure 10.14, Figure 10.15, Figure 10.18, Figure 10.22, Figure 10.24. The area of significant impact of each stage and proposed offsets as detailed in the Biodiversity Offsets Strategy are shown in Table 10.33.

The Biodiversity Offsets Strategy proposes staged offset delivery in line with the progressive Project disturbance and identifies the proposed offset areas for stages 1 to 3 will all be located within the Project proposed MLA on land owned by the proponent (Figure 10.25). The proposed offset site maintains riparian corridors associated with Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek provide east–west fauna movement opportunities through the landscape. The riparian vegetation along these streams is mapped as regionally significant corridors (Boomerang Creek, Hughes Creek, One Mile Creek, Phillips Creek) connecting to state significant riparian vegetation along the Isaac River (Figure 10.25). The riparian corridors associated with these streams provide dispersal habitat for the MNES offset matters Koala and Greater Glider.

The proposed offset areas for stages 1 to 3 including the allocation of available offset assessment units within the offset area are detailed in Appendix K, MNES Biodiversity Offsets Strategy (Section 2.7). The offset strategy provides the total breakdown of assessment units (Refer Appendix K, MNES Biodiversity Offsets Strategy, Section 7) as allocated to each proposed offset matter.

The proposed offset strategy satisfies the requirements of the EPBC Act Environmental Offsets Policy 2012 (DSEWPaC, 2012b) for stages 1 to 3 and offset areas would be secured prior to the start of each respective Project stage by declaration as an area of high conservation value under section 19F of the VM Act. Offset areas will be subject to Appendix U, Offset Area Management Plan (Section 5), which provides offset completion criteria to be attained and maintained for the period of EPBC Act approval. Statutory protection of the offset area would be maintained under the VM Act, Nature Conservation Act 1992 (Qld) (NC Act) and EPBC Act.

Stage 4 offsets

Stage 4 MNES offsets would be proposed within a subsequent offsets strategy which will likely be developed over land within the proposed MLA. The stage 4 offset strategy would provide:

- detail of the environmental offset for the stage 4 significant impacts
- justification that the proposed offsets satisfy the requirements of the EPBC Act Environmental Offsets Policy 2012 (DSEWPaC, 2012b);
- evidence of the offset area connectivity to dispersal habitat and fauna habitat corridors; and
- the means of legally securing the proposed offset area.

Table 10.33: MNES impacts and proposed offset areas

MNES	Significant impact areas					Impact site quality	Impact quantum	Offset areas				Offset start quality	Quality without offset	Quality with offset	Offset quantum and % of liability provided
	Stage 1	Stage 2	Stage 3	Stage 4	Total stages 1 - 3			Stage 1	Stage 2	Stage 3	Total stages 1 -3				
Brigalow TEC	0.6	6.9	0.1	0.3	7.6	5.01	3.8	1.82	20.88	0.30	23.0	5.45	5.45	7	102.33%
Poplar Box TEC	0.0	0.0	44.4	0.0	44.4	7.14	31.08	0.00	0.00	291.7	291.7	6.53	5.97	8	151.37%
Ornamental Snake	41.1	4.6	0.3	165.4	46.0	4.10	18.40	105.48	10.08	0.65	116.21	4.35	4.03	7	117.73%
Greater Glider	4.5	0.0	89.1	7.0	93.58	4.96	46.80	17.55	0.00	347.45	365.0	5.69	5.69	7	100.56%
Koala	4.8	8.2	89.1	7.1	102.1	5.89	61.2	22.61	38.59	418.8	480.0	5.78	5.78	7	101.13%

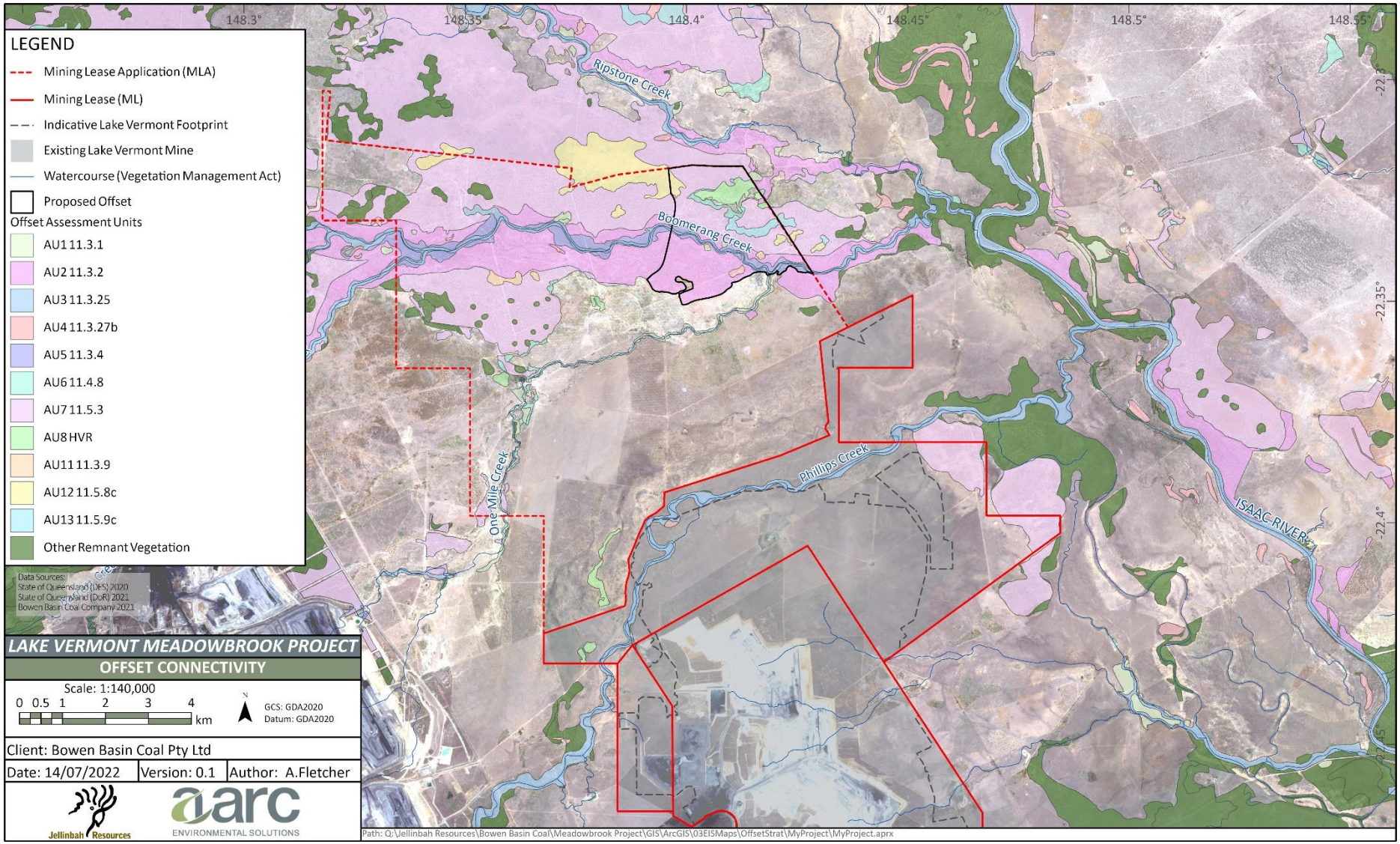

Figure 10.25: Proposed stage 1 - 3 offset area and connectivity

10.9.1.2 State offsets requirements

The environmental offset requirements for the Project are proposed to compensate for the loss of regulated vegetation, as detailed in section 10.9.

Under the Queensland Environmental Offsets Policy, there are three offset delivery options, which include:

1) Proponent-driven offset: A proponent-driven offset may take the form of a traditional land-based offset; be undertaken through actions under a Direct Benefit Management Plan; or a combination of both. For a proponent-driven offset, the offset delivery liability remains with the proponent and the offset must be delivered in accordance with an Offset Delivery Plan approved by the administering agency.

2) Financial settlement offset: For financial settlement offsets, the payment amount must be calculated in accordance with the methodology set out in the QEOP. A web-based 'financial settlement offset calculator' is available on the Queensland government website that can assist in this process. The State is responsible for delivering a conservation outcome from the financial settlement offset payment.

3) A combination of a proponent-driven offset and financial settlement offset may be utilised. However, the Direct Benefit Management Plan can only contribute up to 10% of the offset delivery.

For land-based offsets, the Queensland Environmental Offsets Policy sets multipliers for prescribed environmental matters, with a maximum multiplier of four, or potentially lower if offsetting with regrowth vegetation. A multiplier is defined as "a number used to calculate the size of the offset requirement, given the significant residual impact area, for a given prescribed environmental matter". The offset area is calculated by multiplying the area of impact by the prescribed multiplier:

Offset Area = Area of Impact x Multiplier

10.9.1.3 Proposed state offsets strategy

In accordance with the environmental offset hierarchy of the Queensland Environmental Offsets Policy, most of the offset requirements for the Project will be satisfied with the MNES offset strategy as shown in Table 10.34. The residual required State offsets will be established in stages in accordance with the Queensland Environmental Offsets Policy, accounting for the progressive disturbance of the Project.

The Proponent is planning to deliver a combination of Proponent-driven land-based offsets and financial settlement offsets. Areas of remnant and high-value regrowth vegetation within the Project area, on land owned by the proponent, will remain undisturbed by Project activities with potential to be used for land-based offsets. These areas are outside the Project direct disturbance footprint and indirect subsidence impact footprint and outside areas of significant Project impacts as identified in Section 10.6 and Section 0. These areas of vegetation shown in Figure 10.26 will be sufficient to meet the requirements for stage 1 to stage 3 MSES offsets not able to be co-located within the proposed MNES offset area. Up to 65.2 ha of RE 11.3.1, 282.8 ha of RE 11.3.2 and 16.8 ha of RE 11.5.17 are available in undisturbed parts of the Project area, sufficient to support a land-based offset of MSES impacted REs.

The detail of MSES offsets delivery will be provided as an offset delivery plan to be prepared before each stage of impact on the prescribed environmental matter occurs. The offset delivery plan would include a notice of election and provide the measures that will be taken to legally secure the offset. The requirement for an offset delivery plan will be included as amended conditions for the EA, as detailed in Chapter 23, Proposed Environmental Authority Conditions.

Table 10.34: Proposed MSES offset delivery strategy

Matter of State Environmental Significance		Extent of disturbance (ha)	Impact area required to be offset (ha)	Required offset area after multiplier applied	Co-location with MNES	Remaining impact area required to be offset	Stage 1	Stage 2	Stage 3	Stage 1-3 total	Stage 4	Stage 1-4 total
Endangered REs	RE 11.3.1	12.1 ha (7.3 ha of which is assessed as Brigalow TEC under the EPBC Act).	4.8 ha	19.2	1.78 ha co-located with Ornamental Snake habitat	**16.2 ha co-**located with RE 11.3.1 within the defined distance of a vegetation management watercourse for option stage 1-4	0.0	0.0	0.0	0.0	16.2	16.2
	RE 11.4.8	3.9 ha (0.6 ha of which is assessed as Brigalow TEC under the EPBC Act).	3.3 ha	13.2	Fully co-located with Ornamental Snake habitat	**0**	NA	NA	NA	NA	NA	NA
Of Concern REs	RE 11.3.2	58.3 ha (44.4 ha of which represents the Poplar Box TEC assessed under the EPBC Act).	13.9 ha	55.6	NA	**55.6 ha**	0.0	0.0	55.6	55.6	0.0	55.6

Matter of State Environmental Significance		Extent of disturbance (ha)	Impact area required to be offset (ha)	Required offset area after multiplier applied	Co-location with MNES	Remaining impact area required to be offset	Stage 1	Stage 2	Stage 3	Stage 1-3 total	Stage 4	Stage 1-4 total
	RE 11.3.4	4.9 ha	4.9 ha	19.6	Fully co-located with Koala and Greater Glider habitat	**0**	NA	NA	NA	NA	NA	NA
REs within mapped vegetation management wetlands	RE 11.5.17	Significant hydrological change impacts to three wetland areas of RE 11.5.17 (4.7 ha).	4.7 ha	18.8	1.45 ha col-located with Koala and Greater Glider habitat	**17.4 ha**	0.0	0.0	**17.4**	**17.4**	0.0	**17.4**
REs within the defined distance of a vegetation management watercourse	RE 11.3.1	8.0 ha (and assessed as Brigalow TEC under the EPBC Act).	8.0 ha	32	NA	**32 ha**	1.2	30.8	0.0	32	0.0	32
	RE 11.3.25	6.1 ha	6.1 ha	24.4	Fully co-located with Koala and Greater Glider habitat	**0**	NA	NA	NA	NA	NA	NA

Matter of State Environmental Significance		Extent of disturbance (ha)	Impact area required to be offset (ha)	Required offset area after multiplier applied	Co-location with MNES	Remaining impact area required to be offset		Stage 1	Stage 2	Stage 3	Stage 1-3 total	Stage 4	Stage 1-4 total
Protected wildlife habitat	Squatter Pigeon	15.5 ha	15.5 ha	62	Fully co-locatable within Koala habitat	**0**	NA	NA	NA	NA	NA		NA
						Financial settlement		$16,000	$193,836	$388,962	$598,798	$108,320	$707,118

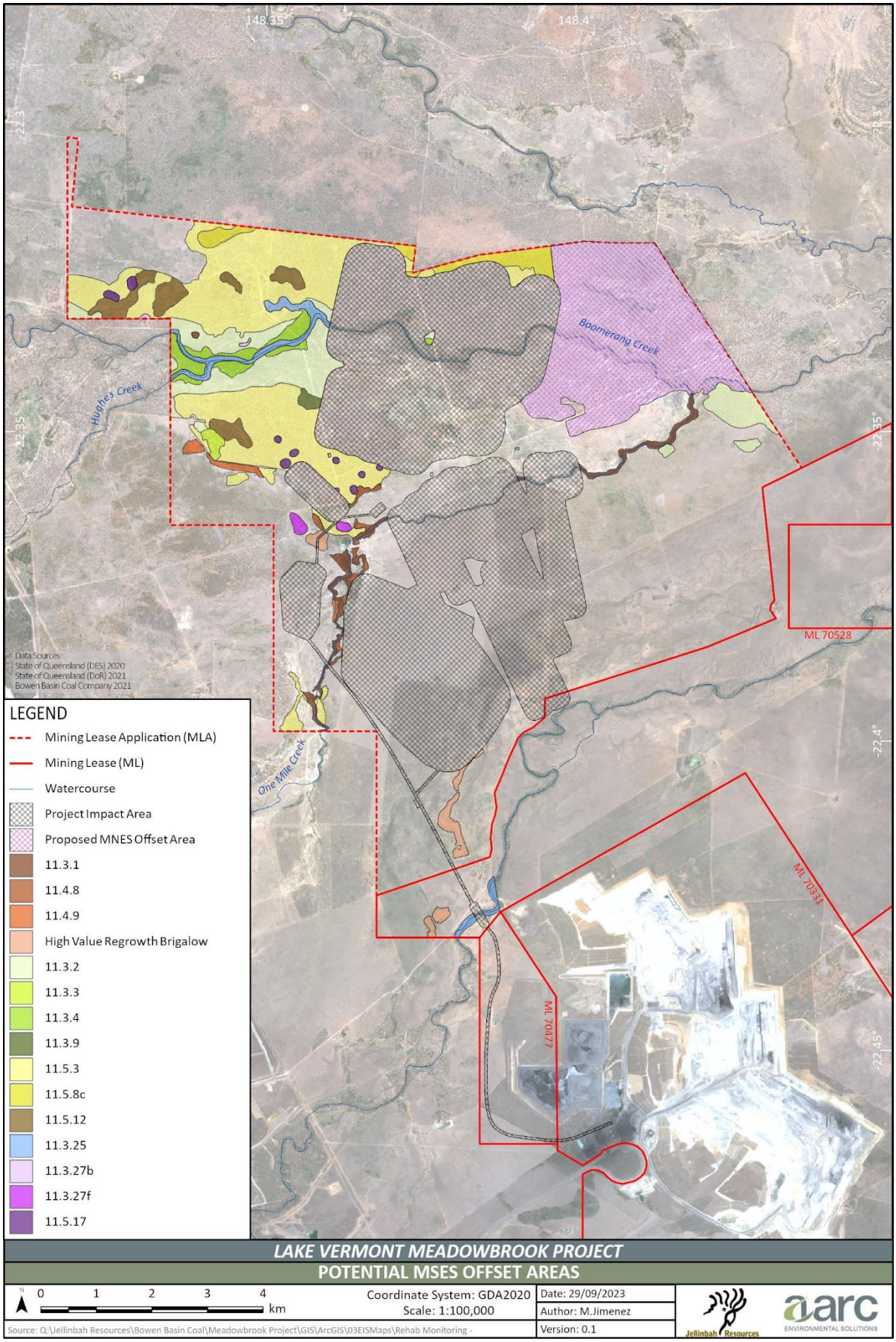

Figure 10.26: Potential MSES offset areas