Environment Effects Statement

VHM Limited Goschen Rare Earths and Mineral Sands

Chapter 20 Matters of National Environmental Significance

November 2023

VHM Limited

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Abbreviations

Term	Definition	
AHD	Australian Height Datum	
CPS	Components, processes and services	
DBH	Diameter at breast height	
DCCEEW	Department of Climate Change, Energy, the Environment and Water	
DMIRS	West Australia Department of Mines	
DoE	Department of Environment	
DoEE	Department of the Environment and Energy	
dB	Decibel	
EC	Electrical conductivity	
ECD	Ecological character description	
EE	Environment Effects	
EES	Environment Effects Statement	
EPA	Environment Protection Authority	
EPBC	Environment Protection and Biodiversity Conservation	
ERML	Environmental radiation monitoring location	
ERS	Environmental Reference Standard	
FPP	Feed preparation plant	
GMW	Goulburn-Murray Water	
HAL	Hot acid leach	
HiTI	High titanium	
НМС	Heavy mineral concentrate	
НМР	Hydrometallurgical plant	
LAC	Limits of Acceptable Change	
LNG	Liquified natural gas	
MNES	Matters of National Environmental Significance	
MREC	Mixed rare earth carbonate	
MSP	Mineral separation plant	
Mtpa	Million tonnes per annum	
MUP	Mining unit plant	
NGZ	No go zone	
PBFD	Psittacine beak and feather disease	
PCRZ	Public Conservation and Resource Zone	
ppm	Parts per million	
PMST	Protected Matters Search Tool	
REMC	Rare earth mineral concentrate	
TIA	Torrumbarry Irrigation Area	
VBA	Victorian Biodiversity Atlas	
VFA	Victorian Fisheries Authority	
VHM	VHM Limited	
WCP	Wet concentrator plant	

20. Matters of National Environmental Significance

This chapter of the Goschen Rare Earths and Mineral Sands Project (the Project) Environment Effects Statement (EES) presents the findings of the investigations and impact assessments undertaken into Matters of National Environmental Significance (MNES) for the Project.

20.1 Purpose of the chapter

This chapter summarises the assessments of MNES undertaken as part of the following technical studies prepared for the Project:

- EES Technical Report A: Flora vegetation impact assessment.
- EES Technical Report B: Fauna ecology impact assessment.
- EES Technical Report N: Radiation impact assessment.

More detail on the matters discussed in this chapter can be found in these reports and in the relevant chapters of the EES.

20.1.1 Matters of National Environmental Significance

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides the legal framework to protect and manage designated MNES. There are nine MNES protected under the EPBC Act:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (listed under the Ramsar Convention).
- Listed threatened species and ecological communities.
- Migratory species protected under international agreements.
- Commonwealth marine areas.
- The Great Barrier Reef Marine Park.
- Nuclear actions (including uranium mines).
- A water resource, in relation to coal seam gas development and large coal mining development.

Under the EPBC Act, if the Commonwealth Minister for the Environment decides that a project could potentially have a significant impact on a MNES, the project becomes a 'controlled action' that must be assessed and approved by the Minister before it can proceed. The matters which the project may have a significant impact on are known as the controlling provisions.

On 19 December 2018, the Australian Government Department of the Environment and Energy (DoEE), now the Department of Climate Change, Energy, the Environment and Water (DCCEEW), determined the Project to be a controlled action. The relevant controlling provisions for the Project include:

- Ramsar wetlands (Kerang Wetlands, a wetland of international significance) (sections 16 & 17B of the EPBC Act).
- Listed threatened species and communities (sections 18 & 18A of the EPBC Act).
- Nuclear actions (sections 21 & 22A of the EPBC Act).

In October 2022, a variation to the original EPBC referral (referral 2018/8291) was submitted to the Minister. The variation related to reduced impacts on MNES as a result of changes to the Project originally presented in 2018. These changes included a reduction of the proposed mining area from 8,300 hectares to 1,479 hectares, as well as the addition of approximately 28.6 hectares. This addition represented the disturbance footprint of a proposed pump station adjacent to Kangaroo Lake and a 38 km water supply pipeline to the Project mine site. On 30 January 2023, a delegate of the Minister for the Environment accepted the variation.

The EES process under the Victorian *Environment Effects Act 1978* (EE Act) is the accredited environmental assessment process for the controlled action decision under the EPBC Act in accordance with the bilateral agreement between the Commonwealth and Victorian governments.

Ramsar wetlands

A Ramsar wetland is a wetland that has been designated under Article 2 of the Ramsar Convention, or which has been declared by the Federal Environment Minister to be a Ramsar wetland under the EPBC Act.

The Ramsar Convention encourages the designation of sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity. Once designated, these sites are added to the Convention's List of Wetlands of International Importance and become known as Ramsar sites.

In designating a wetland as a Ramsar site, countries agree to establish and oversee a management framework aimed at conserving the wetland and ensuring its wise use. Wise use under the Convention is broadly defined as maintaining the ecological character of a wetland.

Listed threatened species and communities

The EPBC Act provides for the listing of nationally threatened native species and ecological communities, native migratory species and marine species. Threatened species refers to those species that are considered 'threatened, including species that are listed as 'vulnerable', 'endangered' or 'critically endangered' under the EPBC Act.

The EPBC Act protects Australia's native species and ecological communities by providing for:

- Identification and listing of species and ecological communities as threatened.
- Development of conservation advice and recovery plans for listed species and ecological communities.
- Development of a register of critical habitat.
- Recognition of key threatening processes.
- Where appropriate, reducing the impacts of these processes through threat abatement plans.

Nuclear actions

Section 528 of the EPBC Act provides definitions for the terms nuclear action and nuclear installation which refers to the meaning provided in section 22(1) of the EPBC Act.

In 22(1) of the Act, amongst other items, a nuclear action is defined as;

- (a) establishing or significantly modifying a nuclear installation;
- (d) mining or milling uranium ore;
- (e) establishing or significantly modifying a large-scale disposal facility for radioactive waste;

(f) de-commissioning or rehabilitating any facility or area in which an activity described in paragraph (a), (b), (c),

- (d) or (e) has been undertaken;
- (g) any other action prescribed by the regulations.

The EPBC Regulations in Division 2.1 provide further detail on the definition of a nuclear action, in particular in relation to subclause (g) of clause 22(1) of the Act. Specifically, Clause 2.01 of the Regulations states that a nuclear action includes;

"establishing, significantly modifying, decommissioning or rehabilitating a facility where radioactive materials at or above the activity level mentioned in regulation 2.02 are, were, or are proposed to be used or stored."

In clause 2.02 of the EPBC Regulations, a detailed definition of the activity level is provided, which is linked to the Australian Radiation Protection and Nuclear Safeguards Agency (ARPANSA) Act and Regulations. The activity level, is a combination of the mass of the material, and the radionuclide activity concentrations of the material.

Clause 2.03 refers to a Nuclear Action also including a large scale disposal facility as a facility used for the disposal of radioactive materials above the activity level. This would include a tailings facility or waste facility where the volume of material is sufficient, and the radionuclide activity concentration exceeds the activity level.

The following is stated on the EPBC web site:

"A nuclear action will require approval if it has, will have, or is likely to have a significant impact on the environment. Nuclear actions should be referred to the Minister and undergo an environmental assessment and approval process."

20.1.2 Responding to the controlled action

In response to the controlled action decision under the EPBC Act, this chapter has been prepared to summarise the findings of the EES assessment with respect to the three controlling provisions discussed above (Ramsar wetlands, listed threatened species and nuclear actions).

In order to provide necessary commentary on the likelihood of significant impacts specific to MNES identified in the determination under the EPBC Act, this chapter provides an assessment of the potential mechanisms through which impact on those MNES as a result of the project could be realised. Potential mechanisms of impact on MNES considered in this assessment include:

- Water extraction.
- Habitat removal.
- Fragmentation of vegetation.
- Spread of weeds or pathogens.
- Dust.
- Noise and lighting.
- Vehicle collisions.

From a nuclear perspective, the EPBC Act applicability is to:

- the storage of radioactive materials
- disposal of radioactive materials
- no adverse effects

20.1.3 **Project overview**

VHM Limited (VHM) is proposing to develop the Goschen Mineral Sands and Rare Earths Project (the Project) in the Loddon Mallee Region of Victoria, approximately 30 km south of Swan Hill. The Project would involve the mining and processing of heavy mineral sands and rare earth minerals.

VHM is an Australian owned and operated publicly listed company established in 2014 that is developing an integrated business comprising of heavy mineral sands projects located in Victoria, providing feedstock to down stream customers.

VHM holds over 2,860 km2 of near-contiguous tenements in Victoria. This has provided VHM with access to significant historical exploration data, which formed the basis of VHM's exploration program to generate its own data for estimating mineral resources and ore reserve estimates within its tenements. The exploration undertaken to date has discovered one of the world's largest, highest-grade zircon, rutile and rare earth mineral deposits, comprising an ore reserve of 300 million tonnes, located near Lalbert in the Murray Basin, Victoria.

The Project would involve the mining and processing of heavy mineral sands and rare earths at a throughput of approximately 5 million tonnes per annum (Mtpa) and the production of mixed heavy mineral concentrate (HMC), zircon concentrate, rutile product, leucoxene products, ilmenite product and rare earth mineral products, over a 20 to 25 year mine life. Mine products are proposed to be transported via road and rail for export overseas.

VHM would implement the mine development in phases. Phase 1 would involve a mining unit plant (MUP), wet concentrator plant (WCP), feed preparation plant (FPP) and a rare earth mineral concentrate (REMC) flotation plant. The product suite for Phase 1 consists of zircon, titania heavy mineral concentrate (HMC) and REMC products. Phase 1A would add a hydrometallurgical plant (HMP) downstream of the REMC flotation plant. The HMP would commence operations approximately 18 months post first production. The product suite for Phase 1A consists of mixed rare earth carbonate (MREC) products and zircon/ titania HMC.

Phase 2 would commence either at the same time as Phase 1 or some 24 months post-production depending on prevailing market circumstances, and consist of an additional mineral separation plant (MSP), hot acid leach (HAL) and chrome removal circuit. The additional plant would allow for the production of premium zircon, zircon concentrate, high titanium (HiTi) rutile, HiTi leucoxene and low chromium ilmenite.

The key components of the Project include:

- Mining Mining would take approximately 20 to 25 years at a throughput of 5 Mt per year and would occur above the groundwater table across approximately 1,479 hectares of farmland using conventional open cut mining methods of excavation, load and haul.
- Processing The heavy mineral sands and rare earths ore would be separated via an on-site WCP and MSP to generate a rare earth mineral concentrate (REMC). Refining of the REMC on-site is limited to

hydrometallurgical extraction to produce a mixed rare earth carbonate. Tailings from the various mineral processes would be homogenised and placed back into the ore zone earlier mined.

- Rehabilitation The mined areas would be progressively backfilled in a staged manner, with tailings
 dewatered in-pit to allow overburden and topsoil placement in a profile that reinstates the background soil
 structure. This would result in the ability for a return to the current agricultural land uses within three years.
- Water Water would be required for construction earthworks, processing, dust suppression and rehabilitation. Up to 4.5 gigalitres per year (GL/y) will be required for start-up and commissioning, with the general annual water demand for Phase 1 and 2 requiring approximately 2.9 and 3.1 GL/year respectively. Water would be purchased through the open water market, which has in excess of 500 GL/year in any year from Kangaroo Lake for delivery by Goulburn Murray Water. The water would be delivered from a new pumpstation adjacent to Kangaroo Lake and a 38 km underground pipeline to be constructed beneath existing local roads.
- Power Electrical power needed for mining and processing would be produced on-site from dual fuel diesel/LNG/LPG fired power generators, with a gradual evolution over the life of mine to renewables, hydrogen and/or battery as technologies and commercial viability increase. Heat energy for the on-site gas fired appliances would be provided from an extension of the distribution network from the main LNG storage and regasification system.
- Transport Final products would be containerised in 20 ft sealed sea containers on site and exported to the Port of Melbourne using road and/or rail-based land logistics solutions. The Ultima intermodal is proposed to transport mineral to the Port of Melbourne.

The Project location is presented in **Figure 20-1** below and the underground water pipeline between Kangaroo Lake and the Project site is presented in **Figure 20-2**.



Figure 20-1 Project location



Figure 20-2 Underground pipeline alignment

20.1.4 Assessment overview

An assessment of the existing conditions surrounding the Project to inform the environmental impact assessment for the works was undertaken for the following controlling provisions:

- Ramsar wetlands (Section 20.2).
- Threatened species and ecological communities (Section 20.3).

To understand the potential for the presence of MNES, the existing conditions assessment incorporated:

- A desktop assessment and synthesis of government-curated biodiversity datasets including the Protected Matters Search Tool (PMST) and the Victorian Biodiversity Atlas (VBA).
- Targeted field surveys to identify the potential and actual presence of threatened species and threatened ecological communities.
- Literature review relating to the aquatic biodiversity and/or rare or protected aquatic species and communities of Kangaroo Lake, and a site inspection of Kangaroo Lake to validate the results of the desktop study.
- Field investigations to collect data on gamma dose rates, isotopic radon concentrations, radon decay product concentrations, passive dust deposition rate, annual radionuclide activity concentrations of deposited dust, surface soil radionuclide activity concentrations and radionuclide concentrations in ground water.

An impact assessment was undertaken for each of the three controlling provisions in accordance with the methodology described in EES Chapter 6: Assessment framework and responding to the significant impact criteria in Matters of National Environmental Significance Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999 (DoE, 2013) ('Significant impact guidelines') and/or species-specific guidelines. This is discussed in **Section 20.4** of this chapter.

Detailed descriptions of the flora and fauna survey efforts are presented in Section 6.2, Section 6.3.1 and Section 6.3.2 of EES Technical report A: Flora impact assessment. Flora surveys were conducted within the Project area and extensively surrounding the Project area, along each pipeline alignment option between the Project area and Kangaroo Lake and at eight intersections surrounding the Project area. Appendix 5 of EES Technical report A: Flora impact assessment also describes the strata for flora species recorded as part of the assessment. Fauna

survey efforts are presented in Section 6.3.3, Appendix C and Appendix D of EES Technical report B: Fauna impact assessment.

The fauna survey effort consisted of:

- A targeted fauna survey of the mine tenement area completed between 13 and 19 March 2018.
- A targeted survey for Corben's Long-eared Bat conducted between 17 and 23 October.
- A targeted survey for Plains-wanderer conducted in March 2021.
- A targeted fauna survey of each pipeline alignment option in February, May and June 2022.

Detailed descriptions of the assessment methodologies used are provided in EES Technical Report A: Flora vegetation impact assessment, EES Technical Report B: Fauna ecology impact assessment and EES Technical Report N: Radiation impact assessment.

20.2 Ramsar wetlands

The Kerang Wetlands Ramsar site is located approximately 30 km east of the Project area. The proposed underground water supply pipeline would connect the Project area with Kangaroo Lake, which forms part of the Kerang Wetlands. As described in **Section 20.1.3**, a pump station would be constructed immediately adjacent to Kangaroo Lake to extract water for construction earthworks, processing, dust suppression, and rehabilitation. This water would be delivered to the Project area via the 38 km underground pipeline (refer to **Figure 20-2**).

20.2.1 Overview of Ramsar site

The Kerang Wetlands Ramsar site covers 9,784 hectares and is comprised of 23 named lakes, marshes and swamps (refer to **Figure 20-3**). Each of these vary in area, depth and salinity. The Kerang Wetlands Ramsar site includes permanent and intermittent saltwater lakes, as well as permanent and intermittent freshwater lakes. A diverse range of wetland vegetation communities exists at the Ramsar site and over 50 species of migratory shorebirds have been recorded breeding within the Kerang Wetlands.



Figure 20-3 Kerang Wetlands Ramsar site (Source: Ramsar sites information service, 2022)

The Kerang Wetlands Ramsar site was nominated for listing in 1982 on the basis of meeting four of the eight wetland criteria at the time. Further discussion on the wetland criteria is provided in **Section 20.2.2**.

Of specific interest to the Project is the Kangaroo Lake area of the Ramsar site.

Kangaroo Lake

Kangaroo Lake lies on the western side of the Murray Valley Highway approximately 18 km north of Kerang. It is one of 23 named lakes, marshes and swamps that form the Kerang Wetlands Ramsar site. Under the Ramsar Convention, Kangaroo Lake is classified as a "permanent freshwater lake" and its primary contribution to the Ramsar site is its "special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna" (Kellogg, Brown & Root Pty Ltd, 2011).

With a surface area of approximately 984 hectares and maximum depth of 8.4 metres, Kangaroo Lake is one of the largest and deepest permanent freshwater lakes in the Murray-Loddon region of the Murray-Darling Drainage Division. It is located within the Torrumbarry Irrigation Area (TIA) area of the Loddon-Campaspe irrigation region.

Kangaroo Lake is connected to the TIA via the No. 7 Lakes Channel system which flows from Reedy, Middle and Third Reedy Lakes, via Racecourse Lake into Kangaroo Lake. The No. 6/7 Main Channel flows northwards out of

Kangaroo Lake and outfalls into the Little River Murray at Fish Point Weir (refer to **Figure 20-4**). Irrigation water is also drawn out of Kangaroo Lake via the No. 4/7 Channel on the north west of the lake.

Kangaroo Lake has a capacity of 39.7 GL and is generally maintained at greater than 36 GL (refer to **Figure 20-5**). The lake has a maximum operating level of 73.9 m Australian Height Datum (ADH) and minimum operating level of 73.12 m ADH (VFA 2013). It is a major irrigation supply storage basin and high operational water levels in the lake are required to optimise water supply for regional irrigators with downstream water user demands on the Murray River. Water levels in the lake are also managed to both reduce downstream flooding impacts on the Loddon River and prevent foreshore erosion (Kellogg, Brown & Root Pty Ltd, 2011).

The primary outflow from Kangaroo Lake is the No 7 Channel in the north of the lake. At the time of preparing this report, data and information provided by Goulburn-Murray Water indicated that the design maximum discharge to the No. 7 Channel was 1 GL/day, with the current average discharge approximately 0.15 GL/day (Bailey, M. 2022. per comms. 2 August). The irrigation season operates from August to May each year, leaving three months with zero to low discharge from Kangaroo Lake.

Kangaroo Lake is a popular recreational fishing and boating destination. Between June 2021 and June 2022 the Victorian Fisheries Authority (VFA) stocked 50,000 Murray Cod and 100,000 Golden Perch into the lake (VFA 2021).



Figure 20-4 Schematic Representation of the Kangaroo lake portion of the Torrumbarry Irrigation Area (Source: NCCMA)



Figure 20-5 Kangaroo Lake water storage for years 2015 to 2022 (Source: GM Water)



Figure 20-6 Kangaroo Lake (Photo: A Jenkin 2022)

20.2.2 Significance listing

A Ramsar wetland is a wetland that has been designated under Article 2 of the Ramsar Convention, or which has been declared by the Federal Environment Minister to be a declared Ramsar wetland under the EPBC Act. The Kerang Wetlands Ramsar site was listed in December 1982 (RS265).

According to Butcher and Hale, 2016, an assessment against the nine Ramsar listing criteria indicates that the Kerang Wetlands Ramsar site meets four criteria: 2, 3, 4 and 5 (**Table 20-1**).

Table 20-1 Ramsar criteria met	y Kerang Wetlands Ramsar site	(Source: Butcher and Hale, 2016)
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Criteria	Justification (Butcher and Hale, 2016)
Criterion 2 - A wetland should be considered internationally important if it supports wulnerable endangered or	This criterion is only applied to wetland dependent flora and fauna, and the site regularly supports two waterbird species listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and / or IUCN Red List:
critically endangered species or threatened ecological communities.	 Australasian bittern (<i>Botaurus poiciloptilus</i>) – Endangered (EPBC and IUCN). Curlew sandpiper (<i>Calidris ferruginea</i>) – Critically endangered (EPBC). There are numerous, but patchy records of Australasian bittern from within the Ramsar site. The Atlas of Living Australia (http://www.ala.org.au/), together with data provided by North Central Catchment Management Authority (NCCMA) indicates the species was present in Hird and/or Johnsons Swamp in 2003, 2004, 2005, 2006, 2007, 2014, 2015 and 2016.
	There are over 150 records of curlew sandpiper in the Kerang Wetlands Ramsar Site from the 1970s to 2015. Between 1980 and 2015 they were recorded in 69 percent of years (data from the Atlas of Living Australia and the Victorian Biodiversity Atlas). They have been recorded at Fosters Swamp, Kangaroo Lake and Lakes Cullen, Kelly and Tutchewop.

Criteria	Justification (Butcher and Hale, 2016)
Criterion 3 - A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.	The Kerang Wetlands Ramsar Site supports a high diversity of waterbirds, most likely related to the diversity of habitats provided by the site (permanent and temporary, fresh and saline, vegetated and open water). The ECD indicates that a total of 75 species of waterbird have been recorded within the site, but more recently accessed data combining records from the Atlas of Living Australia, The Victorian Biodiversity Atlas, Annual Summer Waterfowl Counts (DELWP unpublished) and NCCMA unpublished data indicate that the total number of waterbird species recorded at Kerang Wetlands Ramsar Site is 86 (this list includes species that regularly occur as well as vagrants and isolated records). This represents the second most species rich Ramsar site, with respect to waterbirds, in the bioregion after the Coorong and Lakes Alexandrina and Albert Ramsar Site (118 waterbird species; Butcher and Cottingham 2011). In addition, data collected between 2010 and 2012 confirms that Kerang was among the most species rich of waterbird sites in the bioregion, ranking in the top 20 sites for each year and at number four in 2012 (Kingsford et al. 2014). Biodiversity is not just measured in terms of species richness but encompasses some aspects of variability between species represented (DeLong 1996). Therefore, a site may be considered more diverse if it contained the same number of species, but these species were from a larger range of families or groups. Kingsford et al. (2014) indicated that the Kerang Lakes not only supports a relatively high number of waterbird species, but that these are distributed across all defined functional groups (ducks, herbivores, large wading birds, piscivores and shorebirds); representing a higher diversity than sites that support species from only one or two functional groups.
Criterion 4 - A wetland should be considered internationally important if it supports plant/or animal species at a critical life stage in their life cycles or provides refuge during adverse conditions.	Thirty-five species of waterbirds listed under international migratory agreements have been recorded within the Ramsar site. This includes species that, in Australia, are residents (e.g. eastern great egret) and 23 international migratory species. There are five species of international migratory shorebirds that are regularly recorded in the Kerang Wetlands Ramsar Site. The Kerang Wetlands Ramsar Site supports Australian shelduck (<i>Tadorna tadornoides</i>) and musk duck (<i>Biziura lobata</i>) during the critical life stage of moulting. These species aggregate on the open waters of the permanent lakes during moult of primary flight feathers, when the birds are vulnerable to predators (Kellogg Brown and Root 2011). There are records of 28 species of waterbird breeding within the Ramsar site (Victorian Biodiversity Atlas, Atlas of Living Victoria). The site is particularly important for colonial nesting species, and this has been recognised as significant at the bioregion scale (Kingsford et al. 2014). The ECD states that there were 99 colonial nesting breeding events within the site between 1980 and 2005 (Kellogg Brown and Root 2011). More recent data, suggests that the site continues to support large-scale waterbird breeding. For example, >20,000 colonial nesting species, predominantly, straw-necked ibis (<i>Threskiornis spinicollis</i>) bred in the site during 2010, with smaller breeding colonies in 2011 and 2012 (Kingsford et al. 2014) and 1000s of nests in 2014 (Australian Waterbird Surveys database). In 2016, large numbers of Australian white ibis (<i>Threskiornis molucca</i>) and straw necked ibis bred at Middle Reedy Lake (NC CMA unpublished data). There are also records of wetland dependent raptors (swamp harrier; <i>Circus approximans</i>) and other wetland dependent birds (e.g. Australian reed warbler; <i>Acrocephalus australis</i>) breeding in the site (Victorian Biodiversity Atlas). These wetlands Ramsar Site contains several permanent wetlands that are maintained as water storages (e.g. Reedy Lakes complex, Lake Charm and Kang
Criterion 5 - A wetland should be considered internationally important if it regularly supports 20 000 or more waterbirds.	Complete counts of waterbirds across all wetlands within the Kerang Lake Ramsar site are rare. Despite this, there is good evidence that the site regularly supports >20,000 waterbirds. Data pooled from all sources indicates that between 1977 and 2016, the annual maximum count exceeded 20,000 on 18 occasions (46 % of years). While this falls below the two thirds of seasons requirement, the average maximum abundance (1977 to 2016) is 31,600. Indicating that the site meets this criterion with respect to average annual maximum abundance, despite a lack of consistent counts across the Ramsar site.

Ecological character (values)

As a signatory to the Ramsar convention, Australia is expected to conserve and maintain the ecological character of all Ramsar wetlands in its territory. To achieve this, ecological character descriptions (ECD) are being prepared for all Ramsar sites. These provide a benchmark against which to assess any future change in ecological character.

The Kerang Wetlands Ramsar Site Ecological Character Description was prepared by the Commonwealth of Australia in May 2011 (Kellogg, Brown & Root Pty Ltd, 2011) and amended by Butcher and Hale in 2016. The ECD identifies and describes the components, processes and services (CPS) that are critical to the ecological character of the Ramsar site. Four critical components, processes and services have been identified that significantly contribute to the recognised ecosystem value and importance of the Kerang Wetlands Ramsar site. These are summarised in **Table 20-2**.

Value	Description (Kellogg, Brown & Root Pty Ltd, 2011; Butcher and Hale, 2016)
Hydrology – (percentage full, depth/volume, frequency of inundation)	The hydrology of much of the Kerang area was significantly modified from natural conditions in 1923, prior to listing of the Ramsar site. Connectivity, particularly on the Loddon floodplain and on Pryramid Creek, had been significantly reduced by the construction of levees and dredging and regulation of natural water carriers to increase capacity.
	impact directly on salinity (including risks of hypersalinity), and reduction in biodiversity, loss of community vegetative structure and species distribution and loss of habitat and food resources.
Physiochemical – salinity	The Ramsar site exhibits a full range of salinities from very fresh to hypersaline, measured in electrical conductivity (EC). The Ramsar site includes deep permanent freshwater lakes with salinities typically less than 500 EC, wetlands that range between 4,000 EC to 50,000 EC and salt disposal basins.
	Salinity is identified as a critical component in the system as it directly impacts on the ability of biota to survive. Salinity is affected by rising saline groundwater, saline surface water run-off, disposal of drainage water, lack of regular flushing and prolonged inundation.
Waterbirds – abundance	Between 1980 and 2003, 76 waterbird species were recorded at the Ramsar site. Of these, 25 are threatened in Victoria, two are listed as nationally threatened (under the EPBC Act) and three are listed as threatened internationally (IUCN Red List). In addition, 21 avian species known to occur within the Ramsar site are listed under international migratory species agreements. Two of the four original criteria for which the Ramsar site was listed are based to the site's value as waterbird habitat.
Waterbirds – colonial breeding/ nesting (ibis, darters, cormorants, spoonbills) and large numbers	Since 1980, 28 species of colonially breeding waterbirds (ibis, darters, cormorants, spoonbills) have been recorded at the site (DSE 2010a). Ninety-nine colonial nesting breeding events have been recorded across the site between the years of 1980 and 2005 (Table 3.9). Third Marsh, Second Marsh, Middle Reedy Lake and First Marsh are particularly important colonial nesting areas in terms of number of events recorded.
	In general, the suitability of an area for waterbird breeding is dependent upon food supply, nesting sites, cover, water level and salinity. The Ramsar site provides a diverse range of breeding habitat which varies by wetland type and hydrology source.
Vegetation diversity	Recent surveys of vegetation at each of the wetlands has provided additional information and evidence to support this component as being critical to the ecological character of the Ramsar site. There are over 170 wetland dependent native plant species within the Kerang Wetlands Ramsar Site. This includes a broad range of species including both freshwater and saline tolerant flora.
Supports a diversity of wetland types	 There are eight Ramsar wetland types in the Kerang Wetlands Ramsar Site. This diversity of wetland types is largely due to the combination of hydrology and salinity. This diversity of wetland types provides a diversity of habitats for wetland dependent for flora and fauna, particularly waterbirds; as well as provision of other services such as recreation. Apart from the Kerang Wastewater Treatment Plant which occupies only six hectares, wetlands can be grouped by type into five broad categories: Permanent freshwater lakes and swamps.
	 Seasonal /intermittent freshwater lakes. Seasonal /intermittent freshwater marshes and shrub-dominated wetlands. Permanent caline lakes

Table 20-2 Critical CPS of the Kerang Wetl	ands Ramsar site (Kellogg,	Brown & Root Pty Ltd,	2011; Butcher and
Hale, 2016)		• •	

•

Seasonal intermittent saline wetlands.

Value	Description (Kellogg, Brown & Root Pty Ltd, 2011; Butcher and Hale, 2016)
Supports threatened species	There are two threatened waterbird species that are regularly supported by the Ramsar site. These are the curlew sandpiper and Australasian bittern.
	A small number of curlew sandpiper are regularly recorded in the Kerang Wetlands Ramsar Site, with maximum counts of around 200 in 1987 and 1990. The species is most often observed in the saline wetlands of Lake Tutchewop (60 % of records) and Lake Cullen (8% of records), with occasional sightings at Lake Kelly, Foster Swamp Lake Bael Bael and Hird and Johnson Swamp (Victorian Biodiversity Atlas; Atlas of Living Australia).
	The Australasian bittern (<i>Botaurus poiciloptilus</i>) is a shy and cryptic wading species of wetland bird. Habitat preferences are for permanent, densely vegetated freshwater wetlands (Higgins and Marchant 1990). The Australasian bittern has been recorded at Hird and Johnson swamps, with single records also from Lakes Tutchewop and Cullen (Atlas of Living Australia and NC CMA unpublished).

A summary of the non-critical CPS for the Ramsar site is as follows:

- Component:
 - Physical form.
 - Soils.
 - Water quality.
- Process:
 - Climate.
 - Physiochemical (nutrients and nutrient cycling).
 - Species interaction and population dynamics (competition, predation, herbivory).
- Service:
 - Agriculture (provisioning).
 - Irrigation (provisioning).
 - Flood mitigation (regulating).
 - Salt disposal (regulating).
 - Spiritual (cultural).
 - Recreational.
 - Biodiversity –(supporting).

Limits of Acceptable Change

The ECD for the Ramsar site sets Limits of Acceptable Change (LAC) for each critical CPS. LAC is the term used to describe the acceptable variation in a particular component of a Ramsar site without a change in ecological character leading to a reduction or loss of a value for which the site was listed as a Ramsar site. LAC are a tool by which change in ecological character and management effectiveness can be measured.

LAC for the Kerang Wetlands Ramsar site were developed in 2011 by Kellogg, Brown & Root and amended in 2016 by Butcher and Hale. The LAC have been applied to each of the 23 named lakes, marshes and swamps. For the purpose of this chapter and considering that the Kangaroo Lake area of the Ramsar site is of specific interest to this Project, the LAC for each critical CPS for Kangaroo Lake is presented in the table below (Kellogg, Brown & Root Pty Ltd, 2011; Butcher and Hale 2016).

Table 20-3 Limits of Acceptable Change for Kangaroo Lake (Kellogg, Brown & Root Pty Ltd, 2011; Butcher and Hale, 2016)

Component/process	Baseline condition	Limit of Acceptable Change
Hydrology – (percentage full, depth/volume, frequency of inundation)	 The operating ranges (metres AHD) for the Goulburn-Murray Water operated storages are as follows (data provided by K. Mason, Goulburn-Murray Water): Kangaroo, Racecourse and Little Lake Charm – 73.10 to 73.93 (0.83 m). 	Kangaroo Lake, Racecourse Lake, Lake Charm and Little Lake Charm: permanently inundated, water level to not be >74.1 m AHD or <72.9 m AHD for more than two years in a row.

Component/process	Baseline condition	Limit of Acceptable Change
Physiochemical – salinity	Mean salinity level 360 EC, maximum 900 EC.	Salinity levels to be less than 4,000 EC when lake is more than 75% full.
Waterbirds – abundance*	Data from multiple sources has now been consolidated to provide annual total maximum waterbird counts for the Ramsar site. Abundance is highly variable due to two separate factors: firstly, inconsistent counts across all wetlands within the Ramsar site: and secondly, the highly mobile nature of waterbirds, that respond to climatic and other factors. A plot of moving averages at five and ten-year time frames illustrates this variability and the fact that a five- year average is probably too short a period of time to derive a LAC. The ten-year average is more stable and does not indicate a sustained trend in waterbird abundance at the site. Data used span both wet and dry periods and the 10-year average never falls below 10,000.	The 10-year rolling average for annual maximum waterbirds is not <10,000.
Waterbirds – colonial breeding/ nesting (ibis, darters, cormorants, spoonbills) and large numbers*	The LAC is based upon colonial nesting species breeding anywhere within the Ramsar site, noting that the Reedy Lake complex is the most likely to support this on a regular basis.	No more than 10 consecutive years in which there are no colonial nesting events of at least 1000 nests in the Kerang Wetlands Ramsar Site.
Waterbird diversity	The site supports a diversity of waterbirds with a total of 86 wetland dependent species recorded from the site. Annual total wetland bird species richness from 1980 to 2016 is 45. Similar to waterbird abundance, this measure suffers from a lack of complete counts across the Ramsar site each year and, prior to the mid-1980s in particular, sampling effort was low. Since the 1990s, the rolling five-year average has remained above 35 (Figure 9). LAC is set on a 50% decline in average species richness to account for the high degree of variability.	Total annual species richness of wetland dependent birds shall not be less than 22.
Vegetation diversity	 Recent vegetation mapping has been used to establish a benchmark, as data from the time of listing is not available. Vegetation communities have been grouped into broad types, reflecting the variability in response to annual water conditions (for example, non-woody vegetation may occur as submerged macrophytes during inundation, but transition to lakebed herbland during drying). The extent of the broad vegetation communities is as follows (Cook et al. 2013, Cook and Bayes 2014): Freshwater herb/grass/sedge/forb – 3278 hectares Brackish herb/grass/sedge/forb – 600 hectares Samphire – 290 hectares Lignum dominated – 1562 hectares Intermittent swampy woodland – 1300 hectares In addition, a total of 170 native wetland dependent plant species have been recorded from the site (Cook and Bayes 2014). LAC is based on a 25% decline in the extent / species richness of these vegetation across the Ramsar site. 	 The total extent of the following vegetation communities will not be less than: Freshwater herb/grass/sedge/forb –2400 hectares Brackish herb/grass/sedge/forb – 450 hectares Samphire – 220 hectares Lignum dominated – 1170 hectares Intermittent swampy woodland – 975 hectares The species richness of native wetland dependent plant species will not be less than 125.
Supports a diversity of wetland types	Wetland type is a product of hydrology, salinity and vegetation. This criteria service is covered by the LACs for those respective components and processes.	See LAC for hydrology, salinity and vegetation.

Component/process	Baseline condition	Limit of Acceptable Change
Supports threatened species - waterbirds	There is insufficient data on the two threatened waterbird species within the site to develop a quantitative LAC. The Australasian bittern occurs in Hird and Johnsons Swamps, and the Curlew Sandpiper is most often recorded in Lake Tutchewop (and other saline wetlands in the site) – with records of presence in 69% of years. LAC is based on presence, over a medium timeframe (10 years) to account for shorter term variability.	Australasian bittern (<i>Botaurus poiciloptilus</i>) present in five out of 10 years in Hird and / or Johnsons Swamp. Curlew sandpiper (<i>Calidris ferruginea</i>) recorded within the Ramsar site in no less than five years out of 10.

Note: * - LAC applies to whole Ramsar site

Threats

Threats identified for the Kerang Wetlands Ramsar site and their likelihood and timing of occurrence is summarised in the table below (Kellogg, Brown & Root Pty Ltd, 2011).

Table 20-4 Summary of threats to the Ramsar site and their likelihood and timing of occurrence (Kellogg, Brown & Root Pty Ltd, 2011)

Actual or likely threat or threatening activities	Potential impact(s) to wetland components, processes and/or services	Likelihood of threat or risk	Timing of threat or risk
Presence of pest plants and animals	Vegetation communities, threatened flora, recreation	Highly likely	Immediate
Altered watering regimes	Significant wetland types, vegetation communities, fish species, soils, recreation	Highly likely	Immediate
Surrounding land-use change	Vegetation communities, water quality, threatened flora	Likely	Immediate
Unsustainable recreational activities	Vegetation communities, waterbird populations and habitat	Moderately likely	Immediate to medium-term
Changes to level and trend in surface water quality	Significant wetland types, threatened flora and fauna species, waterbird breeding habitat, aquatic species, recreation	Likely	Immediate to medium term
Climate change	Significant wetland types, hydrology, flora and fauna, waterbird breeding habitat, recreation, irrigation-related services	Likely	Medium to long-term
Bed and bank erosion	Cultural services	Moderately likely	Medium to long-term

A detailed risk assessment was undertaken for the Kerang Wetlands Ramsar site by Butcher and Hale, 2016. The following threats were determined to pose a very high or high risk to Kangaroo Lake (Butcher and Hale, 2016):

- Climate change and severe weather events higher temperatures.
- Flood mitigation.
- Invasive non-native species aquatic vegetation e.g. Arrowhead.
- Invasive non-native species non-woody weeds e.g. creepers.
- Invasive non-native species woody weeds e.g. willows, boxthorn, blackberry, briar rose.
- Invasive non-native species: carp and Gambusia.
- Invasive non-native species: Cats, fixes, pigs, rabbits.
- Loss of standing timber habitat.
- Recreational activities.
- Residential and commercial development.
- Resource use grazing licenses.

20.3 Threatened species and ecological communities

Following desktop reviews and targeted surveys, no EPBC Act-listed threatened flora species and two threatened ecological communities were recorded within 5 km of the Project area. An assessment on Kangaroo Lake identified four threatened aquatic fauna species as known, likely or possibly present within 10 km.

One threatened terrestrial fauna species, the Superb Parrot (Polytelis swainsoni) was considered to have a high likelihood of occurrence in the area surrounding the Project and was recorded during initial Project surveys in 2018.

20.3.1 Threatened flora

Review of the EPBC Protected Matters Search Tool indicated that records of, or potential suitable habitat occurred for 10 species listed under the EPBC Act, within 10 km of the Project area. These have been summarised in the table below.

EPBC Threatened flora	Conservation status	Occurrence
Austrostipa metatoris	Vulnerable	No records exist within 10 km of the Project area. Unlikely to occur.
Rigid spider orchid (<i>Caladenia tensa</i>)	Endangered	Sandy soils present, though well beyond known range. No records in search region. Unlikely to occur.
Candy Spiderorchid (Caladenia versicolor)	Vulnerable	No suitable habitat occurs in the study area. Well beyond known range. No records in search region. Unlikely to occur.
Striate Spike-sedge (<i>Eleocharis obicis</i>)	Vulnerable	No extensive aquatic habitats occur in the Project area. Unlikely to occur.
Spiny Peppercress (<i>Lepidium aschersonii</i>)	Vulnerable	No records exist within 10km of the Project area and study area does not support typical habitat. Unlikely to occur.
Basalt Peppercress (<i>Lepidium hyssopifolium s.s</i>)	Endangered	No records exist within 10km of the Project area. By and large the Project area does not support areas prone to inundation. Unlikely to occur.
Winged Peppercress (Lepidium monoplocoides)	Endangered	Study area does not support preferred waterlogged habitats. Understorey largely disturbed and constitutes high cover of introduced annual grasses. No records in the search region. Unlikely to occur.
Chariot Wheels (<i>Maireana cheelii)</i>	Vulnerable	No preferred habitat for the species was recorded in the area, namely no floodplains supporting chenopod shrubland or grassland were present. Unlikely to occur.
Slender Darlingpea (Swainsona murrayana)	Vulnerable	Only small remnants of Black Box dominant woodland occur. Unlikely to occur.
Yellow Swainson-pea (<i>Swainsona pyrophila</i>)	Vulnerable	No records within 10km of the Project area and study area does not support typical habitat. Unlikely to occur.

Table 20-5 EPBC Act listed threatened flora and likelihood of occurrence

Despite this, no EPBC Act-listed threatened flora species were recorded within 10 km of the Project area during the field assessment undertaken as part of EES Technical Report A: Flora vegetation impact assessment and no species are considered to have the potential to occur based on habitat suitability and a paucity of records.

20.3.2 Threatened ecological communities

The EPBC Protected Matters Search Tool indicated that six threatened ecological communities listed under the EPBC Act had the potential to occur within 10 km of the Project area. These have been summarised in the table below.

Table 20-6 EPBC Act listed ecological communities and likelihood of occurrence

Ecological community	Conservation status	Occurrence
Plains Mallee Box Woodland of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions	Critical	Found to occur extensively within 10 km of the Project area.
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered	Recorded within 10 km of the Project area.
Grey Box Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Does not occur within 10 km of the Project area. Grey Box (the dominant canopy species in this community) was not recorded within 10 km of the Project area.
Natural Grasslands of the Murray Valley Plains	Critical	Not considered to occur within 10 km of the Project area. While some small treeless areas of native vegetation were recorded in roadsides within 10 km of the Project area, these areas were considered to have been derived from the treed EVCs recorded broadly throughout the study area, namely the mallee EVCs and Black Box Woodland. Treeless patches were recorded between areas of treed vegetation and lacked any noticeable change in the understorey flora from the adjoining treed areas. Further to this, treeless patches did not meet the native flora species diversity requirements as detailed in the listing advice for the Natural Grasslands of the Murray Valley Plains community. For the above reasons, treeless areas were not considered to constitute the native grassland community.
Seasonal Herbaceous Wetlands (Freshwater) or of the Temperate Lowland Plains	Critical	Does not occur within 10 km of the Project area. No native wetlands were recorded in proximity to the Project area. Remnant native vegetation was associated with mallee woodland and chenopod-dominated EVCs, which are contraindicative of this listed community. Patches of native vegetation did not support the characteristic biota of this listed community as a dominant component (e.g. native wetland graminoids), as per the listing advice for Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains. Based on a desktop review of aerial photography and knowledge of the Project area and surrounding landscape, no native wetlands are considered to exist within 1-kilometre of the study area boundary.
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critical	Does not occur within 10 km of the Project area. White Box, Yellow Box and Blakely's Red Gum were not recorded in within 10 km of the Project area and are not associated with the EVCs identified or modelled to occur within 10 km of the Project area. Furthermore, associated and co-dominant tree species were also absent. Given that these species are the characteristic canopy species of this community, their absence indicates that this community is unlikely to have occurred within 10 km of the Project area.
Mallee Bird Community of the Murray Darling Depression Bioregion	Endangered	Potentially present within 10 km of the Project area.

Plains Mallee Box Woodland of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions

Patches of native vegetation within the Project area were assessed against the key diagnostic characteristics and condition indicators outlined in the Conservation Advice for the community. Where information on patch quality was not available, a precautionary approach was taken and patches were considered to be of sufficient quality for listing where Black Mallee Box, Bull Mallee, Red Mallee or Dumosa Mallee were the dominant species of

Eucalyptus, and the minimum patch size requirement of 0.5 hectares in conjunction with other nearby patches was met.

For the purpose of this assessment, this precautionary approach was also applied throughout the entire area within 10 km of the Project. This ecological community was found to occur extensively throughout this area, comprising mostly of recorded patches of Woorinen Mallee and Ridged Plains Mallee.

The listing of the Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions occurred subsequent to the Project being deemed a Controlled Action under the EPBC Act and cannot be assessed for that referral. This is consistent with EPBC Act Policy Statement: *Listing events under the EPBC Act* (DSEWPac, n.d) which states that "*for listing events that occur after a section 75 decision is made section 158A of the EPBC Act provides that approval process decisions under Parts 7-9 of the EPBC Act will not be affected by the listing event. That is, the listing event does not need to be considered."*

Nonetheless, impacts to this community were considered as part of the EES, through the Project's approach to avoidance and minimisation and in the development of mitigation measures. Further information is provided in EES Chapter 7: Terrestrial and aquatic ecology and Technical Report A: Flora impact assessment.



Figure 20-7 Patch of remnant Woorinen Mallee along a farm boundary

Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions

This ecological community was classified as present where Buloke was noted to be the dominant or co-dominant canopy tree species in the patch, as defined in the recovery plan for the community and the patch was at least 0.1 hectares in area. On this basis, seven habitat zones were classified as the listed community within 10 km of the Project area, however no patches of this woodland were identified near the impact footprint of the Project

Further information is provided in EES Technical report A: Flora impact assessment.

Mallee Bird Community of the Murray Darling Depression Bioregion

The EPBC listed Mallee Bird Community of the Murray Darling Depression Bioregion was modelled to potentially occur in proximity to the Project. The Mallee Bird Community of the Murray Darling Depression Bioregion was listed on the 21 December 2021 as an endangered community under the EPBC Act. The Mallee Bird Community

consists of an assemblage of 20 birds that are reliant on mallee habitat to persist. Two groups are recognised within the assemblage, specialists and dependents.

Mallee specialists are bird species found almost exclusively in mallee habitats, especially within the Murray Darling Depression bioregion. The group comprises eight bird species, all of which are recognised as threatened by at least two State jurisdictions, with five taxa listed as nationally threatened. The loss of suitable mallee habitats for these birds can potentially lead to their extinction, certainly at a local or regional scale (DAWE, 2021).

Mallee dependents are bird species that are dependent on mallee but can extend into non-mallee woodland and shrubland habitats. The group comprises twelve bird species, five are recognised as threatened in at least one State jurisdiction, and one – the Regent Parrot – is listed as nationally vulnerable. The loss of all suitable mallee habitats for these species may not necessarily lead to extinction but could result in substantial declines in abundance in the Murray Darling Depression bioregion, as well as loss of ecological diversity in the assemblage (DAWE, 2021).

Six mallee dependent birds of the twenty species associated with the Mallee Bird Community of Murray Darling Depression Bioregion were recorded during field surveys and desktop reviews undertaken as part of EES Technical Report B: Fauna ecology impact assessment, none of which were listed as threatened at Commonwealth or State level.

Conservation advice for the Mallee Bird community of the Murray Darling Depression Bioregion (DAWE, 2021) provides the thresholds required to meet the criteria of the Mallee Bird Community of the Murray Darling Depression Bioregion. The presence of six mallee dependant species did not meet the threshold of three categories (DAWE, 2021):

- Category A: At least five Mallee Bird Community species, any mix of mallee specialist and dependant species.
 - This statement was interpreted as requiring a mix of both specialist and dependent species.
- Category B: Three to four Mallee Bird Community species including at least one mallee specialist species.
 - No mallee specialist species are present based on field surveys or curated database records.
- Category C: Three to four Mallee Bird Community plus 5 mallee associated thresholds.
 - Five mallee associated species as per the conservation advice (DAWE, 2021) were present based on field surveys or curated database records.
- Category D: three to four Mallee Bird Community species and at least 20 or more terrestrial species, as defined in the survey guidelines in Section 2.3.1.
 - Category D is considered to be borderline when species exempted as per the conservation advice (DAWE, 2021), are excluded. If, other common / widely distributed species such as Red-rumped Parrot, Musk Lorikeet, Superb Fairy-wren, Buff-rumped Thornbill, Grey Currawong, Black-faced Cuckoo-shrike and Grey Shrike-thrush were excluded, it would not meet the threshold.

Considering this, the bird species assemblage recorded in the Project area is not considered to meet the threshold for this community. The listing of the Mallee Bird Community of the Murray Darling Depression Bioregion occurred post the Project being deemed a Controlled Action under the EPBC Act and cannot be assessed for that referral. Nonetheless, impacts to birds within this community were considered as part of the EES, through the Project's approach to avoidance and minimisation in relation to fauna habitat and in the development of mitigation measures.

Further information is provided in EES Chapter 7: Terrestrial and aquatic ecology and Technical Report B: Fauna impact assessment.

20.3.3 Threatened aquatic fauna

A desktop review was undertaken for aquatic fauna species either occurring, potentially occurring or potentially having habitat within 10 km of Kangaroo Lake. Six aquatic fauna species were listed under the EPBC Act as follows:

- Flatheaded Galaxias (*Galaxias rostratus*) –Critically Endangered, two Victorian Biodiversity Atlas (VBA) records as recent as 1963 and associated with Lake Cullen and Third Reedy Lake.
- Murray Cod –Vulnerable, 16 VBA records as recent as 1981, however VFA stock tens of thousands each year into Kangaroo Lake.

- Murray Hardyhead (*Craterocephalus fluviatillis*) –Endangered, six VBA records as recent as 1971, however there is a 2013 record from Middle Reedy Lake and a 2019 record from Third Reedy Lake (Iervasi, D. 2022, pers. comm. 9 June).
- Silver Perch (*Bidyanus bidyanus*) –Critically Endangered, 21 VBA records as recent as 2021 in Third Reedy Lake, the connecting channel between Middle and Third Reedy Lake in 2013 and Lake Tutchewop, Lake Charm, Racecourse Lake and Middle Lake in 2007. In 1983, there was a record in Kangaroo Lake.
- Trout Cod (*Macullochella macquariensis*) Endangered, no existing records, species returned on Protected Matters Search Tool as "species or species habitat may occur."
- Growling Grass Frog (*Litoria raniformis*) Vulnerable, a single 2021 record of a dead individual being found near Winlaton approximately 8 km north northeast of Kangaroo Lake. Nearest recent/valid records approximately 17 km east at Chapels Crossing.

Murray Cod is known to be present. Up to 50,000 fish are stocked annually into Kangaroo Lake by VFA as part of VFA's '10 million fish' recreation fishing stocking program. Silver Perch is considered likely to be present in Kangaroo Lake. There was a 1983 record of Silver Perch in Kangaroo Lake and more recently in 2007 in Lake Tutchewop, Lake Charm, Racecourse Lake and Middle Lake. Given the direct connectedness of Racecourse Lake, it is highly likely that if still present, they would also be in Kangaroo Lake.

Murray Hardyhead and Growling Grass Frog are considered possibly present at Kangaroo Lake. There were records in 2019 of Murray Hardyhead in Third Reedy Lake and historical records from early 1970 in Lakes Cullen and Tutchewop. In 2021, there was a record of a dead Growling Grass Frog 8 km north northeast of Kangaroo Lake, but suitable habitat is still present and only few surveys have been undertaken in the region. Flathead Galaxias is considered possibly present, but further research is required.

20.3.4 Threatened terrestrial fauna

The desktop assessment identified 14 EPBC-listed fauna species surrounding the Project area. These species, their conservation status, habitat preference and likelihood of occurrence is summarised in the table below.

Species	Conservation status	Habitat preference	Likelihood of occurrence
Corben's Long-eared Bat (<i>Nyctophilus corbeni</i>)	Vulnerable	Large woodlands and forests with dense understorey.	Low - Preferred habitat limited and very fragmented in region, no desktop records.
Curlew Sandpiper (<i>Calidris ferruginea</i>)	Critical	Forages on exposed intertidal mudflats and occasionally on inland freshwater wetlands	Medium - Preferred habitat limited and very fragmented in region, Most recent database records are; 2020 Bael Bael; 2018 at Lake Kelly, Lake Tutchewop Northern End and Cullens Lake Wildlife Reserve.
Eastern Curlew (<i>Numenius madagascariensis</i>)	Critical	Occurs on exposed intertidal mudflats and occasionally fresh brackish lakes.	Low - Preferred habitat limited and very fragmented in region, no recent desktop records.
Australasian Bittern (<i>Botaurus poiciloptilus</i>)	Endangered	Prefers vegetated shallow freshwater and brackish swamps.	High - Suitable habitat present, recorded from the study area, some regional records.
Australian Painted-snipe (<i>Rostratula australis</i>)	Endangered	Prefers and breeds in freshwater marshes with temporary water regimes.	Low - No suitable habitat. Remnant habitat present is too open, desktop record 1912.
Plains-wanderer (<i>Pedionomus torquata</i>)	Critical	Native grasslands with a suitable mix of vegetation and bare ground.	Low - No suitable habitat present. Some suitable areas to the east of the study area.
Malleefowl (<i>Leipoa ocellata</i>)	Vulnerable	Dense shrubland and woodland dominated by mallee and wattle species.	Low - No suitable habitat. Remnant habitat present is too open, no desktop records.

Table 20-7 EPBC-listed fauna species

Species	Conservation status	Habitat preference	Likelihood of occurrence
Superb Parrot (<i>Polytelis swainsoni</i>)	Vulnerable	Variety of habitats, typically forested areas and adjacent grasslands for foraging.	High - One individual recorded from the study area during the initial targeted survey (Ecoscape 2018).
Regent Parrot (eastern) (<i>Polytelis anthopeplus monarchoides</i>)	Vulnerable	Riparian vegetation with River Red Gum and adjacent Black Box woodland. Also, farmland with remnant roadside woodland.	Medium - Study area on eastern edge of species' dispersal range; dispersing individuals may pass through study area. No desktop records.
Painted Honeyeater (<i>Grantiella picta</i>)	Vulnerable	Dry open forest and woodland associated with mistletoe, rivers, plains and farmland.	Medium - Some suitable habitat present and study area within distribution, no desktop records.
Night Parrot (<i>Pezoporus occidentalis</i>)	Endangered	Long unburnt spinifex and chenopods in association with salt lakes.	Very Low - Study area outside species' known range, no suitable habitat, no regional records.
Satin Flycatcher (<i>Myiagra cyanoleuca</i>)	Migratory	Heavily vegetated eucalypt forests and tall woodlands, also coastal forests, mangroves and drier woodlands during migration.	Low - No suitable habitat, no desktop records.
Yellow Wagtail (<i>Motacilla flava</i>)	Migratory	Damp or wet habitats, meadows, hay fields, grassy tundras and marshes.	Low - No suitable habitat due to farmland dominated habitats, no desktop records.
Pink-tailed Legless Lizard (<i>Aprasia parapulchella</i>)	Vulnerable	Well drained rocky areas in open woodlands with grassy understory.	Low - No suitable habitat, no desktop records

Conservation significant migratory species associated with the Plains Mallee Box Woodland of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions and migratory species associated with the Mallee Bird Community of Murray Darling Depression Bioregion include:

- Curlew Sandpiper (*Calidris ferruginea*).
- Eastern Curlew (Numenius madagascariensis).
- Australasian Bittern (*Botaurus poiciloptilus*).
- Australian Painted-snipe (*Rostratula australis*).

As presented in **Table 20-7**, the Curlew Sandpiper and Australasian Bittern have a medium and high likelihood of occurrence surrounding the Project area. The remaining conservation significant migratory species have a low likelihood of occurrence. Both the Curlew Sandpiper and Eastern Curlew are listed as critically endangered.

Of the five threatened fauna species with a medium or high chance of occurrence in **Table 20-7**, only one has been recorded in proximity to the Project during surveys undertaken as part of EES Technical Report B: Fauna ecology impact assessment. The Superb Parrot was recorded in 2018 during initial Project surveys (Ecoscape, 2018). A significant impact assessment for the Superb Parrot is presented in **Section 20.4.2**.

20.4 Impacts on MNES

This section describes the potential impacts on MNES associated with the construction, operation and decommissioning of the Project. Measures to manage or mitigate the potential impacts are recommended and any impacts that remain following the adoption and implementation of those measures (residual impacts) are outlined.

As described in the following sections, the Project would not meet the significant impact criteria for Ramsar wetlands, threatened species and ecological communities. With the adoption of management and mitigation measures, residual impacts on MNES would be minimised and significant impacts are unlikely.

20.4.1 Ramsar wetlands

The Significant impact guidelines (DoE, 2013) provide significant impact criteria for wetlands of international importance (Ramsar sites). An action will be deemed to have the potential for a significant impact if it will result in:

- Areas of the wetland being destroyed or substantially modified
- A substantial or measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration, and frequency of ground and surface water flows to and within the wetland
- The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected
- A substantial and measurable change in the water quality of the wetland, for example a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity, or human health, or
- An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.' (DoE, 2013, p13).

The assessment against the significant impact criteria indicates that the project would not have a significant impact on the Kerang Wetlands Ramsar site (refer to **Table 20-9**). There would be minimal impact to water quality and quantity at Kangaroo Lake and minimal impact to fauna species. The critical CPS of Kangaroo Lake would be unaffected by the project and LAC would continue to be met.

Construction

The Project does not involve construction works within 22 of the 23 Kerang Lakes Ramsar site named lakes, marshes and swamps. The pump station, however, would be constructed at Kangaroo Lake in order to supply the Project with 4.5 GL of water per year during start up and 3.1 GL of water per year during operations, via an underground pipeline approximately 38 km long.

It is anticipated that the pump station would have a small footprint, consisting of two bank-mounted, skidmounted 400 kilowatt (kW) horizontal pumps each with an electric motor (refer to **Figure 20-8**). The motors can be connected to the electricity or powered by diesel generators at Kangaroo Lake. Construction of the 38 km underground pipeline would be undertaken using open trenching methods, except where crossings require trenchless construction.



Figure 20-8 Footprint of the proposed pump station

Removal of habitat

The pump station would be constructed adjacent to the bank of Kangaroo Lake, in the vicinity of the No. 4/7 Channel and existing infrastructure (refer to **Figure 20-8** and **Figure 20-9**). Habitat in the lake is best characterised as open water mostly fringed by dense emergent vegetation consisting namely of reeds such as Common Reed or Cumbungi (Phragmites australis) and Bullrush (Typha sp.).

In the vicinity of the proposed pump station, fringing vegetation consists of a 2-4 m wide monoculture of Common Reed, which reduced in thickness and density into the No. 4/7 Channel. The terrestrial area is highly disturbed and includes spoil (assumed to be from channel clearing) and predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (*Echium plantagineum*). The embankment, like the majority of Kangaroo Lake's shoreline, is steep and therefore not seen as high habitat value or suitable habitat space for wader birds.

More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake.



Figure 20-9 Location of proposed pump station (centre of image)

The construction of the pump station would not result in the removal of critical habitat. The construction footprint of the pump station is highly disturbed and includes spoil and weed species. Adjacent to the proposed construction footprint is approximately 431 m² of Plains Savannah (EVC 826) and 422 m² of wetland vegetation. This vegetation would not be impacted by the construction of the pump station, however mitigation measures would be implemented to ensure that any potential impacts to terrestrial and aquatic wetland vegetation are minimised.

Management and mitigation measures

In order to minimise the potential direct removal of habitat during construction, the following mitigation measures should be implemented:

- The pump station and works area/s should be designed to have the smallest footprint possible and should be designed to minimise the need for in-lake works.
- Install No Go Zone (NGZ) exclusion and sediment fencing to prevent ingress and protect areas of the lake's banks and bed.
- Aquatic, emergent and riparian habitat would be reinstated following construction of the pump station.

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impacts

With implementation of the recommended mitigation measures, the potential for direct removal of habitat at Kangaroo Lake during construction would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed.

Disturbance to lakebed and banks

In addition to the direct removal of habitat at Kangaroo Lake, the construction of the pump station may result in disturbance to the lakebed and banks of Kangaroo Lake. Disturbing the lakebed and banks of Kangaroo Lake would temporarily increase turbidity (suspended solids). An increase in turbidity might increase light attenuation and result in the smothering of lake vegetation with sediment.

Unmanaged works that impinge on the lake's bed or banks may occur beyond the actual construction works area of the pump station. Although unlikely, disturbance would occur if construction areas are not appropriately protected and fenced.

Management and mitigation measures

In order to minimise impacts to the lakebed and banks of Kangaroo Lake during construction, the following mitigation measures should be implemented:

- The pump station and works area/s should be designed to have the smallest footprint possible and should be designed to minimise the need for in-lake works.
- Install No Go Zone (NGZ) exclusion and sediment fencing to prevent ingress and protect areas of the lake's banks and bed.
- For any temporary structure, erosion and sediment controls are to be in place to minimise the number of erodible surfaces during construction.

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impacts

With implementation of the recommended mitigation measures, there would be negligible impacts to the lakebed and banks of Kangaroo Lake during construction.

Reduced water quality

Construction activities associated with the pump station poses a risk to water quality through the disturbance of sediment from earthworks, the removal of vegetation and the release of pollutants into the waterway. This has the potential to impact both immediate and more distant aquatic habitat areas and downstream receiving waterways.

Management and mitigation measures

In order to minimise impacts reduced water quality, the following mitigation measures should be implemented:

- Baseline water quality monitoring should be undertaken upstream and downstream of the limits of the Project area. Parameters should include turbidity, electrical conductivity, pH, dissolved oxygen, temperature, litter, oils and grease (visual assessment) and rainfall.
- Chemicals should be stored away from the lake.
- A waterproof sealed bund would be installed around the pump works area.
- If possible, works at the pump site on Kangaroo Lake are undertaken during dry ground conditions. Alternatively bog mats are deployed.
- Measures should be implemented to filter any onsite surface water before release to the lake. Water discharged from the works site should not detrimentally impact the quality of water in the lake and water quality monitoring should occur to confirm the relevant water quality requirements of the EPA's Environment Reference Standard for "Murray and Western Plans, lowlands of the Loddon basin" (EPA, 2021).

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impacts

With implementation of the recommended mitigation measures, there would be negligible impacts to water quality in Kangaroo Lake during construction of the pump station.

Spills during construction

Spills of fuel and chemicals during construction of the pump station have the potential to enter Kangaroo Lake. Spills or flood inundation of fuels, oils and other construction-related contaminants are possible during works. If these contaminants enter Kangaroo Lake, water and habitat quality may be impacted.

Management and mitigation measures

In addition to mitigation measures mentioned in the above sections, the pump station works area should be designed so that stormwater runoff and/or spills from surfaces are not discharged directly into the lake, or nearby No. 4/7 channel and all fuels, oils and chemicals are not to be stored within 1 km of Kangaroo Lake.

For construction works that occur in/near the lake, emergency measures should be included within the Project's Environmental Management Plan to protect earthworks and works areas from inundation so far as reasonably practicable. Protocols for site closure during times of predicted heavy rainfall events should also be included in the plan.

Residual impacts

With implementation of the recommended mitigation measures, there would be negligible impacts from spills and releases to Kangaroo Lake during construction.

Operation

The primary impact pathways for the Ramsar site are related to the anticipated pumping of water from Kangaroo Lake for use at the Project, entrainment and impingement of aquatic fauna species, disturbance as a result of noise generated at the pump station and incursion by weeds.

Impact to lake water levels

As discussed in **Section 20.2.1**, Kangaroo Lake is a major irrigation supply storage basin, in addition to a popular recreational fishing and boating destination.

Water extraction for the Project significantly beyond that already drawn for irrigation purposes has the potential to lower lake water levels beyond historical levels and therefore reduce the area of occupancy for aquatic biota, especially around the lake fringe. The primary concern in this scenario is that lower water levels could result in detrimental changes to the type, structure and quality of aquatic habitat. Additionally, changes to hydrology and water levels may impact upon the salinity of Kangaroo Lake.

Based on data provided by Goulburn Murray Water the current average lake draw, or discharge is approximately 0.15 GL/day (Bailey, M. 2022. Pers comm. 2 August). Considering that the irrigation season would operate from August to May (i.e. 274 days) and assuming that the Project draws its demand of 4.5 GL/year evenly over 365 days (0.012 GL/day), the maximum Project water demand would represent only a 8% increase on the lake's current average daily demand. As such, the additional water usage as a result of Project operations is likely to have negligible impact to Kangaroo Lake's water height, beyond that already controlled in the lake. Therefore, there would be negligible impact to the aquatic habitat and salinity of Kangaroo Lake from Project operations.

Management and mitigation measures

Given that the extraction of water for the Project would have negligible impact to Kangaroo Lake's water height, no mitigation measures are proposed.

Residual impacts and monitoring

No residual impacts to Kangaroo Lake water levels are anticipated as a result of Project operations on the lake water levels.

Entrainment and impingement

Entrainment is the unwanted passage of fish or small aquatic organisms through a water intake and is generally caused by an absent, or inadequate screen surrounding the water intake. Impingement is the physical contact of a fish with such a screen due to intake velocities which are too high to allow the fish to escape.

Both scenarios have the potential to cause injury or mortality of fish and other aquatic fauna if they are unable to escape the pump inlet.

Management and mitigation measures

In order to minimise the potential impacts of entrainment and impingement from the operation of the Project, the following measures should be implemented:

- Design the pump station to include an angled fish screen on the inlet that is designed to Australian best
 practice standards and able to effectively protect smaller fish and aquatic fauna from entrainment and
 impingement. Guideline examples include:
 - The practical guide to modern fish-protection screening in Australia (NSW DPI 2021).
 - Design specifications for fish-protection screens in Australia (Boys 2021).
 - Development of fish screening criteria for water diversions in the Murray-Darling Basin (Boys et al 2012).
 - Screening Irrigation Offtakes in the Murray-Darling Basin to Reduce Loss of Native Fish (Blackley 2003).

If the pump inlet fish screen is unable to adequately exclude fish larvae, consideration may need to be given to limiting water offtake during periods when larvae are expected to be present.

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impacts

Following the implementation of mitigation measures, there would be negligible impacts from entrainment and impingement.

Noise

The pump station at Kangaroo Lake would generate noise during its operation. It is assumed that a single 1.5 MVA generator would be operating continuously, and the pump/motor sets and the diesel generator would each be housed in acoustic enclosures to assist in soundproofing.

To assess potential impacts, predicted noise levels have been considered against the Category IV and Category V indicators and objectives in the Environment Reference Standard (ERS) relating to Public Conservation and Resource Zone (PCRZ) and natural areas such as wildlife reserves, nature reserves and flora and fauna reserves.

Category IV land uses relate to lower density or sparse populations with settlements. Land use Category V relates to unique combinations of landscape, biodiversity and geodiversity. These natural areas typically provide undisturbed species habitat and enable people to see and interact with native vegetation and wildlife.

Predicted noise levels are presented in **Table 20-8** below.

Table 20-8 Kangaroo Lake pump station – predicted noise levels

Receiver	Category	Predicted noise level dBA	ERS objective noise level, Leq,8h dBA	Level of exceedance
Mystic Park Bushland Reserve	IV	< 20	35	0
Forest Plantation East Road	IV	24	35	0
Adj. Kangaroo Lake and Murray Valley Highway	IV	< 20	35	0
Koorangie Wildlife Reserve	v	< 20	Qualitative	-
Yassom Swamp Flora and Fauna Reserve	V	< 20	Qualitative	-
Bael Bael Grassland Nature Reserve	V	< 20	Qualitative	-
Tutchewop Wildlife Reserve	v	< 20	Qualitative	-

The ERS objective levels are typical ambient sound level values and are neither noise limits nor noise design criteria.

Noise levels at the Category IV natural areas are predicted to be less than the objective noise level of 35 dBA. The pump station will likely be inaudible from these locations.

Category V indicators are qualitative with the objective of a sound quality that is conductive to human tranquility and enjoyment having regard to the ambient natural soundscape. Predicted noise levels at the Category V noise sensitive areas are predicted to be less than 20 dB, due to them being located between 4 km and 9 km from the pumping station. The pump station will be inaudible from these natural areas. It is anticipated that such noise emissions would not disturb local fauna species at Kangaroo Lake.

Management and mitigation measures

Noise from the diesel generator can be minimised by installing an engineered acoustic enclosure.

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impacts

With the implementation of the mitigation strategies, there would be negligible impacts to noise sensitive areas.

Incursion by weeds

Several common weed species are present in the Project area. Operation of the pump station at Kangaroo Lake could potentially introduce weed seeds and cuttings if not properly managed. Observations during the native vegetation and flora impact assessment indicated that the following high threat weeds are potentially of concern:

- African Box-thorn.
- Bridal Creeper.
- Field Dodder.
- Horehound.
- Onion Weed.
- Paterson's Curse.
- Soursob.
- Sticky Ground-cherry.

Management and mitigation measures

Implementing disease, pest and hygiene controls for all plant entering the work area, for example introducing clean down bays, would reduce any potential impacts from introduced weeds.

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impacts

The residual impacts from the incursion of weeds are likely to be negligible following the implementation of mitigation measures.

Decommissioning

Decommissioning of the Project would involve returning the land to its pre-existing agricultural land use. Given its proximity to Kangaroo Lake, decommissioning the pump station and underground water pipeline would have the greatest potential to impact Kerang Wetlands. However, where desirable and agreed by relevant stakeholders, mining infrastructure, such as the underground water pipeline and pump station, would remain for use of landholders post Project closure.

Considering this, potential impacts on the Ramsar site are not anticipated to occur as the pump station and associated infrastructure would remain in-situ.

Management and mitigation recommendations

No management and mitigation measures are recommended as decommissioning of the pump station and associated infrastructure is not anticipated to result in impacts to ecological values.

Residual impacts

No residual impacts on the ecological character of the Ramsar site are anticipated as a result of decommissioning of the Project.

Summary of assessment of impact on Ramsar site

The assessment of the Project's potential effects on the Ramsar site values is summarised in Table 20-9.

Table 20-9 Assessment of values of the Ramsar site

Value	Conclusion of assessment	
Critical components and processes		
Hydrology – (percentage full, depth/volume, frequency of inundation)	The irrigation season would operate from August to May (i.e. 274 days) and it is assumed that the Project would draw its water demand of evenly over 365 days (i.e. not exceeding 0.012 GL/day). Based on data provided by Goulburn Murray Water, the current average lake draw or discharge is approximately 0.15 GL/day. As such, the Project's maximum water demand would represent only a 8% increase on the lake's current average daily demand. The additional water usage as a result of Project operations is likely to have negligible impact to Kangaroo Lake's water height, beyond that already controlled in the lake.	
Physiochemical – salinity	Given that changes to Kangaroo Lake's water level would not be significant following operation of the Project, the lake's salinity levels are expected to continue to be less than 4,000 EC when lake is more than 75% full.	

Value	Conclusion of assessment
Waterbirds – abundance	There would be a negligible impact on waterbirds at Kangaroo Lake from the construction and operation of the pump station considering the negligible impact to habitat, lake water levels and potential food sources for waterbirds. The terrestrial area is highly disturbed and includes spoil (assumed to be from channel clearing) and predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (<i>Echium plantagineum</i>). The embankment, like the majority of Kangaroo Lake's shoreline, is steep and therefore not seen as high habitat value or suitable habitat space for waderbirds, including Curlew Sandpiper (<i>Calidris ferruginea</i>) and the Eastern Curlew (<i>Numenius madagascariensis</i>). The remaining 22 named lakes, marshes and swamps of the Kerang Wetlands would not
	be impacted by the construction and operation of the pump stationat Kangaroo Lake.
Waterbirds – colonial breeding/ nesting (ibis, darters, cormorants, spoonbills) and large numbers	There would be negligible impact to waterbird breeding at Kangaroo Lake from the construction and operation of the pump station considering the negligible impact to habitat, lake water levels and potential food sources for waterbirds. The terrestrial area is highly disturbed and includes spoil (assumed to be from channel clearing) and predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (<i>Echium plantagineum</i>). The embankment, like the majority of Kangaroo Lake's shoreline, is steep and therefore not seen as high habitat value or suitable habitat space for waderbirds, including Curlew Sandpiper (<i>Calidris ferruginea</i>) and the Eastern Curlew (<i>Numenius madagascariensis</i>). The remaining 22 named lakes, marshes and swamps of the Kerang Wetlands would not be impacted by the construction and operation of the pump stationat Kangaroo Lake.
Waterbird diversity	There would be a negligible impact on waterbirds and to waterbird diversity at Kangaroo Lake from the construction and operation of the pump station considering the negligible impact to habitat, lake water levels and potential food sources for waterbirds. The terrestrial area is highly disturbed and includes spoil (assumed to be from channel clearing) and predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (<i>Echium plantagineum</i>). The embankment, like the majority of Kangaroo Lake's shoreline, is steep and therefore not seen as high habitat value or suitable habitat space for waderbirds, including Curlew Sandpiper (<i>Calidris ferruginea</i>) and the Eastern Curlew (<i>Numenius madagascariensis</i>).
	be impacted by the construction and operation of the pump stationat Kangaroo Lake.
Vegetation diversity	The construction footprint of the proposed pumpstation adjacent to Kangaroo Lake is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (<i>Echium plantagineum</i>). The nearby aquatic vegetation consists of a 2-4 m wide monoculture of Common Reed.
Supports a diversity of wetland	Wetland type is a product of hydrology, calinity and vogetation
types	As described above, there would be a negligible impact to the hydrology of Kangaroo Lake and an insignificant impact to the salinity of Kangaroo Lake. Given the relatively small footprint of the pump station, it is acknowledged that the area of removal would include lower quality habitat associated with Common Reed. The removal of Common Reed in the vicinity of the pump station would be negligible compared to the overall area of habitat in the lake.
Supports threatened species - waterbirds	The Curlew Sandpiper has a medium chance of occurrence surrounding the Project area. There have been records of the Curlew Sandpiper at Lake Bael Bael in 2020 and at Lake Kelly, Lake TutchewopNorthern End and Cullens Lake Wildlife Reserve in 2018. The Curlew Sandpiper has not been recorded as part of fauna assessments for the Project.
	The Australasian Bittern has a high chance of occurrence surrounding the Project area. Suitable habitat for the Australasian Bittern exists surrounding the Project area and there have been records of Australasian Bittern in proximity to Kangaroo Lake.
	The construction and operation of the pump station at Kangaroo Lake is considered to have a negligible impact to habitat and potential food sources for waterbirds. The construction of the water supply pipeline connecting the pump station to the mine site will occur within the existing disturbed road reserve and does not provide suitable habitat for wading and migratory birds.

Value	Conclusion of assessment
Significant impact assessment	
Areas of the wetland being destroyed or substantially modified	The pumpstation would be constructed adjacent to Kangaroo Lake in the vicinity of the No. 4/7 Channel and existing infrastructure. In proximity to the pump station, fringing vegetation consists of a 2-4 m wide monoculture of Common Reed, which reduces in thickness and density into the No. 4/7 Channel. The terrestrial area is highly disturbed and includes spoil (assumed to be from channel clearing) and predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (<i>Echium plantagineum</i>). The construction footprint of the pumpstation would be small and would not result in areas of Kangaroo Lake being destroyed or substantially modified.
A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland	Kangaroo Lake is a major irrigation supply storage basin with high operational water levels required in the lake to optimise water supply for regional irrigators with downstream water user demands on the Murray River. Kangaroo Lake is maintained at a constant water level via the Kerang Weir located at the confluence of Pyramid Creek and the Loddon River Irrigation season would operate from August to May (i.e. 274 days) and it is assumed that the Project would draw its water demand evenly over 365 days (i.e. not exceeding 0.012 GL/day). Based on data provided by Goulburn Murray Water, the current average lake draw or discharge is approximately 0.15 GL/day. As such, the Project's maximum water demand would represent only a 8% increase on the lake's current average daily demand. The additional water usage as a result of Project operations is likely to have negligible impact to Kangaroo Lake's water height, beyond that already controlled in the lake.
The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected	There would be a negligible impact on invertebrate fauna and fish species at Kangaroo Lake from the construction and operation of the pump station considering the negligible impact to habitat, lake water levels and potential food sources. Entrainment and impingement controls would mitigate the unwanted passage of fish or small aquatic organisms through the water intake.
A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health	Given that changes to Kangaroo Lake's water level would not be significant following operation of the Project, the lake's salinity levels are expected to continue to be less than 4,000 EC when lake is more than 75% full.
An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.	At present, the footprint of the proposed pumpstation is highly disturbed and includes spoil (assumed to be from channel clearing) and predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (<i>Echium plantagineum</i>). During operation of the pumpstation, implementing disease, pest and hygiene controls for all plant entering the work area, for example introducing clean down bays, would reduce any potential impacts from introduced weeds.

20.4.2 Threatened species and ecological communities

An action will require approval if the action has, will have, or is likely to have a significant impact on a species listed in any of the following categories:

- extinct in the wild.
- critically endangered.
- endangered, or
- vulnerable.

An action will also require approval if the action has, will have, or is likely to have a significant impact on an ecological community listed in any of the following categories:

- critically endangered, or
- endangered.

The assessment against the significant impact criteria indicates that the Project would not have a significant impact on threatened species and ecological communities.

While threatened aquatic fauna species are present, likely present or possibly present within Kangaroo Lake, the construction footprint for the pump station at Kangaroo Lake is limited and the implementation of mitigation measures would reduce potential impacts. Additionally, the Project would not have a significant impact on Superb Parrot, especially considering the relatively small percentage of native vegetation and fauna habitat being removed, the lack of suitable habitat for Superb Parrot in proximity to the Project and that the Project would be located 100 km from the known breeding areas and distribution of Superb Parrot.

A total extent of 11.347 ha of Plains Mallee Box Woodlands would be lost during the construction of the Project, however a significant impact test was not undertaken given that its EPBC listing occurred post the determination of the Project as a 'controlled action.' It is anticipated that the extent of native vegetation removed during construction activities would be reduced by the implementation of mitigation measures.

Aquatic species

Construction and operation of the Project has the potential to impact upon aquatic fauna species at Kangaroo Lake. A desktop assessment identified that six EPBC-listed aquatic fauna species either occurred, potentially occurred or had potential habitat within Kangaroo Lake. Of these six species, the Murray Cod, Silver Perch, Murray Hardyhead, Flathead Galaxias and Growling Grass Frog were assessed as being present, likely present or possibly present.

Potential mechanisms of impact on aquatic fauna species during construction and operation of the Project have been discussed in **Section 20.4.1** as part of the Kerang Wetlands Ramsar site assessment. Mitigation measures and residual impacts are presented for each potential mechanism of impact identified.

The assessment of potential impacts on EPBC-listed aquatic fauna species potentially present at Kangaroo Lake found that the Project is unlikely to result in a significant impact.

Residual impact

With implementation of the recommended mitigation measures, the potential for direct removal of habitat at Kangaroo Lake during construction would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed.

An assessment of impact on Murray Hardyhead, Silver Perch and Flathead Galaxias against the significant impact criteria for critically endangered or endangered species in Matters of National Environmental Significance Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999 (DoE, 2013) is presented in **Table 20-10**.

An assessment of impact on the vulnerable Murray Cod and Growling Grass Frog against the significant impact criteria is presented in **Table 20-11**.

Significant impact criteria for critically endangered or endangered species	Criteria met?	Discussion
An action is likely to have a significant impact on possibility that it will:	on a critically	y endangered or endangered species if there is a real chance or
Lead to a long-term decrease in the size of population	No	Potential impacts are unlikely to result in long-term decline of the species. The construction footprint of the pump station at Kangaroo Lake would be relatively small. The terrestrial construction footprint of the proposed pump station adjacent to Kangaroo Lake is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum). The nearby aquatic vegetation consists of a 2-4 m wide monoculture of Common Reed. The removal of this vegetation is not considered to be significant. Operation of the pump station may result in entrainment or impingement of aquatic species. The pump station screen would be designed to Australian best practice standards and able to effectively protect smaller fish from entrainment and impingement.

Table 20-10 Significant impact assessment for Murray Hardyhead, Silver Perch and Flathead Galaxias

Significant impact criteria for critically endangered or endangered species	Criteria met?	Discussion
Reduce the area of occupancy of a population	No	 Habitat in the lake is best characterised as open water mostly fringed by dense emergent vegetation consisting namely of reeds such as Common Reed or Cumbungi (<i>Phragmites australis</i>) and Bullrush (<i>Typha sp.</i>). The construction footprint of the pump station at Kangaroo Lake would be relatively small. The terrestrial construction footprint of the proposed pump station adjacent to Kangaroo Lake is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (<i>Echium plantagineum</i>). Potential aquatic habitat removal would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed.
Fragment an existing population into two or more populations	No	The construction footprint is confined to a small area adjacent to the No. 4/7 Channel inlet. Habitat in this area is considered low quality. More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake.
Adversely affect habitat critical to the survival of a species	No	The habitat present is not habitat critical to the survival of the species. In the vicinity of the pump station, fringing aquatic vegetation consisted of a 2-4 m wide monoculture of Common Reed, which reduced in thickness and density into the No. 4/7 Channel.
Disrupt the breeding cycle of a population	No	Removal of tens of metres of Common Reed would not disrupt the breeding cycle of aquatic species. More complex and extensive habitat exists in other parts of Kangaroo Lake.
Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No	This impact is unlikely. The construction footprint is confined to a small area adjacent to the No. 4/7 Channel inlet. Potential habitat removal would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed. More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the species' habitat	No	Disease, pest and hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
Introduce disease that may cause the species to decline	No	Disease, pest and hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
Interfere substantially with the recovery of the species	No	This impact is unlikely. Potential impacts are restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed. Entrainment and impingement controls would mitigate the unwanted passage of fish or small aquatic organisms through the water intake.

Significant impact criteria for vulnerable species	Criteria met?	Discussion			
An action is likely to have a significant impact	An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:				
		Potential impacts are unlikely to result in long-term decline of the species.			
		Note that the presence of Growling Grass Frog does not constitute an Important Population as defined in the Significant Impact Guidelines (DEWA 2009).			
		An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:			
		key source populations either for breeding or dispersal			
		 populations that are necessary for maintaining genetic diversity, and/or 			
		 populations that are near the limit of the species range. 			
		Notwithstanding this site does not meet this criteria, a significant impact test was undertaken. The results are outlined below.			
Lead to a long-term decrease in the size of an important population	No	The construction footprint of the pump station at Kangaroo Lake would be relatively small. The nearby aquatic vegetation consists of a 2-4 m wide monoculture of Common Reed. The installation of the pipeline is on the road verge and does not impact on Growling Grass Frog habitat. A fauna spotter will be on-site during all the works to move any fauna from the construction footprint.			
		The terrestrial construction footprint of the proposed pump station adjacent to Kangaroo Lake is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).			
		The removal of this vegetation is not considered to be significant.			
		Operation of the pump station may result in entrainment or impingement of aquatic species. The pump station screen would be designed to Australian best practice standards and able to effectively protect smaller fish from entrainment and impingement.			
Reduce the area of occupancy of an important population	No	Habitat in the lake is best characterised as open water mostly fringed by dense emergent vegetation consisting namely of reeds such as Common Reed or Cumbungi (<i>Phragmites australis</i>) and Bullrush (<i>Typha sp.</i>).			
		The construction footprint of the pump station at Kangaroo Lake would be relatively small. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum). Potential aquatic habitat removal would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed.			
Fragment an existing important population into two or more populations	No	The construction footprint is confined to a small area adjacent to the No. 4/7 Channel inlet. Habitat in this area is considered low quality. More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake.			

Table 20-11 Significant impact assessment for Murray Cod and Growling Grass Frog

Significant impact criteria for vulnerable species	Criteria met?	Discussion
Adversely affect habitat critical to the survival of a species	No	The habitat present is not habitat critical to the survival of the species. In the vicinity of the pump station, fringing vegetation consisted of a 2-4 m wide monoculture of Common Reed, which reduced in thickness and density into the No. 4/7 Channel. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).
Disrupt the breeding cycle of an important population	No	Removal of Common Reed would not disrupt the breeding cycle of aquatic species. More complex and extensive habitat exists in other parts of Kangaroo Lake.
Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No	This impact is unlikely. The construction footprint is confined to a small area adjacent to the No. 4/7 Channel inlet. Potential habitat removal would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed. More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No	Disease, pest and hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
Introduce disease that may cause the species to decline	No	Disease, pest and hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
Interfere substantially with the recovery of the species	No	This impact is unlikely. Potential impacts are restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed. Entrainment and impingement controls would mitigate the unwanted passage of fish or small aquatic organisms through the water intake.

Terrestrial species

Superb Parrot

An individual Superb Parrot was recorded in proximity to the Project in 2018. Listed EPBC Act fauna species, such as the Superb Parrot, may utilise remnant vegetation surrounding the Project area to move across the landscape, and the direct removal and fragmentation of vegetation during construction may result in the removal of fauna habitat. Approximately 6.8 Ha of native vegetation, 440 large trees in patches, 37 large scattered trees and 14 small scattered trees would be removed from Project mine areas, and an additional 0.27 Ha, including 30 large trees in patches would be removed from transport intersections during construction activities. The removal of this potential habitat represents 1.3% of native vegetation and fauna habitat mapped as part of the native vegetation and flora impact assessment (541 Ha). The removal of 470 large trees in patches, 37 large scattered trees and 14 small scattered trees from Project mine areas and transport intersections represents 1.13% of the total number of trees within the study area, estimated as part of the native vegetation and flora impact assessment (45,911 trees). The impact to roadside vegetation along the pipeline alignment would be confined to a loss of 61 large trees in patches. While considered lost due to potential encroachments on the tree protection zone, these 61 large trees in patches would remain in-situ and would continue to provide habitat for fauna species.

As such, it is unlikely that impacts would result in a significant removal of potential habitat or cause any significant change to the network of remnant vegetation along road reserves that allow conservation significant species, in particular birds, to move across the landscape to larger conservation reserves. The removal of native vegetation during Project construction is not considered to impact habitat critical to the survival of listed fauna species, such as Superb Parrot.

Management and mitigation measures

Minimising impacts to native vegetation, particularly along road reserves during the construction of the underground pipeline, would nonetheless ensure potential impacts to listed fauna species are minimised. An arborist should be engaged to assist with micro-siting the underground pipeline and to identify additional measures to avoid adverse impacts to structural root zones should be implemented would also minimise potential impacts to native vegetation and fauna habitat.

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impact

Approximately 7 Ha of native vegetation, 470 large trees in patches, 37 large scattered trees and 14 small scattered trees would be removed from Project mine areas and transport intersections during construction activities. Despite this, no threatened flora species would be impacted and residual impacts to threatened fauna species, such as the Superb Parrot, are not expected to be significant considering the relatively small percentage of native vegetation and fauna habitat being removed and considering that this habitat is not critical to the survival of Superb Parrot.

Given that Superb Parrot was the only species recorded in proximity to the Project, an assessment of impact on Superb Parrot against the significant impact criteria for vulnerable species in Matters of National Environmental Significance Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999 (DoE, 2013) is presented in **Table 20-12**. Further information is provided in EES Technical Report B: Fauna impact assessment.

Significant impact criteria for vulnerable species	Criteria met?	Discussion
An action is likely to have a significant impact of	on a vulnerab	le 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	No	The impacts are unlikely to result in long-term decline of the species, given that there is a lack of Superb Parrot records in proximity to the Project and a lack of preferred habitat for both feeding and foraging. This preferred habitat consists of large hollow bearing trees in river red gums (Baker-Gabb 2011), eucalypts associated with box woodland communities, Blakely's red gum, white box and yellow box. It is considered that the Project will not lead to a long-term decrease of Superb Parrot.
Reduce the area of occupancy of an important population	No	The habitat considered important for Superb Parrot is not present in proximity to the Project. The individual Superb Parrot recorded in 2018 is likely to be a vagrant and / or immature dispersing male. The acknowledged area of occupancy is confined to the Barmah Forest area with occasional sightings south to Shepparton and east to Wangaratta and Corryong along the Murray River. Superb Parrot disappeared from central and southern Victoria in the early 1900s, and most of northern Victoria by 1930. They are absent from large parts of the Riverina and northern Victoria. It is concluded that there will not be a reduction of the area of occupancy of Superb Parrot.
Fragment an existing important population into two or more populations	No	The Project would be located over 100 km to the west of the currently recognised distribution (Baker Gabb 2011; Manning 2004) of this species where it is considered an important population. It is considered that the presence of an individual Superb Parrot in proximity to the Project in 2018 does not indicate a continuum of the population east of the known distribution of the species. The individual is likely to be a vagrant or aviary escapee moving through, before utilising more suitable foraging habitat outside the Project area. Fragmentation of an existing important population into two or more populations is not relevant to Superb Parrot in the Project area.

Table 20-12 Significant impact assessment for Superb Parrot

Significant impact criteria for vulnerable species	Criteria met?	Discussion
		The Superb Parrot depend on hollows in dead trees for breeding and prefer trees close to watercourses (25 m), with a large trunk diameter, diameter at breast height (DBH) >1 m (Baker-Gabb 2011).
Adversely affect habitat critical to the survival of a species	No	On the inland slopes of NSW, they use at least six species of eucalyptus but are more closely associated with Blakely's red gum <i>E. blakelyi</i> . It has also been suggested that Superb Parrot may have a reliance on white box <i>E. albens</i> and yellow box <i>E. melliodora</i> . These eucalypt species are not present in proximity to the Project. Whilst there are food sources in proximity to the Project (i.e. seeds and fruits), Superb Parrot habitat is dominated by gum and box eucalypts associated with the Murray River and its tributaries.
		The habitat / vegetation in proximity to the Project is not dominated by gum and box eucalypt communities associated with the Murray River and its tributaries. Canopy trees in proximity to the Project are dominated by mallee trees such as bull mallee and black box.
Disrupt the breeding cycle of an important population	No	The Superb Parrot breed between September and December along the Murray River (in Victoria), in areas of mature river red gum (DBH >1m) and in close proximity to water courses (Baker-Gabb 2011). Canopy trees in proximity to the Project are confined to mallee associated species, located 100km west of the known breeding area and distribution of Superb Parrot. There will not be a disruption to the breeding cycle of Superb Parrot.
Modify, destroy, remove, or isolate or decrease the availability or quality of habitat	No	The impact to native vegetation is limited to approximately 7 ha within the mine areas and transport intersections. Notwithstanding this, the Project would be located 100km from the known breeding areas and distribution of Superb Parrot.
to the extent that the species is likely to decline	NO	The removal of trees in patches and scattered trees in proximity of the Project would therefore not modify, destroy, remove or 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 vulnerable species becoming established in the vulnerable species' habitat	No	Hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
		It is known that Superb Parrot are susceptible to psittacine beak and feather disease (PBFD) and the loss of nest hollows is likely to intensify competition and use of nest trees, and may increase the likelihood of transmission of the disease.
Introduce disease that may cause the species to decline	No	The use of tree hollows is confined to gum and box eucalypts associated with the Murray River and its tributaries, none of which are present within proximity to the Project. The woodlands found within the Project mining areas lack the large trees with hollows preferred by Superb Parrot. Canopy trees are confined to canopy trees associated with mallee vegetation e.g., dumosa mallee, oil mallee, bull mallee and black box. The project works will not introduce disease causing a decline
		in Superb Parrot.
Interfere substantially with the recovery of the species	No	The Project is located 100km from the known breeding area and distribution of Superb Parrot. The habitat within proximity to the Project does not provide suitable habitat for breeding or permanent habitat. The removal of approximately 7 Ha of native vegetation and a 'loss' of 61 large trees in patches along the pipeline alignment, (noting these trees would be left in-situ and not removed), is not associated with critical habitat for Superb Parrot. The observation of an individual Superb Parrot in 2018 is considered an outlier of a dispersing juvenile, or an escapee aviary bird (Martin, A. 2022 pers comm., 30 March). The project works will not interfere substantially with the
		recovery of the species.

Plains-wanderer

Plains-wanderer exhibit very strong site fidelity behaviours with average home ranges of 12 ha with about half the home range overlapping with a bird of the opposite sex (Harrington, Maher and Baker-Gabb, 1988). Population density estimates indicate that 9 ha of suitable habitat per bird is required (Harrington, Maher and Baker-Gabb, 1988). If disturbed or displaced, Plains-wanderer are unlikely to return to previously occupied territories. Plains-wanderer breed in spring with clutches of eggs (average five eggs) laid in late August to early November however summer rains may allow a second breeding period in January or February (Harrington, Maher and Baker-Gabb, 1988; Baker-Gabb, Benshemesh and Maher, 1989).

Plains-wanderer diet comprise a mix of fallen grass, chenopod and other seeds (50-60%) and Arthropods (40-50%) with foraging behaviours occurring during the day and dawn and dusk periods (Baker-Gabb, 1988). The diet and foraging behaviour are linked with their habitat requirements. Plains-wanderer requires bare ground to forage and vegetation clumps to provide cover (Baker-Gabb, 1988).

Major threats for the Plains-wanderer include historical loss of habitat due to clearing or overgrazing by stock. The species has a specific requirement for native grasslands and can be absent from areas where grass becomes too dense or too sparse (DoE, 2019). Due to their ground dwelling behaviour, the Plains-wanderer is also particularly susceptible to predation by feral cats and foxes.

Transect surveys were undertaken at the ideal time for observing Plains-wanderer; "autumn is the time when the greatest number of juveniles can be found if there has been successful breeding during the previous spring / summer" (Baker-Gabb et al, 2016).

Plains-wanderer were observed on Parks Victoria (PV) managed land approx. 20km from the study area over the Easter 2021 weekend (2 ~5 April 2021). The observation of adults, sub-adults and juveniles at the PV site supports the timing of the transect surveys at the study area. Figure 7.2 in EES Technical Report B: Fauna ecology impact assessment details the VBA records. No VBA records occur within Area 1 or Area 3 of the Project, however records exist between the Project area and Kangaroo Lake.

Of note was the extent of prey sources as likely predators of Plains-wanderer e.g., birds of prey, foxes, and feral cats. Mice and active mice nests were seen in high density throughout the study area as were rabbits. Foxes or fox activity was seen across the study area and a feral cat was seen in Area. There would be a considerable amount of predator pressure on ground dwelling birds. Plains-wanderer are considered particularly vulnerable to predation (Birdlife Australia, 2017).

Land management is based on a continuous cycle over the course of the year. The properties within the study area run a 3 to 4-year cropping cycle of wheat and barley and on the 3 or 4th year planting a legume for nitrogen fixing in the soil. The stubble is retained for soil stabilisation.

Seeding starts early April onwards using an Air tyne seeder. Herbicide is applied before they seed and as required when the weeds grow within the crop. Fertiliser is applied when seeding occurs. Stripping usually starts in November and goes through to December using a harvester.

There is a continuous cycle of heavy vehicle / equipment activity throughout the year that is likely to limit the suitability of stubble as viable habitat for Plains-wanderer. Based on our research, there has not been a Plains-wanderer record in areas that have a continuous cycle of cropping and soil improvement.

The site managed for Plains-wanderer by PV was previously used for grazing and consists of a mixture of native grassland and introduced pasture. PV manages the site for Plains-wanderer through low pressure grazing (Anon. 2021, pers comm., 2 June).

Based on the above information, a Significant Impact Test was not required.

Regent Parrot

The eastern subspecies of the Regent Parrot is restricted to a single population in the lower Murray-Darling basin region of South Australia, New South Wales and Victoria. The eastern Regent Parrot occurs in riverine, mallee woodlands and forests and the population is estimated to be no more than 1,500 adult breeding pairs. Like the Superb Parrot, it is heavily reliant on large River Red Gum trees within the Murray Darling Basin for breeding.

The Regent Parrot is predominantly reliant on River Red Gum forests and woodland for breeding. All known breeding colonies are located along the Murray River, Wimmera River floodplains or associated creeks and lakes. Nest trees are typically large (mean 160 cm DBH), tall (mean 28 m), mature, healthy River Red Gums with many hollows, usually close to water. Nests are mainly in hollow branches, 6–36 m above the ground.

They search for food on the ground or rest in large trees along rivers. They may travel long distances between roost sites and feeding grounds outside of the breeding season, however they are reluctant to fly over open areas. This is because they are vulnerable to predation by raptors particularly during the breeding season.

Vegetated corridors between nesting and foraging sites are acknowledged as extremely important for movement. They are known to use remnant woodlands along roadsides or in farm paddocks for movement and occasionally foraging, but rarely found in extensively cleared areas. Preferred food sources are seeds, but also known to eat buds, flowers, and occasionally insects. Most foraging occurs on the ground in mallee.

The nearest recent Regent Parrot public records were three individuals 30km northwest on the Murray River at Swan Hill in 2018 (Ebird 2023) and, 50km southwest near Jill Jill where five individual were recorded in 2023 (Ebird, 2023). The Swan Hill record is likely to be birds from the Redcliffs breeding area that have followed their preferred habitat of River Red Gums along the Murray River. The Jill Jill birds are likely to be from the Wyperfeld breeding population.

The woodlands found in within Area 1 and Area 3 of the Project are confined to canopy trees associated with mallee vegetation communities e.g., red mallee E. calycogona, black box E. largiflorens, dumosa mallee E. dumosa, oil mallee E. oleosa and bull mallee E. behriana. The Project area lacks the large hollow bearing River Red Gums within 120 m of water and vegetated flight corridors within 20km of the breeding areas. There is no suitable breeding within the mining areas or along the proposed pipeline route.

Vegetation connectivity for foraging is well outside acknowledged flight distances of 100 km from known breeding areas. The is also a lack of canopy tree connectivity from both these sites due to larger scale clearing of vegetation because of agricultural activities and a lack continuity of canopy trees along roadside reserves.

No Regent Parrot was observed during surveys undertaken as part of the fauna impact assessment. This is considered an artefact of the distance of the Project area from known breeding areas, lack of contiguous roadside vegetation used as flight corridors and behavioural characteristics such as avoiding cleared areas.

Based on this information, there were no triggers to undertake a Significant Impact Test and it is considered that the Project would not directly or indirectly impact on Regent Parrot.

Threatened flora

No EPBC Act-listed threatened flora species were recorded within 10 km of the Project area during the field assessment undertaken as part of EES Technical Report A: Flora vegetation impact assessment and no species are considered to have the potential to occur based on habitat suitability and a paucity of records.

Threatened ecological communities

The Plains Mallee Box Woodlands, listed as a threatened ecological community under the EPBC Act, would be impacted by the construction of the Project and underground water pipeline.

It has been estimated that prior to the implementation of mitigation measures, a total extent of 11.347 ha of Plains Mallee Box Woodlands would be lost during the construction of the Project.

This conservative calculation is based on the removal of all native vegetation associated with the construction of the Project. The removal of Plains Mallee Box Woodlands would be confined to approximately 6.8 Ha within Project mining areas (Area 1 and Area 3), 0.27 ha at the transport intersections and 4.7 ha along the proposed pipeline alignment. The extent of impact to the Plains Mallee Box Woodland community along the pipeline alignment is confined to the 'loss' of 61 large trees in patches. The trees have been assumed as lost based on the Guidelines for the removal, destruction or lopping of native vegetation (DELWP 2017), however the understorey and groundcover component would be retained in-situ and would continue to provide habitat for fauna species.

As discussed in Section 20.4.2 -

Significant impact criteria for vulnerable species	Criteria met?	Discussion
An action is likely to have a significant impact	on a vulnerabl	e species if there is a real chance or possibility that it will:
		Potential impacts are unlikely to result in long-term decline of the species.
		Note that the presence of Growling Grass Frog does not constitute an Important Population as defined in the Significant Impact Guidelines (DEWA 2009).
		An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:
		key source populations either for breeding or dispersal
		 populations that are necessary for maintaining genetic diversity, and/or
		 populations that are near the limit of the species range.
	No	Notwithstanding this site does not meet this criteria, a significant impact test was undertaken. The results are outlined below.
Lead to a long-term decrease in the size of an important population		The construction footprint of the pump station at Kangaroo Lake would be relatively small. The nearby aquatic vegetation consists of a 2-4 m wide monoculture of Common Reed. The installation of the pipeline is on the road verge and does not impact on Growling Grass Frog habitat. A fauna spotter will be on-site during all the works to move any fauna from the construction footprint.
		The terrestrial construction footprint of the proposed pump station adjacent to Kangaroo Lake is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).
		The removal of this vegetation is not considered to be significant.
		Operation of the pump station may result in entrainment or impingement of aquatic species. The pump station screen would be designed to Australian best practice standards and able to effectively protect smaller fish from entrainment and impingement.
		Habitat in the lake is best characterised as open water mostly fringed by dense emergent vegetation consisting namely of reeds such as Common Reed or Cumbungi (<i>Phragmites australis</i>) and Bullrush (<i>Typha sp.</i>).
Reduce the area of occupancy of an important population	No	The construction footprint of the pump station at Kangaroo Lake would be relatively small. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum). Potential aquatic habitat removal would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed.
Fragment an existing important population into two or more populations	No	The construction footprint is confined to a small area adjacent to the No. 4/7 Channel inlet. Habitat in this area is considered low quality. More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake.

Table 20-11 Significant impact assessment for Murray Cod and Growling Grass Frog

Significant impact criteria for vulnerable species	Criteria met?	Discussion
Adversely affect habitat critical to the survival of a species	No	The habitat present is not habitat critical to the survival of the species. In the vicinity of the pump station, fringing vegetation consisted of a 2-4 m wide monoculture of Common Reed, which reduced in thickness and density into the No. 4/7 Channel. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).
Disrupt the breeding cycle of an important population	No	Removal of Common Reed would not disrupt the breeding cycle of aquatic species. More complex and extensive habitat exists in other parts of Kangaroo Lake.
Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No	This impact is unlikely. The construction footprint is confined to a small area adjacent to the No. 4/7 Channel inlet. Potential habitat removal would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed. More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No	Disease, pest and hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
Introduce disease that may cause the species to decline	No	Disease, pest and hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
Interfere substantially with the recovery of the species	No	This impact is unlikely. Potential impacts are restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed. Entrainment and impingement controls would mitigate the unwanted passage of fish or small aquatic organisms through the water intake.

Terrestrial species, it is unlikely that impacts would result in a significant removal of potential habitat or cause any significant change to the network of remnant vegetation along road reserves that allow conservation significant species, in particular birds, to move across the landscape to larger conservation reserves. The removal of native vegetation during Project construction is not considered to impact habitat critical to the survival of EPBC-listed fauna species, such as Superb Parrot.

The Project mining areas and the proposed pipeline route are presented in **Figure 20-2**. Specific information on where this threatened ecological community occurs within the Project mining areas and along the proposed pipeline route is provided in EES Technical Report A: Flora vegetation impact assessment.

The listing of Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions occurred in June 2021, post the determination of the Project as a 'controlled action' in 2019. The EPBC Act Policy Statement: *Listing events under the EPBC Act* (DSEWPac, n.d) states that "*for listing events that occur after a section 75 decision is made section 158A of the EPBC Act provides that approval process decisions under Parts 7-9 of the EPBC Act will not be affected by the listing event. That is, the listing event does not need to be considered." Any potential impacts to this community have been quantified even though they are not considered a threatened ecological community and no offsets under the EPBC Act for this listed community will apply.*

Nonetheless, under Victorian State guidance, offsets are required for the removal of native vegetation, including Plains Mallee Box Woodlands. The offset target for the proposed removal of native vegetation for this project totals 4.819 general habitat units (GHU) plus 568 large trees (mallee trees), in an area with a strategic biodiversity value score of at least 0.179 in the North Central CMA region and/or Gannawarra Shire.

Once offsets are secured, the impacts of the Project to native vegetation will be in line with the over-arching objective of the Victorian native vegetation retention controls, namely, that there will be 'no net loss' of biodiversity as a consequence of native vegetation removal for the Project.

Management and mitigation measures

Opportunities to avoid impacts on native vegetation were adopted during the EES process for Area 1 and Area 3 leading to retention of native vegetation, including Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions. The retention comprises:

- Area 1 14.02 ha of patches of Woorinen Mallee (EVC 824), the majority of which were identified as the EPBC Act listed community.
- Area 3 21.83 ha of patches of Woorinen Mallee (EVC 824) which were identified as the EPBC Act listed community.

This was achieved by the careful siting of mine infrastructure to avoid native vegetation, retaining trees along boundaries by appropriate buffers from infrastructure and careful siting of access routes within the mine site to avoid lines of trees. Additionally, the protection of native vegetation can also be achieved along the pipeline route by moving the pipeline corridor to the centre of the road or to an opposite roadside to native vegetation (refer to EES Technical Report A: Flora impact assessment).

It is anticipated that the extent of native vegetation impacted during construction activities would be further reduced by the implementation of mitigation measures. These mitigation measures would include engaging an arborist to assist with micro-siting the underground pipeline and to identify additional measures to avoid adverse impacts to structural root zones and safeguard trees at the mine site and along the pipeline alignment. This assistance from an arborist would help to ensure that the pipeline is located to avoid and minimise impacts to existing native vegetation so far as reasonably practicable. Measures to protect native vegetation to be retained would also be implemented and would include the establishment of vegetation and tree protection zones. This would reduce the total impact to native vegetation and the number of trees removed.

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impacts

Residual impacts to threatened ecological communities from the construction of the Project is expected to be high, with consideration to the loss of a total extent of 11.347 Ha of Plains Mallee Box Woodlands. As described in Section 20.4.2 -

Significant impact criteria for vulnerable species	Criteria met?	Discussion			
An action is likely to have a significant impact	on a vulnerabl	e species if there is a real chance or possibility that it will:			
		Potential impacts are unlikely to result in long-term decline of the species.			
		Note that the presence of Growling Grass Frog does not constitute an Important Population as defined in the Significant Impact Guidelines (DEWA 2009).			
		An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:			
		key source populations either for breeding or dispersal			
		 populations that are necessary for maintaining genetic diversity, and/or 			
		• populations that are near the limit of the species range. Notwithstanding this site does not meet this criteria, a significant impact test was undertaken. The results are outlined below.			
Lead to a long-term decrease in the size of an important population	No	The construction footprint of the pump station at Kangaroo Lake would be relatively small. The nearby aquatic vegetation consists of a 2-4 m wide monoculture of Common Reed. The installation of the pipeline is on the road verge and does not impact on Growling Grass Frog habitat. A fauna spotter will be on-site during all the works to move any fauna from the construction footprint.			
		The terrestrial construction footprint of the proposed pump station adjacent to Kangaroo Lake is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).			
		The removal of this vegetation is not considered to be significant.			
		Operation of the pump station may result in entrainment or impingement of aquatic species. The pump station screen would be designed to Australian best practice standards and able to effectively protect smaller fish from entrainment and impingement.			
		Habitat in the lake is best characterised as open water mostly fringed by dense emergent vegetation consisting namely of reeds such as Common Reed or Cumbungi (<i>Phragmites australis</i>) and Bullrush (<i>Typha sp.</i>).			
Reduce the area of occupancy of an No important population	No	The construction footprint of the pump station at Kangaroo Lake would be relatively small. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum). Potential aquatic habitat removal would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed.			
Fragment an existing important population into two or more populations	No	The construction footprint is confined to a small area adjacent to the No. 4/7 Channel inlet. Habitat in this area is considered low quality. More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake.			

Table 20-11 Significant impact assessment for Murray Cod and Growling Grass Frog

Significant impact criteria for vulnerable species	Criteria met?	Discussion
Adversely affect habitat critical to the survival of a species	No	The habitat present is not habitat critical to the survival of the species. In the vicinity of the pump station, fringing vegetation consisted of a 2-4 m wide monoculture of Common Reed, which reduced in thickness and density into the No. 4/7 Channel. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).
Disrupt the breeding cycle of an important population	No	Removal of Common Reed would not disrupt the breeding cycle of aquatic species. More complex and extensive habitat exists in other parts of Kangaroo Lake.
Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No	This impact is unlikely. The construction footprint is confined to a small area adjacent to the No. 4/7 Channel inlet. Potential habitat removal would be restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed. More complex habitat of a greater extent is present in other parts of Kangaroo Lake, including the southwest corner of Kangaroo Lake. The terrestrial construction footprint of the proposed pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and is predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (Echium plantagineum).
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No	Disease, pest and hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
Introduce disease that may cause the species to decline	No	Disease, pest and hygiene controls would be employed to mitigate this potential impact. This impact is unlikely.
Interfere substantially with the recovery of the species	No	This impact is unlikely. Potential impacts are restricted to fringing vegetation consisting of a 2-4 m wide monoculture of Common Reed. Entrainment and impingement controls would mitigate the unwanted passage of fish or small aquatic organisms through the water intake.

Terrestrial species, residual impacts to threatened fauna species, such as the Superb Parrot, are not expected to be significant considering the relatively small percentage of native vegetation and fauna habitat being removed relative to the native vegetation and fauna habitat mapped as part of the native vegetation and flora impact assessment.

A significant Impact test was not undertaken for species associated with the Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community given that its EPBC listing occurred post the determination of the Project as a 'controlled action.' Under Victorian State guidance, offsets are required for the removal of native vegetation. This would include Plains Mallee Box Woodlands.

20.4.3 Nuclear actions

The Project will be assessed against the applicable criteria specified in Clause 22(1) (e) and (g) of the EPBC Act, by looking at the radiological properties and quantities of Project wastes and product.

Assessment against this criteria indicates that the Project would not have significant radiological impacts.

Radiological properties of product and waste

The Project will be implemented across three phases with varying process streams (refer to **Section 20.1.3**). The Project will also mine two areas. Mining Area 1 ore has higher uranium and thorium concentrations compared to Area 3 ore.

During processing, uranium and thorium can concentrate in materials, and secular equilibrium can be disturbed. Sections of the processing facility will contain radioactive materials and will require radiation protection controls and management.

The radionuclide activity concentrations for product material (produced from Area 1 ore) are listed in **Table 20-13**. Where materials are not in secular equilibrium, the concentration of the decay product has been included.

Phase 1	Material	Activity Concentration (Bq/g)							
		U-238	Pb-210	U-235	Ac-227	Th-227	Th-232	Ra-228	
-	Ore	0.28	-	-	-	-	0.54	-	
1	REMC	40.7	-	-	-	-	156	-	
	Zircon Titania HMC	2.98	-	-	-	-	1.13	-	
1A	MREC	< 0.07	-	-	1.77	1.77	< 0.023	-	
	Zircon Titania HMC	2.98	-	-	-	-	1.13	-	
2	MREC	< 0.07	-	-	1.77	1.77	< 0.023	-	
	Low Chrome Ilmenite	0.50	0.53	0.02	-	-	0.64	-	
	HiTI/Rutile	1.0	-	0.08	-	-	0.48	-	
	Leucoxene	0.92	awaiting furt	her analyses			0.88	-	
	Zircon	7.6	6.9	0.31	-	-	1.6	-	
	Zircon concentrat e	8.2	awaiting further analyses				3.0	-	
-	Tailings Phases 1a & 2	0.14	-	-	-	-	0.54	-	

 Table 20-13 Radionuclides in products and waste steam for Area 1 ore

EPBC Act Clause 22(1)(e) – Disposal facility for radioactive waste

The waste streams from all circuits of the processing plants will be homogenised and radionuclides will be in chemically stable forms before being returned as a Tailings Stream to the ore zone of the mine pit void. Test work has indicated that the mined material and subsequent tailings waste streams do not exceed the criteria for being defined as radioactive.

The tailings produced in Phase 1 will contain lower uranium and thorium concentrations than Phases 1a and 2, due to the high concentration of uranium and thorium in the REMC product. The concentrations of uranium and thorium in the Phase 1a and Phase 2 Tailings stream is listed in **Table 20-13**, and are less than those of the ore.

With regards to Clause 22(1)(E) of the EPBC Act, the Project's tailings are not classified as radioactive, therefore Clause 22(1)(e) of the EPBC Act is not triggered.

EPBC Act Clause 22(1)(g) – Storage of radioactive material

There will be interim contained storage of products onsite prior to transportation offsite. The Victorian Radiation Regulations provide activity limits which, in conjunction with the activity concentration of the product (**Table 20-13**) enable calculation of the maximum quantities of each material that can be stored on site before exceeding the levels provided in the EPBC Act. The calculated maximum quantities of materials to be stored on site prior to shipping, the EPBC Act Level material quantity, and the on-site storage methods are detailed in **Table 20-14**.

		Product storage (t)			
Phase	Material	Maximum to be Stored at Project	EPBC Act Level Material Quantity	Storage method	
1	REMC	300	5.1	Surge bin and in bulk bags in lined shipping containers	
	Zircon Titania HMC	5,625	243	Stockpile in buildings and lined shipping containers	
1A	MREC	300	513	Product bin and bulk bags in lined shipping containers	
	Zircon Titania HMC	5,625	243	Stockpile in buildings and lined shipping containers	
2	MREC	300	513	Product bin and bulk bags in lined shipping containers	
	Low Chrome Ilmenite	1,525	854	Product bins and lined	
	HiTI/Rutile	500	676	snipping containers	
Leucoxene		100	556		
	Zircon	1,525	109		
	Zircon concentrate	300	89		

Table 20-14 Material storage quantities and storage method

With regards to the EPBC Act Nuclear Action Clause 22(1)(g), the quantities of Phase 1 - REMC and Zircon Titania HMC, Phase 1a - Zircon Titania HMC, and Phase 3 – Zircon and Zircon concentrate, to be stored on site, prior to shipping exceed the EPBC Act levels. However, these materials will be contained as detailed in **Table 20-14**. to ensure no emission of products, and access will be restricted.

Environment and members of public

All mineral separation, processing and packaging will occur in enclosed building with bunding, sumps and bag house dust extraction to minimise likelihood of release of materials to the environment. Project increment radiological changes to the environment, doses to non-human biota and members of the public have been conservatively determined and are presented in **Table 20-15** and **Table 20-16**.

Further information is provided in EES Technical Report N: Radiation.

Table 20-15 Project increment radiological changes to the environment and doses to non-human biota

Parameter	Conservative Pro (mSv/y – unless	ject Impact Radiological Dose otherwise indicated)	Comparison		
Flora & Fauna – ERICA Assessmen	Screening level for further investigation (µGy/h)				
Lichen & Bryophytes (highest impact species)	0.466 µGy/h		10		
Environmental changes – Assessment using dust modelling data and baseline radiological data				Current Soil / Crop (Bq/kg)	
Soil	U _(nat) (Bq/kg)	Th _(nat) (Bq/kg)	U-238	Th-232	
	0.968	1.82	25	37	
Crops	U-238 (Bq/kg)	Ra-228 (Bq/kg)	U-238	Ra-228	
(nighest isotope)	0.007	0.012	0.134	0.198	
Environmental changes –Metallurgical test work, baseline radiological data, engineering and operational procedures				Highest measured (Bq/L)	
Groundwater	Expected to be neg	Ra-226	Ra-228		
Giouliuwalei	0.635	1.16			

Table 20-16 Project doses to members of the public

Parameter	rameter Conservative Project Impact Radiological Dose (mSv/y – unless otherwise indicated)					Comparison		
Member of Public Doses – Air Quality modelling, radiological composition of products, transportation parameter, dose assessment								
	Receptor Location	1 Y	5 Y		10 - 15 Y		Adult	
Project Receptors	Closest Receptor	0.125	0.13		0.192		0.095	1
	All Receptors - Range	0.036 - 0.125	0.036 – 0.135		0.037 – 0.192		0.035 – 0.095	
	All Receptors - Median	0.038	0.039	Ð	0.042		0.037	
	Receptor Location	Phase 1 product		Phase 1a Product		Phase 2		
	Closest receptor Ultima	0.80		0.02		0.12		
Transport	Vehicle at train crossing	2.3 x 10 ⁻⁴						
Receptors	Residence adjacent to transport route	0.006						
	Vehicle from truck	0.023						
	Vehicle parked beside truck	0.010	0.010					

As described in **Table 20-15** and **Table 20-16**, radiological impacts to Flora and Fauna are demined to be insignificant. All conservative Project impact radiological doses were reported below comparison limits. Changes to soil, crops and groundwater are negligible and are below comparison limits and all member of public doses are below member of public limits. The radiological impact of the Project to the environment is assessed as being very low.

Management and mitigation measures

Mitigation measures to minimise the potential for radiological impacts include the following:

- Project to be operated in accordance with a management licence addressing radiation safety in accordance
 with the provisions of the Radiation Regulations, including likely conditions such as compliance with the
 Radiation Protection Series No. 9 and preparation of a radiation sub-plan for all operations. The plan would
 account for any special conditions or exemptions from specific provisions of the Radiation Regulations that
 might apply to the Project.
- A wheel wash and vehicle washdown bay would be established to minimise the spread of potential contamination around the site and off the site.
- The processing facility will be constructed with spillage containment. This includes all tanks having concrete bunds, as secondary containment, to store at least the volume of the tank [Vic EPA 2018].
- Provision for hose down facilities and sumps, access ways and sufficient room for bobcats for clean up under conveyors.
- Tailings pipelines will be fitted with a leak detection system that will turn off pumps if a pipe failure is detected
 – with a schedule of preventative maintenance and inspection to be established for pipelines carrying radioactive process materials.
- Dust minimisation and suppression system within process plant with a schedule of preventative maintenance and inspection to be established for areas with radioactive process materials.
- All product packing will occur within building, including the use of a packing booth for REMC.

Mitigation measures are presented in EES Chapter 21: Environmental management framework.

Residual impacts and monitoring

There would be no residual radiation impact as a result of the Project.

20.5 Conclusion

On 19 December 2018, the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW), determined the Project to be a controlled action under the EPBC Act. The relevant controlling provisions for the Project include Kerang Wetlands (a wetland of international importance), listed threatened species and communities and nuclear actions.

An underground water supply pipeline would be constructed between Kangaroo Lake, part of the Kerang Wetlands Ramsar site, and the Project mine site to supply up to 4.5 GL of water per year for start-up and commissioning, with a steady state during operations of between 2.9 to 3.1 GL/year. A pump station would be constructed at Kangaroo Lake to facilitate the supply of water. In the vicinity of the proposed pump station, fringing vegetation consists of a 2-4 m wide monoculture of Common Reed, which reduces in thickness and density into the No. 4/7 Channel. The small, terrestrial footprint of the pump station is highly disturbed and includes spoil (assumed to be from channel clearing) and predominantly covered in weed species including exotic grasses, thistles and Patterson's curse (*Echium plantagineum*). There would be no impact to matters of national environmental significance from the construction of the pump station.

During operation, the maximum Project water demand would represent only a 8% increase on Kangaroo Lake's current average daily demand and as such, the additional water usage as a result of Project operations is likely to have negligible impact to Kangaroo Lake's water height, aquatic habitat and salinity. To minimise the potential for the entrainment of fish and small aquatic organisms, the pump station would include an angled fish screen on the inlet that is designed to Australian best practice standards. The Project would have a negligible impact to habitat and potential food sources for waterbirds at Kangaroo Lake and the remaining 22 named lakes, marshes and swamps of the Kerang Wetlands would not be impacted by the Project.

An individual Superb Parrot was recorded in proximity to the Project in 2018. This individual is likely to be a vagrant and / or immature dispersing male and the Project would be located over 100 km to the west of the currently recognised distribution of this species. Therefore it is considered that residual impacts to the Superb Parrot are not expected to be significant.

While listed EPBC Act fauna species, such as the Superb Parrot, may utilise remnant vegetation surrounding the Project area to move across the landscape, impacts to native vegetation would be limited. Approximately 7 Ha of native vegetation, 470 large trees in patches, 37 large scattered trees and 14 small scattered trees would be removed from Project mine areas and transport intersections during construction activities. This represents approximately 1.3% of the native vegetation and fauna habitat and 1.13% of the total number of trees mapped within the study area. The impact to roadside vegetation along the pipeline alignment would be confined to a loss

of 61 large trees in patches, however this loss represents potential encroachments on the tree protection zone and these 61 large trees in patches would remain in-situ to continue to providing habitat for fauna species. As such, it is unlikely that the Project would result in a significant removal of potential habitat or cause any significant change to the network of remnant vegetation along road reserves that allow conservation significant species, in particular birds, to move across the landscape to larger conservation reserves.

Prior to the implementation of mitigation measures, a total extent of 11.347 Ha of Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions would be lost during the construction of the Project. This conservative calculation is based on the removal of all native vegetation associated with the construction of the Project. The listing of Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions occurred in June 2021, post the determination of the Project as a 'controlled action' in 2019. Nonetheless, mitigation measures would be implemented to minimise impacts to native vegetation. An arborist would be engaged to micro-site the water supply pipeline and to identify additional measures to avoid adverse impacts to structural root zones and to safeguard trees at the Project mine site and along the pipeline alignment. Vegetation and tree protection zones would also be established during construction of the Project to reduce the total impact to native vegetation and the number of trees removed. Under Victorian State guidance, any removal Plains Mallee Box Woodlands would require offsets and these would be secured under the relevant State legislation.

The assessment of radiological impacts determined that the Project's tailings would not be classified as radioactive and that Project increment changes to the environment, including soil, crops and groundwater, are negligible. All conservative Project impact radiological doses to the environment, non-human biota and members of the public were reported below comparison limits. The storage of radioactive material exceeds EPBC Act levels, however the materials would be contained appropriately to ensure no emission of products.

Overall, no significant impacts are anticipated for MNES protected under the EPBC Act. The implementation of mitigation measures proposed for the Project, as summarised in EES Chapter 21: Environmental Management Framework, would ensure all potential impacts are minimised.

20.6 References

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