



CHAPTER 12

VEGETATION, WEEDS AND PLANT PATHOGENS



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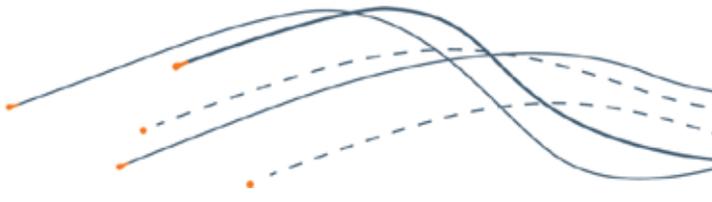
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12 Vegetation and Weeds

The landscape of the proposed CEIP mine site is dominated by agriculture and supports fragmented, degraded and isolated patches of remnant vegetation, providing restricted habitat opportunities for native flora species. The ecological integrity of the region is further degraded as a result of historic grazing and the presence of weeds and feral and pest animal species.

The area of the proposed mining lease (the mine site) is surrounded by agricultural land, with the Hambidge Wilderness Protection Area (WPA) approximately 3.6 km to the southeast of the mine site boundary and a series of dry playa 'salt' lakes known as Lake Warrambo located approximately 1.2 km to the north of the mine site boundary. As groundwater modelling undertaken for the project indicates there is potential for groundwater drawdown to occur in the vicinity of the Lake Warrambo complex, the ecological values and potential impacts to Lake Warrambo are considered in this chapter. Potential impacts to the Hambidge WPA were investigated as part of the groundwater impact assessment, but no impacts are anticipated as a result of the proposed mine development (construction, operation or closure). Other potential impacts to the Hambidge WPA are considered as part of Iron Road's Environmental Impact Statement for the proposed CEIP Infrastructure and are not dealt with in this document.

This chapter describes the effects the proposed mine will have on vegetation condition and native flora species within the mine site and in adjacent areas where potential impacts exist. This chapter also describes the effects of weed species which have the potential to further degrade ecological values. It discusses specific design modifications and management measures to be implemented to minimise impacts on native flora, including minimising the design footprint of the project and staged vegetation clearance and rehabilitation. High level concepts for providing a Significant Environmental Benefit (SEB) as required under the Native Vegetation Act 1991 are considered. This chapter also assesses the effectiveness of these measures and the residual impacts upon and risks to, native flora species with a focus on conservation significant species listed under State and Commonwealth legislation.

12.1 Applicable Legislation and Standards

Threatened flora species and some vegetation communities within South Australia are protected (as indicated by legislatively established Conservation Status) both at the Commonwealth and State levels via the following legislation:

- *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (Commonwealth)
This Act prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas. Under the environmental provisions of the EPBC Act, actions that are likely to have 'significant impact' on a matter of National Environmental Significance require assessment and approval by the Commonwealth Environment Minister. There are nine matters of national environmental significance identified under the EPBC Act.

Aspects of this Act that are relevant to vegetation include conservation listings for Threatened Flora species and Threatened Ecological Communities. Categories of threat include Critically Endangered, Endangered and Vulnerable.

A referral of the proposed mining lease pursuant to Section 68 of the EPBC Act was made on 30 September 2014. The proposed mining lease was declared to be 'not a controlled action' and therefore approval under the EPBC Act is not required.

- *National Parks and Wildlife Act, 1972* (Schedules 7, 8 and 9 of the Act) (NPW Act) (SA)
This Act provides for the protection of flora habitat through the establishment of parks and reserves (both on land and in State waters) and provides for the use of vegetation through a system of permits allowing certain actions, i.e. keeping, selling, trading, harvesting, farming and the destruction of native species.
This Act also assigns flora species to state conservation categories; Endangered (Schedule 7), Vulnerable (Schedule 8) and Rare (Schedule 9).
- *Natural Resource Management Act, 2004* (NRM Act) (SA)
This Act is to assist in the achievement of ecologically sustainable development in the State by establishing an integrated scheme to promote the use and management of natural resources that recognise and protects the intrinsic value of natural resources, including native flora and fauna, soils, water resources and the coastal environment.
This Act also sets out the legal framework for management of pest plants and animals. Pest plants that are a significant threat to agriculture, native flora and fauna and public health and safety are called 'Declared' plants. Under this Act landowners have a legal responsibility to manage pest plants. In addition, the Act sets out a framework for banning the sale of Declared weeds, controlling the movement of Declared weeds, destroying or controlling infestations of Declared weeds and notifying authorities when an infestation is detected.
The CEIP Mine falls within the authority of the Eyre Peninsula Natural Resource Management (NRM) Board, which is the relevant authority administering the NRM Act.
- *Native Vegetation Act, 1991 (NV Act) and Native Vegetation Regulations, 2003* (SA)
This Act controls the clearance of native vegetation and provides incentives and assistance to landowners and proponents in relation to the preservation and enhancement of native vegetation. Broad objectives of this Act include:
 - The conservation, protection and enhancement of the native vegetation of the State and in particular, remnant native vegetation, in order to prevent further reduction of biological diversity and degradation of the land and its soil, loss of quantity and quality of state vegetation and loss of critical habitat.
 - Provision of incentives and assistance to landowners for preservation and management of vegetation.
 - Limitations on clearance of native vegetation.
 - Encouragement of research into protection and management of vegetation.
 - Encouragement of re-establishment of native vegetation in areas where vegetation has been cleared or is degraded.
 - Sets out principals of clearance and if permitted, details conditions and requirements for a Significant Environmental Benefit (SEB) to be made to counter the loss of habitat and impacts to biodiversity.

The Department of State Development (DSD) currently has delegation for the administration of the NV Act for native vegetation clearance undertaken as part of mine developments.

For more detail about the application of these Acts, refer to Chapter 4.

12.2 Assessment Method

An assessment of the proposed mining lease study area, including vegetation composition, habitat condition and conservation status of flora species was conducted in the Spring of 2011 and updated in 2014 to reflect a revised proposed mining lease boundary (Appendix J – Jacobs 2014a, Mine Terrestrial Ecology Technical Report). The assessment involved desktop analysis and a detailed in-field flora (and fauna) survey. Floristic information for the study area and region was also gathered during an additional survey of Lake Waramboo (2014) and several vegetation surveys undertaken for the environmental impact statement associated with the broader project (2012, 2013). These additional studies described vegetation composition and condition of vegetation, including presence of weeds and general disturbance. In addition, the assessment considered regional literature (e.g. Biodiversity Plans, Biological Surveys, Threatened Flora of the Eyre Peninsula and the Bush Condition Monitoring Manual for the Eyre Peninsula Region) when considering the potential for species to occur (DEH 2002, Brandle 2010, Pobke 2008 and Milne, Croft and Pedler 2008).

12.2.1 Desktop Review

Desktop investigations were undertaken to identify the possible occurrence of threatened species, conservation significant ecological communities or exotic species of particular significance, at the mine site through a search of the EPBC Act Protected Matters Database and the historical species records in the Biological Database of South Australia (BDBSA). The EPBC Protected Matters Search was conducted using a 5 km buffer zone around the mine site and compared to BDBSA records within the same search area as well as the larger Exploration Licence (EL 4849) area. This expanded search area provided a greater spread of flora records across comparative landscapes to the area of interest and provided a greater dataset for analysis in a region where there is a general paucity of records. The search precluded records from Pinkawillinie Conservation Park and the majority of Hambidge WPA, both located approximately 4-20 km from the proposed mine site. The inclusion of data from these areas would skew the results and provide an unrealistic indication of species potentially present in the study area, particularly given the habitat in conservation areas is not representative of the condition of the habitat at the mine site. The data comprised flora records, including threatened species and ecological communities.

12.2.2 Field Surveys

Field studies targeted remnant vegetation patches which represented the most intact habitat in the study area to maximise native flora observations within the mine site. The survey was undertaken at the optimum time of year and established a baseline of the site's ecology by assessing 15 sites across the mine site, describing vegetation condition, habitat value and landform. Broadly, methodologies followed vegetation guidelines developed for the Biological Survey of South Australian (Heard and Channon 1997) (see Appendix J for further detail). The surveyed sites were also representative of the habitat types present across the whole mine site, thus providing an indication of actual species or ecological communities of conservation significance at potential risk from the proposed development. The location of the 15 survey sites is shown on Figure 12-1. Sites 1 to 5 were detailed flora and fauna sites, whilst sites A to J were targeted flora survey sites.



Plate 12-1 Field Ecologist Collecting Floristic Data

12.2.3 Condition

The condition of the vegetation within the mine site was assessed in the field as part of the flora survey (Appendix J). In addition, some patches of vegetation were assessed as part of surveys for the infrastructure corridor (Jacobs 2014b). The average condition of the remaining native vegetation within the mine site has been inferred based on proximity to assessed patches, vegetation density via aerial imagery, size and contiguity of patch, surrounding land use and DEWNR vegetation layer (DEWNR 2011).

A key component of this assessment was the determination of vegetation condition and the assignment of a preliminary 'Significant Environmental Benefit' (SEB) ratio to calculate the overall requirement for an environmental offset (as per the NV Act) to compensate for the clearance of native vegetation habitat as a result of the project. Habitat condition of remnant native vegetation patches was derived from criteria outlined by DWLBC (2005). Condition categories are presented in Section 12.3.2; where 10:1 represents excellent condition, 8:1 is good, 6:1 is moderate, 4:1 is poor and 2:1 is very poor. Further details of the proposed SEB for the project are provided in Section 12.6 and 12.7.

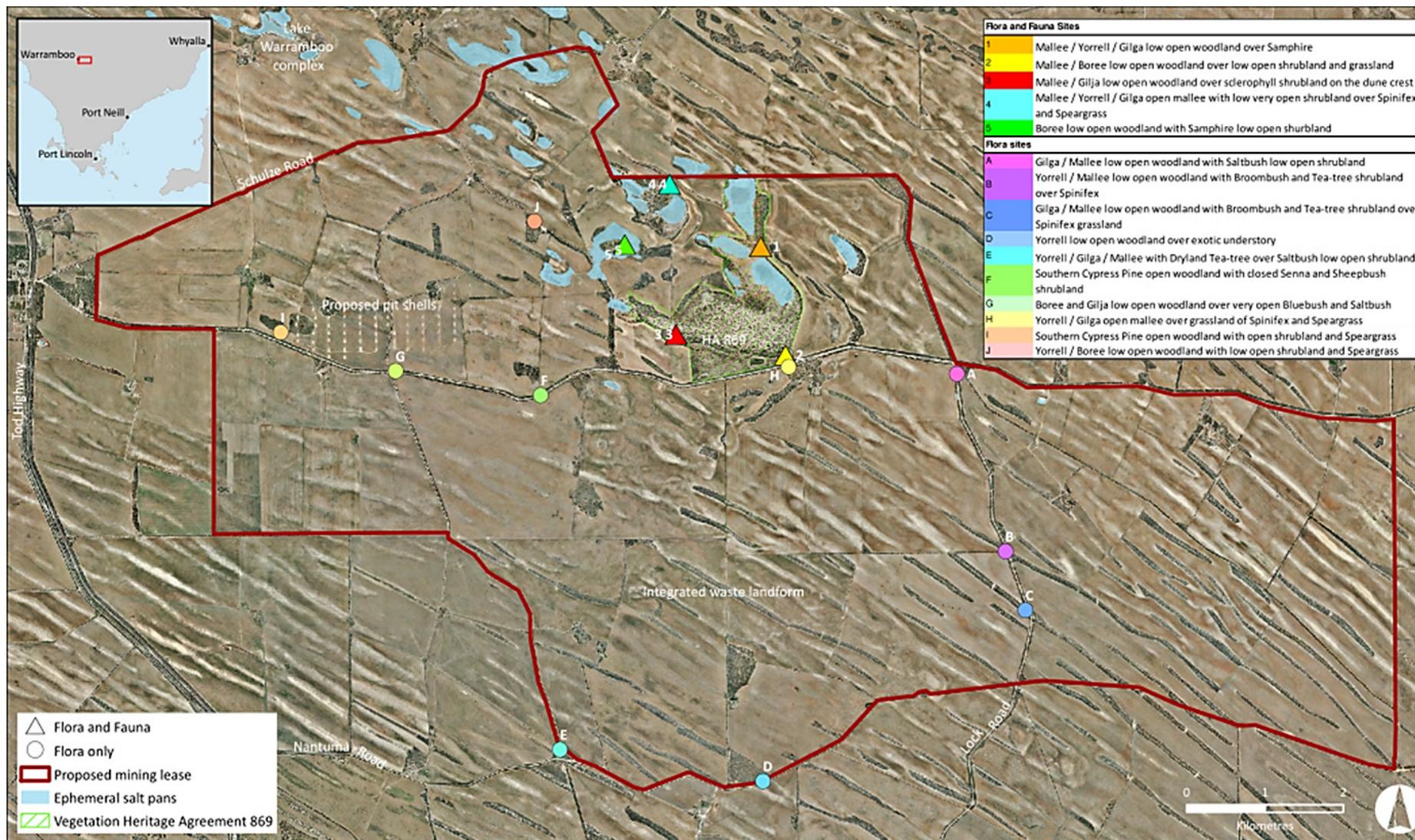


Figure 12-1 Location of Survey Sites within the Proposed Mining Lease Area

In addition, a survey of the Lake Warrambo Complex (see Section 12.3.7) was undertaken to determine the vegetation communities present, habitat condition and identify the potential for flora and fauna (including conservation significant species) to utilise the habitat.

12.3 Existing Environment

This section provides an overview of the existing environment within and surrounding the mine site in relation to native vegetation, weeds and pest pathogens and a summary of the predicted impacts and risks of the project to native flora. Flora habitat and species of particular conservation significance are also discussed.

12.3.1 Regional Context

The mine site is located within the Eyre Mallee subregion of the Eyre Yorke Block (EYB) bioregion as described by the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell 1995). The landscape of the wider EYB bioregion is unique and varied, comprising limestone rolling plains, granite inselbergs, coastal and inland wetlands, salt lakes, ephemeral lakes, stands of mangroves and offshore islands. The EYB bioregion contains the transition from semi-arid to arid ecological communities, with at least 25 plant species endemic to the bioregion. Habitat fragmentation and degradation are key threatening processes for native flora as a result of the significant clearance of native vegetation for agriculture and grazing. Feral animals and introduced stock, present substantial threats to native habitat and flora species through grazing, trampling and weed spread. Competition from aggressive exotic weed species such as bridal creeper, wild oats and veldt grass presents a further threat to habitat values in the bioregion (DEH 2002, Brandle 2010).

As discussed in Chapter 11, the Eyre Mallee subregion has the highest biodiversity within the EYB (DEH, 2002). The vegetation of this subregion occurs on undulating calcareous plains which are overlain by quartz sands and widely spaced low sand dunes. Dominant vegetation formations found in the sub-region include Mallee low woodland and shrubland, tea-tree low woodland and chenopod low shrubland. A large proportion of the remnant native vegetation in the region has been cleared for agriculture and habitat for flora species is now typically found as comparatively small, disjunct remnant blocks within farmland, often restricted to dune crests. Regional exceptions are Pinkawillinie Conservation Park and Hambidge WPA.

Plate 12-2 below depicts some of the vegetation of the bioregion that occurs on dunal crests, note cleared areas in the background.



Plate 12-2 Broad Landscape of the Eyre Mallee Subregion

Regional Vegetation Association

Within the Eyre Mallee subregion, the study area falls within the Koongawa Environmental Association (Laut et al. 1977). This vegetation association is characterised as an undulating plain with parallel dunes and occasional quartzite or granite inselbergs. Most of the plains and dunes have grassland cover used for rotation cereal cultivation and livestock grazing. The remainder retains a cover of open mallee scrub of Ridge-fruited Mallee, Narrow-leaved Mallee or Broombush which is used for light cereal cultivation (Laut et al. 1977). This association has moderate remnancy (35%) of which greater than 49% (92,027 ha) is protected in reserves, parks or Heritage Agreements (DEWNR 2013). Heritage Agreements are private conservation areas, where an agreement has been made between the landholder and the Minister for Sustainability, Environment and Conservation.

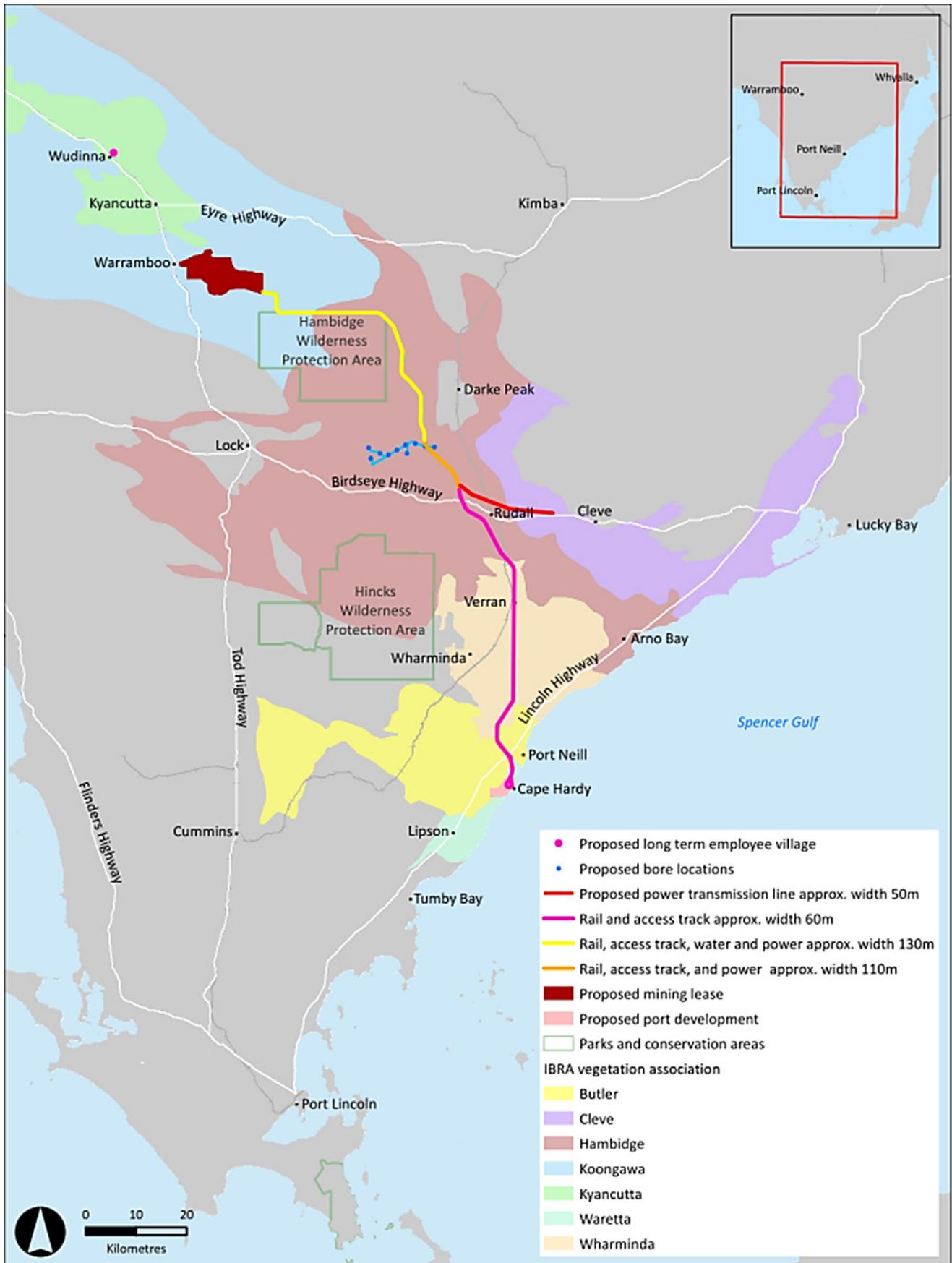


Figure 12-2 IBRA Environmental Associations of the Eyre Peninsula

12.3.2 Vegetation Type and Condition

Typical of the district, a large proportion of the mine site has been historically cleared for agriculture and remnant vegetation is restricted to scattered and isolated patches of varying size on farmland or as roadside vegetation. The mine site is approximately 8,458 ha, of this 1,118 ha has been mapped as native vegetation (approximately 13%) and the remaining 87% comprises cleared agricultural land dominated by exotic species as well as roads and housing (DEWNR 2011, Appendix J). Larger areas of the native vegetation representing habitat for individual native flora species are found on the northern (central) portion of the mine site including a group of larger (though degraded) patches which comprise Vegetation Heritage Agreement 869 (HA 869) (Figure 12-1).

The vegetation condition across the mine site has been heavily influenced by the significant clearance and ongoing agricultural practices immediately adjacent to and often completely surrounding, each patch of native vegetation. Vegetation condition therefore varies considerably with the size of the remnant patch and there are also some large areas devoid of vegetation or supporting stressed vegetation affected by saline groundwater (e.g. within and adjacent HA 869). Where present, most degradation is observed within the understorey layers, with herbaceous and grassy weeds comprising the majority of introduced species. This is commensurate with poorer condition Mallee on sand dunes and Mallee and low woodland communities described for the Eyre Peninsula by Milne et al. (2008). Generally, native vegetation observed throughout the mine site is mature with little evidence of active recruitment. In addition, the average condition of roadside patches within the mine site (i.e. most of Sites A-J) is relatively poor (for location see Figure 12-1). These sites are often long and narrow with high edge effects and significant influence from adjacent land uses (e.g. herbicide use, weeds, dust, roadside drainage cuttings, rubbish, grazing). Plate 12-3 to Plate 12-12 demonstrate some of the variation in habitat condition across the mine site.

Four broad vegetation types were identified during the flora survey, namely:

- Red Mallee (*Eucalyptus oleosa*) / Yorrell (*E. gracilis*) / Narrow-leaved Mallee (*E. leptophylla*) low open woodland on calcareous sandy plains and low dune flanks.
- Ridge-fruited Mallee (*E. incrassata*) / Beaked Red Mallee (*E. socialis*) / Gilga (*E. brachycalyx*) low open woodland on the deeper sands of dune crests.
- Southern Cypress Pine (*Callitris gracilis*) open woodland on sandy calcareous plains.
- Boree (*Melaleuca pauperiflora* ssp. *mutica*) low open woodland with Brown-head Samphire (*Tecticornia indica* ssp. *leiostachya*) and Grey Samphire (*T. halocnemoides* ssp. *halocnemoides*) open low shrubland on saline depressions.

These four vegetation types broadly fall within two representative Eyre Peninsula vegetation communities described by Milne et al. (2008) as EP 5 "Mallee with open to mid-dense sclerophyll shrub understorey on inland dunes and sandy-loams" and EP 8 "Mallee and low woodlands with an open sclerophyll shrub and chenopod understorey on calcareous loams". For both of these broad communities where more than 25 weeds are present the condition of the vegetation is considered to be in poor or very poor condition (Milne et al. 2008).

Vegetation groups identified during the surveys are common throughout the central Eyre Peninsula and condition of vegetation was moderate to poor.

As mentioned earlier, vegetation was assessed in the field at 15 sites as described below.

Flora Site 1

Site 1 is the largest remnant 'scrub block' (260 ha) and is located within HA 869 (see Figure 12-1, Plate 12-3). Although this block includes some of the best habitat with the mine site, it also includes large areas of fragmented habitat devoid of vegetation and large areas impacted by saline soils. The site is located on a red sand plain fringing a salty shallow depression. Low open woodland of Ridge-fruited Mallee (*Eucalyptus incrassata*) / Yorrell (*E. gracilis*) / Gilga (*E. brachycalyx*) with patches of tall shrubland dominate the sand plain. This community grades into Boree (*Melaleuca pauperiflora* ssp. *mutica*) shrubland over a low open shrubland understory fringing the bare saline clay flats. Large areas support vegetation affected by saline groundwater or are devoid of vegetation. Understorey shrubs on the sand plain include Mallee Blue-flower (*Halgania cyanea*), Thick-leaved Emubush (*Eremophila crassifolia*) and Wild Rosemary (*Dampiera rosmarinifolia*), while hummock grassland and tussock grassland dominate the ground storey. A small succulent herb, the Large-fruited Crassula (*Crassula exserta*), rated Rare (NPW Act) occurs at this site. This species typically occurs in small numbers (e.g. 1-3 individuals).

This site is currently free of significant patches of weeds, but the elevated saline water table and reduced habitat quality have the potential to create opportunities for future weed infestations. No Declared weeds occur on the site, but small areas of Small Ice Plant were found on the saline clay flats. It is estimated that the site has not been burnt for more than 10 years, with no recent fire scars evident. Existing grazing levels at this site are low, including light browsing of palatable shrubs by kangaroos. Although the site currently supports a medium to high diversity of native plants for this type of Eyre Peninsula vegetation community, the presence of salt affected vegetation, saline clay flats and elevated groundwater is only likely to provide a moderately sustainable habitat for native flora species in the future.

A complete list of flora species for this site is provided in Appendix J (baseline ecology report).



Plate 12-3 Vegetation of Site 1 and the Adjacent Salinisation

Flora Site 2

Site 2 is located on a low gypsiferous rise just off Kimba Road, within the south eastern corner of HA 869 (see Figure 12-1, Plate 12-4). Red Mallee (*Eucalyptus oleosa*) / Narrow-leaved Mallee (*E. leptophylla*) / Boree (*M. pauperiflora* ssp. *mutica*) low open woodland occurs on pale sandy soils over a sparse understory. Areas of deeper sand are dominated by Spinifex (*Triodia irritans*) hummock grassland, along with understorey species such as Westringia (*Westringia rigida*), Comesperma (*Comesperma volubile*) and Speargrass (*Austrostipa scabra* ssp. *scabra* and *A. flavescens*). There is no evidence of recent fire and it is estimated that the site has not been burnt for more than 10 years. This site is surrounded by cleared land used for cereal cropping and recent grazing levels are low (light Kangaroo browsing). While this site is free from weed infestations and currently supports a medium diversity of native flora species, the presence of edge effects from cereal cropping is high, hence the site is likely to provide a moderately viable habitat for native flora species in the future.



Plate 12-4 Mixed Mallee and Boree Low Open Woodland

Flora Site 3

Site 3 is located in the southwest of HA 869 on a low pale sand dune. The vegetation is characterised by Beaked Red Mallee (*E. socialis*) / Gilja / Narrow-leaved Mallee low open woodland with Ridge-fruited Mallee on the dune crest (see Figure 12-1, Plate 12-5). The deeper sandy soils of the dune crests supports a diverse range of shrubs including Broombush (*Melaleuca uncinata*), Honeysuckle Grevillea (*Grevillea juncifolia*) and Bottlebrush Hakea (*Hakea francisiana*), whilst the shallower dune flanks support Dryland Tea-tree (*Melaleuca lanceolata*) and Sheep Bush (*Geijera linearifolia*). Grazing levels at this site are low, with only light kangaroo browsing of palatable shrubs. No recent fire scars are evident and it is estimated that the site has not been burnt for more than 10 years. This site is surrounded by cleared land used for cereal cropping, similar to site 2. While this site is currently free from significant weed infestations and supports a medium to high diversity of native flora species for this type of Eyre Peninsula vegetation community, the presence of edge effects from cereal cropping is high, hence the site is likely to provide a moderately viable habitat for native flora species in the future.



Plate 12-5 Site 3 within the South-West Corner of HA 869

Flora Site 4

Site 4 is located in the northeast of mine site within a 48 ha remnant scrub block (see Figure 12-1, Plate 12-6). The site is positioned on a low pale sand plain adjacent a shallow saline depression and is dominated by open mallee of Ridge-fruited Mallee / Yorell / Gilga with a diverse range of mid-storey species. The ground storey is dominated by a grassland of Spinifex hummocks and Speargrass tussocks (*Austrostipa scabra* spp. *scabra*, *A. flavescens*). This community grades into Boree shrubland over Samphire low open shrubland fringing the bare saline clay flats of the lake bed (see Plate 12-6). The small herb, Large-fruited Crassula (Rare - NPW Act), occurs at this site.

No Declared weeds occur at the site, however an infestation of Declared weed False Caper (*Euphorbia terracina*) has been recorded in adjacent cleared land immediately east of the site. The site itself is free of weed infestations apart from scattered small patches of minor weed species (Wild Turnip, *Brassica tournefortii*; Pimpernel, *Anagallis arvensis*; Small Ice Plant, *Mesembryanthemum nodiflorum*) on the saline clay flats fringing the depression. Grazing levels at this site are low with only light kangaroo browsing of palatable shrubs observed. It is estimated that the site has not been burnt for more than 10 years, with no evidence of recent fire scars. This site currently supports a medium-high diversity of native flora species for this type of Eyre Peninsula vegetation community, however given the presence of weed infestations at this site and the adjacent this site, combined with the presence of edge effects (including salinisation) this site is likely to sustain low to moderate habitat conditions for native flora species in the future.



Plate 12-6 Representative Habitat and Vegetation Condition at Site 4 (note salinisation adjacent to the site)

Flora Site 5

Site 5 is located in the northeast of the mine site within a remnant patch of vegetation of approximately 31 ha (see Figure 12-1, Plate 12-7). Brown-headed Samphire and Grey Samphire low open shrubland dominate this which occurs within a shallow saline depression. The depression is fringed with tall shrubland of Boree and a Samphire understorey which grades into Red Mallee low open woodland on the adjoining sand plain and low sandy rise north and south of the site. The site supports a few individuals of the small herb Large-fruited Crassula (Rare - NPW Act), but floral diversity is generally low.

Habitat degradation at the site has been heavily influenced by cleared cropping land (north and south of the site), two old abandoned shafts (unrelated to Iron Road's exploratory activities in the area) and existing two-wheel tracks (adjacent the site). In addition, the saline soils support dense patches of the introduced Ice Plant with moderate infestations of several other weeds including two declared (SA) species; False Caper and Horehound (*Marrubium vulgare*). There is also evidence of extensive die off in the Boree tall shrubland in the saline depressions, due to apparent rise in the saline water table (see dead Boree in Plate 12-7).

Whilst, total grazing pressure at the site is low and there is no evidence of rabbit grazing, the edge effects are high. The ongoing effects of salinisation (dead Boree), weed infestations (some Declared) and edge effects from surrounding landuse are likely to sustain low habitat conditions for native flora species in the future.



Plate 12-7 Dying Boree Tall Shrubland with Samphire Low Open Shrubland

Roadside Sites (Flora Only)

Flora was also assessed at Sites A-J across the mine site (Figure 12-1). These sites are primarily smaller blocks of vegetation (1.5-29 ha) or roadside strips within or fringing the mine site. The vegetation condition of the majority of these patches is poor to moderate and weeds are prevalent. Brief descriptions of these sites are summarised below in Table 12-1. No nationally threatened flora species were found at any of these sites. The Large-fruited Crassula (SA rated) was found at three sites. Weeds at these sites include declared species such as Horehound, False Caper, Bridal Creeper and a number of aggressive species including Wild Turnip, Pimpernel, Onion Weed, Black Nightshade, Saffron Thistle, Ward's Weed, Oats and Fescue. For further detail see Appendix J.

Table 12-1 Summary of Site-Specific Vegetation Associations and Condition

Site	Site Specific Vegetation Association	Condition Indicators ¹	Condition
1	Ridge-fruited Mallee / Yorrell / Gilga low open woodland +/- Boree over Samphire low open shrubland	Low weed presence, low grazing pressure, one rare (NPW Act) plant present, salinisation, surrounded by cleared agricultural land (edge effects)	Moderate
2	Red Mallee / Narrow-leaved Mallee / Boree low open woodland over low open shrubland and grassland	No weeds, low grazing pressure, some disturbance, edge effects	Good
3	Beaked Red Mallee / Gilja / Narrow-leaved Mallee low open woodland +/- Ridge-fruited Mallee over sclerophyll shrubland on the dune crest	Low weed presence, low grazing pressure, edge effects	Good
4	Ridge-fruited Mallee / Yorrell / Gilga open mallee with low very open shrubland over Spinifex and Speargrass species	Low weed presence, low grazing pressure, one rare (NPW Act) plant present, salinisation, edge effects	Good
5	Boree low open woodland with Brown-head Samphire and Grey Samphire low open shrubland	Highly disturbed, moderate declared and aggressive weeds, low grazing pressure, salinisation, one rare (NPW Act) plant present, edge effects	Poor
A	Gilga / Red Mallee low open woodland with Mallee Saltbush (<i>Rhagodia preissii</i> ssp. <i>preissii</i>) and Ruby Saltbush (<i>Enchylaena tomentosa</i>) low open shrubland	Disturbed, low floral diversity, moderate to high declared and aggressive weeds, edge effects	Poor
B	Yorell / Ridge-fruited Mallee low open woodland with Broombush (<i>Melaleuca uncinata</i>) and Dryland Tea-tree (<i>M. lanceolata</i>) shrubland over Spinifex	Low weed presence, regrowth Mallee, moderate floral diversity, edge effects	Moderate
C	Gilga / Ridge-fruited Mallee low open woodland with Broombush and Dryland Tea-tree shrubland over Spinifex hummock grassland	Low weed presence, regrowth Mallee, moderate grazing pressure, edge effects	Moderate
D	Yorrell low open woodland over highly modified exotic understorey	Regrowth Mallee, moderate weeds, edge effects	Poor
E	Yorell / Gilga / Beaked Red Mallee low open woodland with Dryland Tea-tree over Mallee Saltbush low open shrubland	Low floral diversity, moderate declared and aggressive weeds, grazing impacts, edge effects	Poor
F	Southern Cypress Pine (<i>Callitris gracilis</i>) open woodland with a closed Desert Senna (<i>Senna artemisioides</i> ssp. <i>platypoda</i>) and Sheepbush (<i>Geijera linearifolia</i>) shrubland	Low floral diversity, low to moderate declared and aggressive weeds, edge effects	Moderate
G	Boree and Gilga low open woodland over very open shrubland of Erect Mallee Bluebush (<i>Maireana pentatropis</i>) and Bitter Saltbush (<i>Atriplex stipitata</i>)	Low floral diversity, low to moderate declared and aggressive weeds, edge effects	Moderate

Site	Site Specific Vegetation Association	Condition Indicators ¹	Condition
H	Yorrell / Gilga open mallee with Stiff Westringia (<i>Westringia rigida</i>) and Mallee Blue-flower (<i>Halgania cyanea</i>) over grassland of Spinifex and Speargrass	Regrowth Mallee, low aggressive weeds, rubbish dump within patch, edge effects	Moderate
I	Southern Cypress Pine open woodland with open shrubland of Veined Wait-a-while (<i>Acacia colletioides</i>), Short-leaved Bluebush (<i>Maireana brevifolia</i>) and Speargrass	Low floral diversity, moderate aggressive and declared weeds, edge effects	Poor
J	Yorrell /Boree low open woodland with Twinleaf (<i>Zygophyllum aurantiacum</i>) and Grey Bindyi (<i>Sclerolaena diacantha</i>) low open shrubland and Speargrass	Low diversity, moderate weeds, highly disturbed, edge effects	Poor

¹ Grazing primarily relates to Kangaroos and Rabbits. Edge effects for all sites as they are surrounded by cleared agricultural land. See Appendix J (baseline ecology report) for further details.

Summary of Overall Mine Site Vegetation Type and Condition

The previous section describes vegetation type for a number of representative sites across the mine site. As mentioned earlier, the mine site is approximately 8,458 ha in total and 1,118 ha of this is native vegetation that occurs as fragmented and isolated patches, primarily on dune crests surrounded by agricultural land.

Broad vegetation types across the mine site are depicted in Figure 12-3. There are gaps in the government vegetation data for of this area, hence vegetation type has been inferred from both the DEWNR vegetation cover layer (DEWNR 2011) and field results presented in Appendix J. It should be noted that the 'mixed mallee' vegetation type is very high level, in reality approximately five broad mallee associations occur across the site.

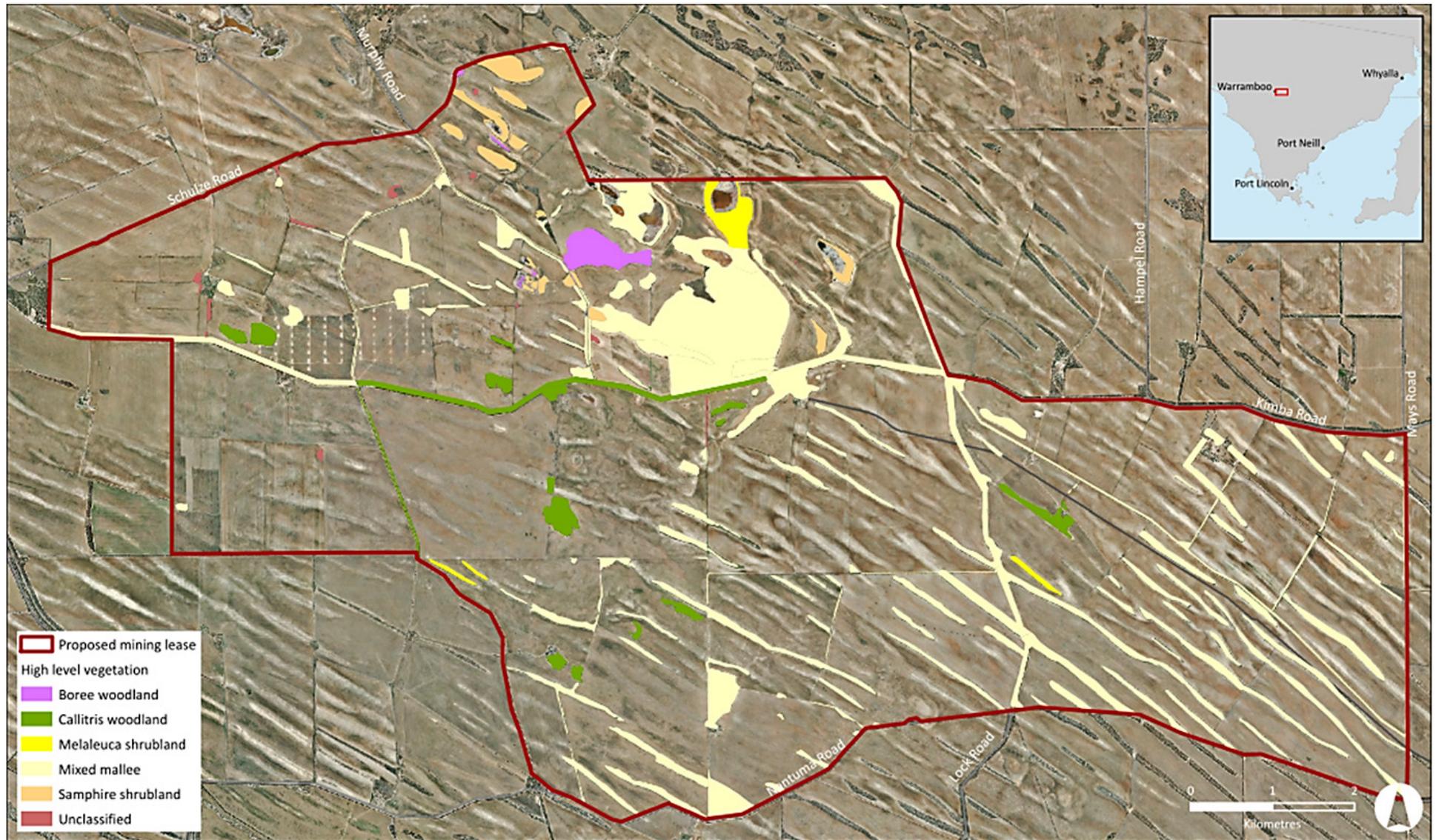


Figure 12-3 Vegetation Types of the Proposed Mining Lease Area

The previous section describes the condition of the vegetation for the highest quality sites within the mine site that were assessed during the flora and fauna field survey (Appendix J). As mentioned in the methods (Section 12.2.3), the average condition of the remainder of the vegetation patches was determined via desktop assessment. These condition criteria are likely to be an overestimate, given that a large portion of patches that are small, highly fragmented patches on dune crests within the middle of paddocks, subject to multiple edge effects (including invasion of pasture weeds) and recent stock grazing. It should also be noted that the Heritage Agreement area is mapped as 'moderate' below as this represents the 'average' condition across the whole area, based on site-specific information, aerial imagery of density and the condition of vegetation that was adjacent the sites visited in the field. A summary of vegetation condition across the whole mine site is presented in Table 12-2 and Figure 12-4.

Table 12-2 Summary of Condition of Vegetation across the Proposed Mining Lease Area

Condition ²	Total Vegetation within Footprint (ha)
Excellent	0
Good quality	32.9
Moderate quality	759.7
Poor	226.5
Very poor	99.2
Non-native vegetation / agricultural land / roads	7,377.7
Total	8,496

¹ As per DWLBC 2005 categories based on disturbance levels and diversity.

² Vegetation condition based on field assessment, knowledge of site, aerial imagery, vegetation cover, surrounding land use and inferred from DEWNR vegetation cover layer (DEWNR 2011).

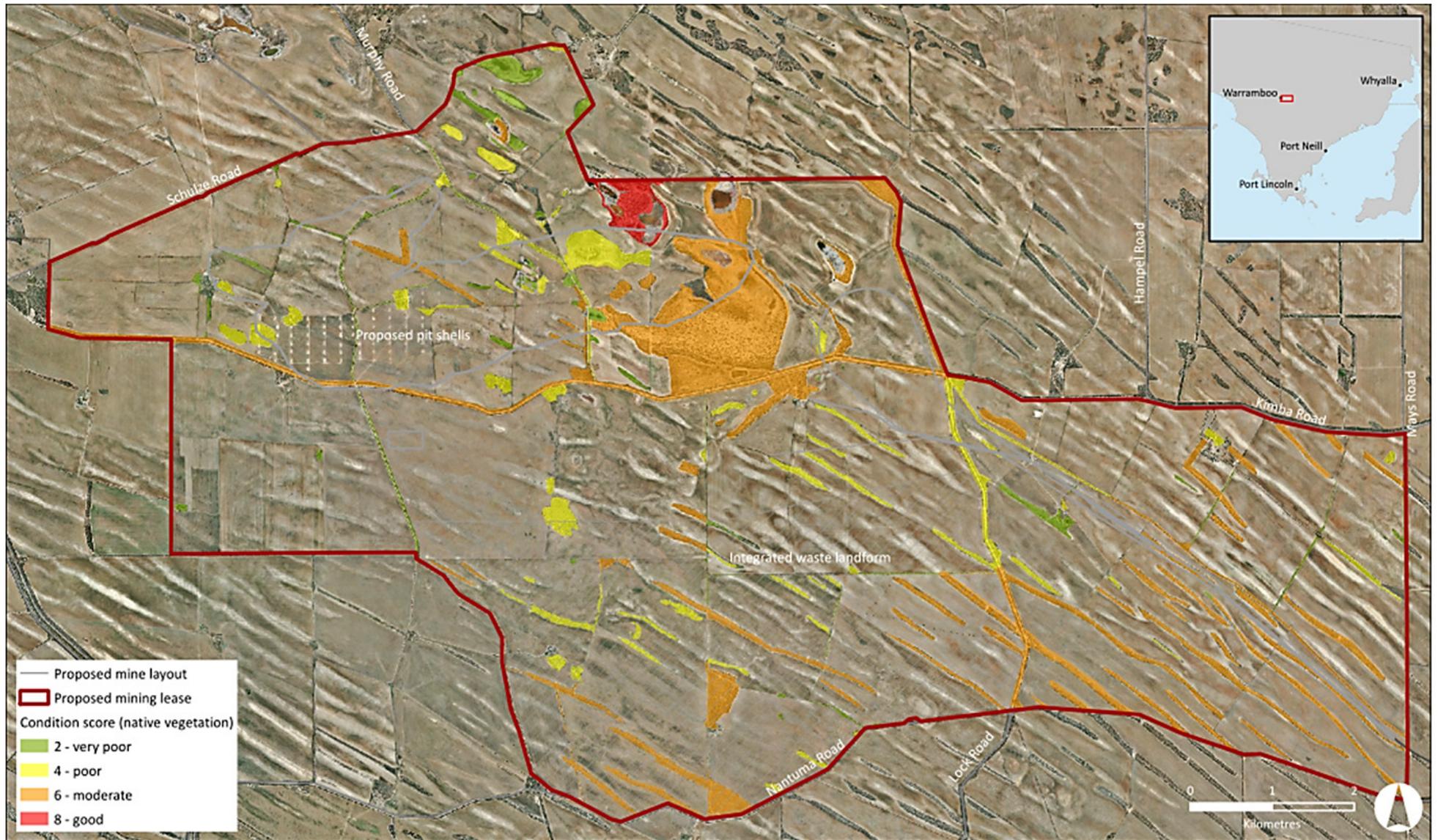


Figure 12-4 Vegetation Condition of the Proposed Mining Lease Area

12.3.3 Native Flora Diversity

The area of the mine site and the general surrounds provide low to moderate habitat for native flora due to the very high rates of historical vegetation clearance and subsequent small size, isolated occurrence and degraded nature of remnant vegetation patches in the area. A total of 145 flora species (107 native and 38 introduced) were recorded from the survey of the mine site, 62 of which represent new records for the area for the Biological Database of South Australia (BDBSA) (Appendix J). The new records are all known to occur in the wider Eyre Peninsula region (DEH 2002). The most diverse community was found to be associated with the deeper sand soils of the low dunes (e.g. Site 4). Flora diversity recorded at each site, including native and exotic species, is presented in Table 12-3. In addition, an additional 184 species are known to occur within the wider surrounds of the Exploration Licence (BDBSA 2011, 2013), but these species were not located at the survey sites within the mine site (Appendix J).

Table 12-3 Flora Species per Site across Proposed Mining Lease Area

	1	2	3	4	5	A	B	C	D	E	F	G	H	I	J	Opp ¹
Native Species	34	26	37	51	25	6	7	7	3	6	25	6	8	13	5	9
Exotic Species	3	0	1	6	16	4	3	2	3	9	8	6	3	13	7	0
Total	37	26	38	57	41	10	10	9	6	15	33	12	11	26	12	9

¹Opp = recorded opportunistically, not within designated survey sites

12.3.4 Conservation Significant Flora

No threatened communities of national or state significance were identified; however, a total of 12 flora species of national or state conservation significance were identified by the desktop review as potentially occurring within the mine site. The actual likelihood of occurrence for all these species was assessed and a justification for the assessment is provided in Table 12-4. Likelihood is based on identification through the EPBC Act PMST, BDBSA records, field survey results and regional information (e.g. DEH 2002, Pobke 2007, Brandle 2010). Of the 12 flora species, three orchids and one wattle are considered unlikely to occur (three EPBC species and one NPW species) and seven flora species are considered to possibly occur at the site (three EPBC and four NPW species). In addition, one state significant species was confirmed as present within the study area; the Large-fruited *Crassula* (*Crassula exserta*), rated as Rare (NPW Act).

The Large-fruited *Crassula* is known to occupy diverse habitats including clay, sandy soils, low-lying depressions, saline areas and mudflats (Western Australian Department of Environment and Conservation 1996). This species is widely scattered but not common across South Australia, usually on sandy clay, in low lying areas and often with other species of *Crassula* including *C. colorata* and *C. sieberana ssp. tetramera* (Black 1986). Black (1986) notes that young plants are often not distinguishable from *C. sieberana ssp. tetramera*, which holds no conservation significance and for which there are some 28 regional (non-confirmed) BDBSA records. Brandle (2010) suggests the *Crassula* genera has unresolvable taxonomic issues and includes both *C. exserta* and *C. tetramera* within the *Crassula sieberiana* complex. Large-fruited *Crassula* was recorded in the survey area at Sites 1, 4 and 5, which all had low-lying salt pans either within or adjacent to the site. The BDBSA has one record of Large-fruit *Crassula* (from near Wudinna in 1935), but there are many records across the broader central Eyre Peninsula including Hambidge WPA, Lock, Waddikee and Carapee Hill Conservation Park.

Table 12-4 Likelihood of Occurrence Assessment for EPBC / NPW Flora Species within the Proposed Mining Lease Study Area

Species Name	Common Name	EPBC Act ¹	NPW Act ²	Likelihood of Occurrence	Justification for Likelihood Assessment
<i>Crassula exserta</i>	Large-fruited Crassula	-	R	Present	Known to occupy diverse habitats including clay, sandy soils, low-lying depressions, saline areas and mudflats. Young plants can be confused with two other species. Unresolvable taxonomic issues. No records within 5 km, but records from 2001 (21-66 km from study area). Confirmed at sites 1, 4 and 5 which all had low-lying salt depressions within or adjacent to the site.
<i>Acacia rhetinocarpa</i>	Resin Wattle	VU	V	Possible	Broadly associated with mallee woodland, including common <i>Eucalypt</i> and <i>Melaleuca</i> that occur within the mine site. On the Eyre Peninsula grows in association with vegetation classified as dune crest and dunes / hills, plains and swales; sand to clay loam and sandy soils. No records within 5 km, nearest historic record 14.7 km from mine site (Hambidge WPA, 1967), most recent record (2001), 99 km away. Occurs in degraded roadside areas (e.g. at Arno Bay). Not located in 1995 targeted survey within Hambidge WPA. Conservation advice suggests fragmented distribution on the Eyre Peninsula, occurring between Streak Bay, Kimba and Arno Bay, but also known from seven populations in that area. Remnant vegetation within mine site likely too fragmented and disturbed, but potential to occur given number of dune crest patches present.
<i>Austrostipa echinata</i>	Spiny Spear-grass	-	R	Possible	Known to occur in open Mallee on sandy soils with limestone. Can occur in similar habitat as Knotted Poa. Not recorded in Eyre Peninsula Biological survey. No records within 5 km, most recent record 67 km from site (2001). Only two records 16 km from mine site (HA area west of Hambidge WPA, 1998). Not observed during field study, but preferred habitat and associated species occur in the area. If individuals occur, they are unlikely to be part of a significant population.
<i>Austrostipa vickeryana</i>	Vickery's Spear-grass	-	R	Possible	Known to occupy saline areas of gypsum sands or limestone. Not recorded in Eyre Peninsula Biological survey. No records within 5 km. Only one regional record from disturbed rail siding at Kopi (9.2 km from mine site, 2000). Can be confused with Club Spear-grass (<i>A. nullanulla</i>). Potential habitat is present on site in and around the salt depressions. Not observed during field study, but may still occur.

Species Name	Common Name	EPBC Act ¹	NPW Act ²	Likelihood of Occurrence	Justification for Likelihood Assessment
<i>Olearia picridifolia</i>	Rasp Daisy-bush	-	R	Possible	Occurs in open Mallee and heath on alkaline soils derived from limestone or low dunes in association with <i>Melaleuca</i> and possibly with <i>Gahnia</i> or <i>Triodia</i> spp. Not recorded during Eyre Peninsula biological survey. No records within 5 km, most recent record (2003), Hinks Conservation Park (73 km from site). Closest records are 12.7 km from site (Hambidge WPA and HA area, 1986). Although not observed in the field, suitable habitat occurs at sites 2, 3 and 4 (Mixed mallee with <i>Melaleuca</i> and grassy understory).
<i>Pterostylis</i> sp. <i>Hale</i>	Hale Dwarf Greenhood	E	V	Possible	Orchid that occupies distinct, clonal sub-populations across SA where it is endemic and known to occur in association with mallee <i>Eucalyptus incrassata</i> and <i>Melaleuca uncinata</i> (Eyre Peninsula and Murraylands) and heathy woodland of <i>E. goniocalyx</i> and <i>Callitris rhomboids</i> (Mount Lofty Region). <i>E. incrassata</i> and <i>M. uncinata</i> occur on the mine site but are common across the Eyre Peninsula. On the Eyre Peninsula occurs in Rudall Conservation Park, Darke Range Conservation Park, Carapee Hill Conservation Park and pre 1960 in Hambidge WPA. Has been observed on loose white sands in mallee shrubland. Remains highly vulnerable to trampling by livestock and weed invasion, its distribution is limited to regions of low stock and high conservation value. The total population size is small, but is considered secure (SPRAT 2015). No BDBSA records of the species in the wider EL or within 25 km of the mine site. Not identified during the field survey. The site is too disturbed to support this species, however there may be potential to occur within HA 869 which has had less disturbance. However it is highly unlikely a viable population or critical habitat occurs within the site.
<i>Poa drummondiana</i>	Knotted Poa	-	R	Possible	Prefers sand, sandy loam, dunes and shrubland associated with <i>Melaleuca</i> and <i>Atriplex</i> species that occur in the study area. Broader habitat type and soil conditions are common throughout central Eyre Peninsula. Occurs in similar habitat to Spiny Spear-grass. No records within 5 km, records in Heritage Vegetation Agreement area west of Hambidge WPA (16 km away, 1998). Most recent records from Hinks WPA and private land (69 km and 76 km from mine site respectively, 2003). Although not observed in the field, suitable habitat occurs within the study area.

Species Name	Common Name	EPBC Act ¹	NPW Act ²	Likelihood of Occurrence	Justification for Likelihood Assessment
<i>Swainsona pyrophila</i>	Yellow Swainson-pea	VU	R	Possible	Short-lived shrub. Occurs in Mallee. Preferred habitat species occur in the study area. Fire and soil disturbance can enhance germination. No records within 5 km. Known records in Hambidge WPA from 1966-2000 (5-25 km from study area). Most recent record (2007) from Pinkawillinie Conservation Park (> 20 km away). Although not currently present, may occur as dormant seed or plant, but being short-lived may not be detected.
<i>Acacia pinguifolia</i>	Fat-leaved Wattle	EN	E	Unlikely	No records within 5 km. Most recent record (2004) is 105 km from mine site. Occurs within roadside reserves and rail reserves (near Cummins). Prefers a variety of subsoils and occurs with mallee woodland and <i>Melaleuca</i> tall shrubland that occur in the study area. Known populations on the Eyre Peninsula occur south of Hinks Conservation Park more than 50 km from the study area
<i>Caladenia tensa</i>	Greencomb Spider-orchid	EN	-	Unlikely	Known from south-east South Australia, rather than Eyre Peninsula. No records within 5 km. Records from 1968-2003 (25-78 km from study area), but likely taxonomic confusion with <i>C. clavula</i> (not protected). Not considered a key regional threatened flora species.
<i>Calochilus pruinosus</i>	Plains Beard-orchid	-	R	Unlikely	Prefers intact, undisturbed stratum of various habitats (e.g. swamp margins to inland dunes under Mallee), but of very isolated occurrence. Historic records within 1 km of study area (1962). Most recent records from Hinks WPA (64-73 km from study area; 2001, 2003). Not observed in field study. Unlikely to occur in degraded agricultural setting.
<i>Prasophyllum goldsackii</i>	Goldsack's Leek-orchid	EN	E	Unlikely	Preferred habitat is <i>Eucalyptus cladocalyx</i> woodlands that support <i>Leptospermum</i> and <i>Allocasuarina</i> spp. No <i>E. cladocalyx</i> woodland habitat within the mine site. Not considered a key regional threatened flora species. No records within 5 km, only one record 44.5 km from study area (Bascombe Well Conservation Park, 1986). Unlikely to occur in degraded agricultural setting.

¹ EPBC Act status: Endangered (EN), Vulnerable (VU), Protected Matters Search Tool suggests species or species habitat 'likely to occur' or 'may occur' within 5 km of study area.

² NPW Act status: Endangered (E), Vulnerable (V), Rare (R).

³ For references and further justification see Appendix J.

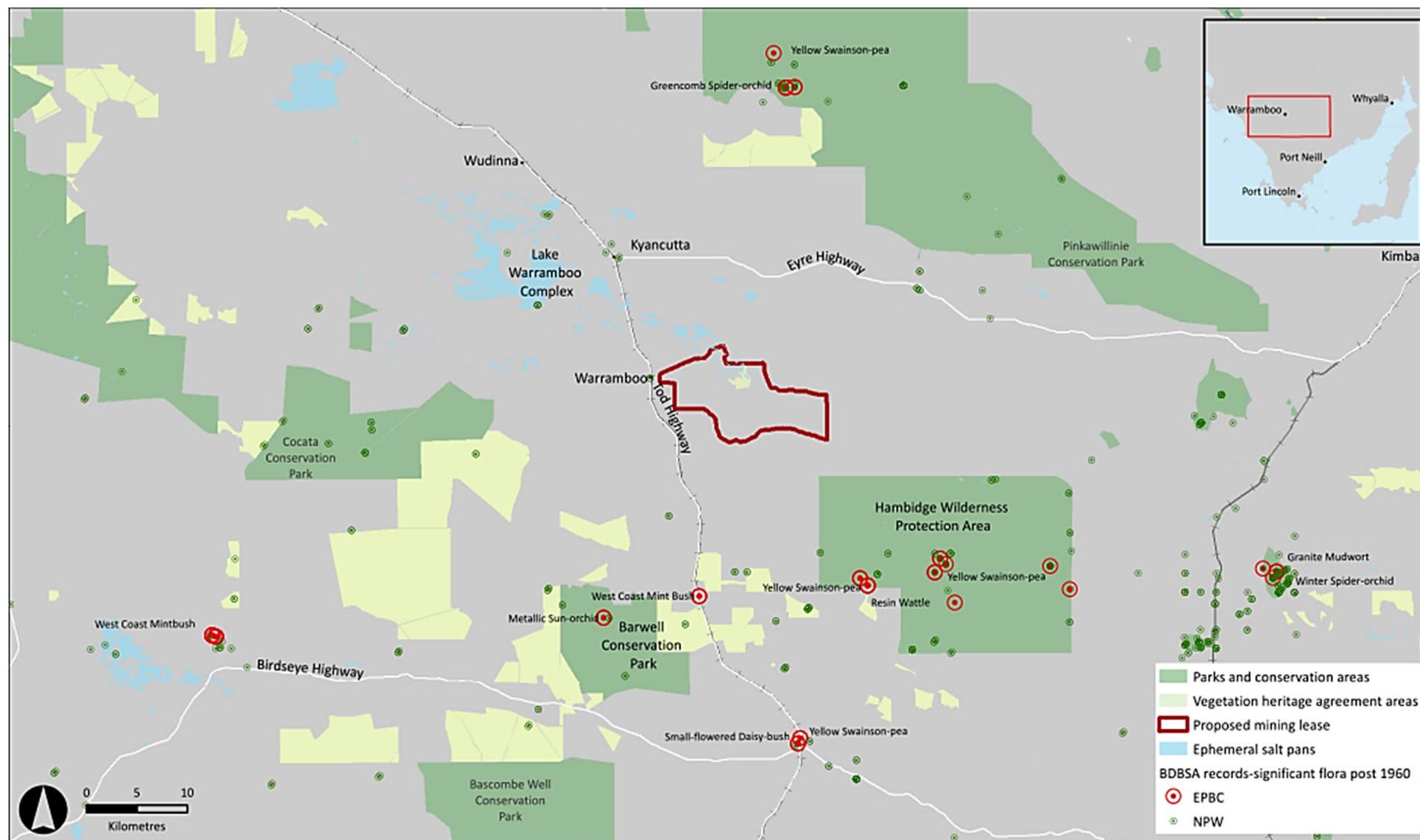


Figure 12-5 Historic Threatened Flora Records of the Proposed Mining Lease Area and Surrounds

12.3.5 Lake Warrambo Complex

The Lake Warrambo complex is located approximately 1.2 km to the northwest of the mine site (see Figure 12-5). This area was included in the study area to determine whether there would be any groundwater impacts as a result of the proposed mine. The complex is comprised of numerous low-lying saline depressions that vary in size from approximately 2.3 ha to 56 ha. There are also three larger depressions of 380, 124 and 240 ha, that rarely hold any water. The lower-lying depressions are typically seasonally inundated for short periods in winter and spring following local rainfall and are characterised by saline localised clayey and silty soils. Numerous low sandy accumulations are scattered throughout the basins and shallow lunettes are present on the south eastern margins of the larger depressions. In addition, smaller depressions located between wide dunal crests are also inundated by winter rains and these ephemeral waterholes retain water for several weeks before evaporating in spring and summer.

Three main vegetation communities are present in the Lake Warrambo complex, as discussed below.

Lake Warrambo Vegetation Community 1

This community occurs on saline basins which support an open low shrubland of Brown-head Samphire (*Tecticornia indica ssp. leiostachya*) and Grey Samphire (*T. halocnemoides ssp. halocnemoides*). Scattered low shrubs at this site include Leafy Sea Heath (*Frankenia foliosa*) and Heathy Bluebush (*Maireana oppositifolia*). Bare areas devoid of vegetation are seasonally inundated by local rainfall.

This community also supports a largely exotic ground storey including Barley Grass (*Hordeum marinum*), Wild Turnip (*Brassica tournefortii*) and Small Ice Plant (*Mesembryanthemum nodiflorum*) (see Plate 12-8).



Plate 12-8 Saline Depression with Samphire (Brown-Head and Grey); Bare Patches are Seasonally Inundated

Lake Warramboe Vegetation Community 2

This community occurs on rarely inundated shallow sandy rises and lunettes which support Bladder Saltbush (*Atriplex vesicaria*) / Brown-head Samphire low open shrubland often with a sparse cover of the tall shrub Boree (*Melaleuca pauperifolia* ssp. *mutica*) +/- White Mallee / Yorrell (*Eucalyptus gracilis*) and an understorey dominated by exotic grass and herb species (see Plate 12-9).



Plate 12-9 Sandy Rises and Shallow Lunettes with Bladder Saltbush and Samphire

Lake Warramboe Vegetation Community 3

This community occurs on shallow interdune basins with temporary saline depressions fringed by sparse Summer Red Mallee (*Eucalyptus socialis* ssp. *socialis*), Boree and Dryland Tea Tree (*Melaleuca lanceolata*). On the adjoining sand dunes there are scattered patches of Brown-head Samphire lining the margins of the ephemeral depression (see Plate 12-10). Anecdotal reports suggest these depressions typically fill following significant rainfall events, hold water for short periods and are usually dry during summer months.



Plate 12-10 Temporary Depression Fringed with Sparse Boree and Mallee

Habitat Condition

The Lake Warramboe complex is surrounded by cleared cropping land and most areas have been historically grazed by livestock resulting in the proliferation of exotic species throughout the ground storey. In addition, the widespread clearance of the predominantly mallee vegetation communities for agriculture has led to a rise of saline groundwater. Known as valley floor seepage, this has been recognised as a significant land management issue on Eyre Peninsula (NDSP 2001). At some of the depressions that make up Lake Warramboe this has resulted in die-off of deeper rooted and less salt tolerant tree and shrub species such as Boree and mallee that once fringed the depressions (see Plate 12-11).



Plate 12-11 Dead and Senescing Boree and Mallee Populations Impacted by Elevated Groundwater

Conservation Significant Species

No nationally or state threatened plant species or communities are known to occur within the complex and none were recorded during a survey of the complex.

The saline depressions associated with the Lake Warrambo Complex form a micro-habitat which is similar to a number of other habitats found throughout Eyre Peninsula. Lake Warrambo may also provide limited flora habitat for additional species for short periods following rain, though it is apparent that the environment is highly saline as a result of historic clearance and consequential elevated groundwater. Surface water appears to be the current and historical cause of inundation, when coupled with elevated groundwater some areas may exhibit extended periods of inundation.

The majority of the Samphire and Chenopod habitat that is present is in poor to moderate condition, subject to edge effects from surrounding agricultural land and subject to impacts of sheep grazing. It is unlikely that this complex forms significant habitat for any national or state threatened flora species.

12.3.6 Heritage Agreement Area

HA 869 is a Heritage Agreement area registered under the Native Vegetation Act 1991. It comprises approximately 260 ha of fenced land. Flora sites 1, 2 and 3 are within the area and described above in 12.3.2. These sites are in reasonable condition and were selected as they represented the best condition vegetation of that type within the area, although all sites showed evidence of previous disturbance. Most vegetation in the area is sparse and degraded.

The area transitions from a longitudinal dune ridge supporting *Eucalyptus* and *Melaleuca* communities which run east to west across the southern portion of the area, through to a low lying sandy plain across the central and northern portions of the HA area. These low lying areas support limited vegetation diversity and abundance and, in some areas, saline ground water appears to be very close to the surface with vegetation stressed, dead or dying. Parts of the area have transitioned from a woodland community to a samphire community. Some elevated areas to the northeast and centrally within the HA area support *Eucalyptus* communities.

12.3.7 Introduced Flora and Pest Species

At least 27 exotic flora species occur within the area of the mine site (Appendix J). This includes Declared weeds and Red Alert weeds (see Milne et al. 2008) which require control under State NRM Act, such as Bridal Creeper, Horehound and False Caper (see Plate 12-12 below). Bridal Creeper is also a Weed of National Significance (WoNS AWC 2012). There are also previous records for an additional 13 weed species within 5 km of the mine site, including Red Alert weed Fountain Grass (*Pennisetum setaceum*). The other 13 species with previous records within 5 km are low threat weeds including species of *Avena*, *Carrichtera*, *Bupleurum*, *Eragrostis*, *Hedypnois*, *Hordeum*, *Medicago*, *Moraea*, *Silene*, *Sisymbrium* and *Vulpia*. Of the 27 species that were recorded at the site, 16 had no previous records within 5 km, however these weeds are known to occur commonly in the wider region (DEH 2002, Brandle 2010). A summary of the weeds that occur within the mine site is provided in Table 12-5 below.



Plate 12-12 False Caper at Flora Site E

Table 12-5 Summary of Weeds (Field Results and /or Historical Records) within Proposed Mining Lease Area

Species Name	Common Name	Presence ¹	Weed Status ²
<i>Anagallis arvensis</i>	Pimpernel	No records, field site 4	Aggressive, WT1
<i>Arctotheca calendula</i>	Cape Weed	No records, field site 5	Aggressive, WT2
<i>Asparagus asparagoides</i>	Bridal Creeper	EPBC PMST 'likely to occur', no records, field site A	Very aggressive, SA / EP Declared, WoNS, WT5
<i>Asphodelus fistulosus</i>	Onion Weed	Records within 5 km (1992), recent record (2008) 11 km from mine site, field sites D, G, E	WT2, not declared for EP
<i>Avena fatua</i>	Wild Oat	No records, field sites 5, A,E,F,G,I	Aggressive, WT2
<i>Brassica juncea</i>	Indian mustard	No records, field site 5	WT2
<i>Brassica tournefortii</i>	Wild Turnip	Records within 5km (1992), field sites 3-5, A-E, H-I	Aggressive, WT2
<i>Bromus diandrus</i>	Great brome	No records, field site F	Aggressive, WT1
<i>Bromus rubens</i>	Red Brome	Records within 5 km (1999). Field site I	Aggressive, WT1
<i>Carrichtera annua</i>	Ward's Weed	EPBC PMST 'may occur', no records, field site A, F, I	Non-aggressive WT2
<i>Carthamus lanatus</i>	Saffron thistle	No records, field site I	Aggressive, WT2
<i>Cyperus rotundus</i>	Nutgrass	No record, field site I	WT1
<i>Euphorbia terracina</i>	False Caper	No records, field site E	Aggressive, Declared SA/EP, WT3
<i>Hordeum leporinum</i>	Wall Barley-grass	No records, field sites 5, E, H, J	WT1
<i>Hypochaeris glabra</i>	Smooth Cat's Ear	Records within 5 km (1999), field site 4, I	WT1
<i>Lolium rigidum</i>	Wimmera Ryegrass	Records within 5 km (1999), field sites 5, C, D, E, G, H, I	Aggressive, WT2
<i>Marrubium vulgare</i>	Horehound	No records, field sites 5, E, F, G, I	Aggressive, WT3, Declared SA/EP
<i>Medicago littoralis</i>	Strand Medic	No records, field sites 5, B, F, J	Aggressive, WT2
<i>Mesembryanthemum crystallinum</i>	Common Iceplant	Records within 5 km (1999), field site 5, I, J	Aggressive, WT2
<i>Mesembryanthemum nodiflorum</i>	Slender Iceplant	Records within 5 km (1999), field site 1, 4, 5	Aggressive, WT2
<i>Minuartia mediterranea</i>	Slender Sandwort	No records within 5 km, record 19 km away (2000), field site five	WT1
<i>Salvia verbenaca</i>	Wild Sage	No records, field site E, F, G	Aggressive, WT2
<i>Sisymbrium officinale</i>	Hedge Mustard	No records, field site F, I, J	Aggressive, WT1
<i>Solanum nigrum</i>	Black Nightshade	Records within 5 km (1975), field site 5, I	Aggressive, WT2
<i>Sonchus oleraceus</i>	Common Sow-thistle	Records within 5 km (1999), field site 1, 4, 5, F, I, J	WT1
<i>Trifolium arvense var. arvense</i>	Hare's-foot Clover	No records, field site 5	Aggressive, WT2
<i>Vulpia bromoides</i>	Squirrel-tail Fescue	No records, field site 5	Aggressive, WT2

¹ Records from BDBSA, or field assessment see Appendix J for further detail.

² Declared status as per NRM Act; aggressiveness as per Appendix 4, DWLBC 2005; Weed Threat (WT) 1 to 5, where 1 is low threat and 3-5 are Red Alert Weeds (page 233 of Milne *et al.* 2008; BushRAT manual 2013, Appendix 6 for EP region S. Croft and T. Milne pers com.).

Pathogens

Phytophthora causes dieback of native and introduced plants in native bushlands, open forests, woodlands and heathlands, farmlands, nurseries and gardens. It is a threat to native fauna and flora as well as ecological communities (Phytophthora Technical Group 2006).

Phytophthora is generally established in areas with rainfall greater than 400mm and where conditions are warm, moist, there is poor drainage and soils are neutral to acid that are low in organic matter (Phytophthora Technical Group 2006). Whilst the Eyre Peninsula is considered to be an area where *Phytophthora* may occur, the mine site occurs to the north of this area and occurs in an area of nil or very low risk for *Phytophthora* (Phytophthora Technical Group 2006). Similarly this pathogen has not been discovered in wilderness areas (e.g. Hambidge WPA) close to the mine site (DEH 2007). Conservation areas well south of the study area that may be vulnerable to the disease, but have no records to date, include Hincks WPA and Conservation Park and Bascombe Well, Peachna and Shannon Conservation Parks (Velzboer *et al.* 2005). There are no records for *Phytophthora* on or near the mine site (Data obtained from Renate Velzeboer DEWNR).

Mundalla Yellows is a disease that causes death in eucalypts and other native plants. This disease is characterised by progressive yellowing and dieback of foliage. The cause of this 'disease' is still unknown and the precise pathogens that cause the disease are still being determined. Once this disease occurs in an area trees of all ages can be affected and even new plantings can become infected, develop the disease and die. This disease occurs across South Australia and there is a strong association with vegetation on roadsides and / or in areas that have been disturbed by humans. The disease occurs amongst a range of climatic conditions (Mundulla Yellows Task Group 2004). The status of this pathogen in the Eyre Peninsula region is unknown.

12.3.8 Summary of Key Environment Values

The mine site is located in an agricultural area which has been largely cleared of remnant vegetation. Isolated patches of remnant mallee vegetation are scattered across the study area and a subset of these patches will require clearing or will be impacted by the mine development.

The majority of the native vegetation within the mine site (approximately 1,118 ha in total) is in moderate to poor condition and highly fragmented, as a result of historical clearing and agricultural practices. As mentioned earlier, sites that were targeted during the vegetation surveys were the best representatives of vegetation within the study area. The condition for the assessed sites ranged from good (three sites) to moderate (seven sites) to poor (five sites). Clearance details are discussed and summarised further in Section 12.6.1 below.

The condition of the remainder of the vegetation patches, primarily Mallee, has also been estimated (see 12.3.2 above). In summary, the condition of all the native vegetation within the mine site is estimated to range from good (33 ha), to moderate (760 ha), to poor and very poor (326 ha). The majority of the Mallee patches are highly degraded with low species diversity and significant weed incursion. They are characterised by low levels of litter cover and overgrazing and display evidence of weeds and regrowth. Similarly, the average condition of most roadside blocks was relatively poor. These sites were often long and thin with high edge effects and significant influence from adjacent land uses (e.g. herbicide use, weeds, dust, roadside drainage cuttings, rubbish, grazing).

The largely isolated patches of vegetation are likely to provide moderate habitat, at best, for flora species that occur there. Eleven flora species of national or state conservation significance potentially occur within the mine site. An assessment of the actual likelihood of occurrence suggested the following (see Section 12.3.4):

- No threatened communities of national or state significance occur within the mine site.
- Four conservation significant flora (three orchids and one wattle) are considered unlikely to occur (three EPBC species and one NPW species).
- Seven flora species could possibly occur (three EPBC and four NPW species).

- One state significant flora species was confirmed as present within the study area; Large-fruited *Crassula* (*Crassula exserta*), (Rare under NPW Act).

The Lake Warrambo Complex is surrounded by cleared cropping land and provides degraded habitat that has historically been grazed. Whilst this area is periodically inundated via surface water which provides ephemeral habitat for some flora species, salinity levels and weed invasion reduce the quality of the habitat. It is unlikely that the Lake Warrambo Complex provides critical habitat for common flora species or conservation significant flora.

12.4 Context and Views of Affected Parties

Stakeholders relevant to native flora and introduced species include:

- The Department of the Environment (Commonwealth)
- The Eyre Peninsula Natural Resources Management Board
- The Department of Environment, Water and Natural Resources
- The Native Vegetation Council (for vegetation / habitat clearance, though it is noted that authority for vegetation clearance is delegated to the Department of State Development (DSD) for the purposes of a Mining Lease Proposal).
- Wudinna DC
- Local naturalist groups
- Members of the community with an interest in ecological values

The key environmental value identified by stakeholders is the importance of remnant vegetation in an already fragmented environment and the potential for threatened flora to occur both within the mine site and the surrounding areas. Long-term management and mitigation of impacts to vegetation and threatened flora are important to the stakeholders.

Stakeholders are seeking the following outcomes in relation to native flora and introduced species at the mine site and surrounds:

- Delivery of the project SEB offset in the local region with large scale revegetation projects (including research and development and carbon sinks) (PIM_12-20).
- Best practice management of existing and no introduction of exotic plant species in the area (IM_12-03, IM_12-04).
- No impacts to flora that may be utilising the water associated with the complex of salt pans and depressions (Lake Warrambo) (PIM_12-13).
- No impacts on flora species of national significance which are Protected Matters under the EPBC Act (IM_12-01).
- No impacts on flora species of state significance which are protected under the NPW Act (IM_12-01).
- Minimise vegetation clearance through design and no clearance beyond approved areas (IM_12-02).
- Minimise dust impacts to native vegetation (IM_12-17).
- No impacts to native vegetation as a result of increase in fire occurrence (IM_12-10).

Impacts and risks relevant to each of the existing environmental values and issues identified by stakeholders are discussed below.

All issues raised by stakeholders across the entire project are presented in Chapter 5 and summarised in Table 5-8. Impacts and risks relevant to each of the existing environmental values associated with native flora and potential issues identified by stakeholders are discussed below and summarised in Table 12-6. All impact events across the entire project are presented in the Impact and Risk Register in Appendix C.

12.5 Potentially Impacting Events

Considering the views and contexts of affected parties and the issues raised during technical studies, an assessment of Source Pathway Receptors (SPR) has been undertaken as per the methodology outlined in Chapter 6, to determine which potential impact events are considered applicable to this project. Potential impact events associated with the construction, operation and closure of the mine site that have a confirmed SPR linkage which affects native flora and weed species include:

- Clearance of vegetation (which represents habitat for flora species) (IM_12-02).
- Direct loss of flora (including conservation significant) as a result of vegetation clearance and other activities (IM_12-01).
- Impacts to threatened ecological communities (IM_12-01).
- Introduction and / or spread of weeds and plant pathogens (indirect and direct effects to flora species and habitat) (IM_12-03, IM_12-04, IM_12-05).
- Activities that might lead to bushfire in the project area and in Hambidge WPA (IM_12-10).
- Establishment of flora habitat and vegetation patch linkage through rehabilitation, landscaping and landform creation (PIM_12-20, IM_12-06 to 12-09, 12-11 to 12-16).
- Dust generation (degradation of vegetation via dust deposition) (PIM_12-16).
- Unauthorised off-road vehicle impacts to vegetation (IM_12-17).

The impact and risk register presented in Appendix C provides confirmation of a source pathway and receptor for each of the potential impact events (PIMs) considered above and therefore follows each through as actual impact events (IMs) with a complete impact and risk assessment.

For native flora and weed species, a number of potential impact events are not considered further as there is no confirmed linkage between source, pathway and receptor, as demonstrated in Appendix C. These include:

- Loss of habitat at the Lake Warrambo complex as a result of reduced groundwater elevation due to pit dewatering, as the habitat present is considered to represent minimal ecological value (PIM_12-13).
- Changes to surface water flow as a result of mining operation impacts on vegetation (PIM_12-18)

12.5.1 Altered Habitat at Adjacent Salt Pans

Groundwater modelling undertaken as part of the environmental impact assessment for the proposed mine indicates that groundwater levels beneath the Lake Warrambo complex north of the mine site boundary may drop by 1-5m as a result of pit dewatering required to access the mine pit (refer to Chapter 19, for further details).

The lake complex is made up of a series of depressions and low lying saline pans. The deeper depressions remain ephemeral (pers. comm with landholder), are hyper-saline and devoid of vegetation within the extent of inundation. The shallower depressions and saline pans support salt-tolerant samphire communities with evidence of dead and senescing boree shrubs and mallee, common as a result of saline groundwater incursion into their root zones. Low shrubland is evident around elevated fringes (salt-bush) where boree and mallee persist. Significant agricultural weed incursion occurs throughout.

The predicted reduction in the groundwater table level may result in minor changes to primarily degraded vegetation communities at the salt pans as the elevated saline groundwater level decreases. It is considered likely that the areas which are currently devoid of vegetation as a result of salt scarring will revert to seasonally inundated samphire low open shrubland communities, more representative of their natural state. In addition, a change in water table is predicted to result in improved survival and recruitment of boree and mallee communities that fringe the depressions. These deep-rooted species have been severely impacted by rising saline groundwater as a result of historic regional vegetation clearance with populations observed to be senescing with no recruitment. A potential lowering of the groundwater table may result in arresting the decline of this community.

Based on the above, the 'receptor' was considered to be degraded vegetation or areas devoid of vegetation. The SPR linkage was not confirmed, since the assessment methodology considers a receptor something which could be harmed by an impact source and pathway. Lowering of the groundwater table will not harm the environmental values of the receptor and, potentially, may have positive impacts.

12.6 Control Measures to Protect Environmental Values

This section identifies design measures and management or control strategies which will be implemented to mitigate the level of impact and risk associated with native vegetation, such that it is considered as low as reasonably practicable (ALARP).

12.6.1 Design Measures

The following design control measures have been incorporated to minimise direct and indirect impacts and risks to native flora as a result of activities involved with the construction, operation and closure of the proposed mine:

- The final proposed integrated waste landform design requires significantly less land (approximately 3,000 ha less) than the preliminary tailings storage and waste rock facility designs considered, resulting in a reduced requirement for vegetation clearance.
- The proposed integrated waste landform design results in significant reduction in process water usage (~ 70% / 31 GL per year), thereby reducing the risk of elevating saline groundwater and impacting surrounding habitat for flora.
- The proposed integrated waste landform design allows progressive rehabilitation of the landform, resulting in more rapid return of vegetation and reducing the risk of significant weed outbreak on the landform.
- Establishment of designated haul routes and light vehicle roads on-site to restrict vegetation impacts to designated areas and minimise ongoing disturbance.
- Establishment of bunded vehicle washdown areas with controlled surface water runoff to maintain weed hygiene practices and reduce weed impacts to flora habitat.
- Dust design measures as per Chapter 15 to minimise impacts to flora habitat via dust impacts to vegetation.

12.6.2 Management Strategies and Commitments

In order to minimise and mitigate impacts to native vegetation and existing weeds during construction, operation and closure activities, the following control and management strategies would be incorporated into the PEPR and implemented for relevant project phases. Key control and management strategies are outlined below in Table 12-6.

Table 12-6 Control and Management Strategies: Vegetation and Weeds

Control and Management Strategies	Project Phase
Progressive Habitat Clearance and Rehabilitation	
<p>Implement soil management practices to limit impacts to and manage topsoil and subsoil, including:</p> <ul style="list-style-type: none"> • Vehicle movements limited to predetermined haul routes and light vehicle roads to minimise compaction of soils comprising native seedbanks. • Deep ripping of soils beneath compacted areas during site rehabilitation to facilitate nutrient cycling and biological processes to support rehabilitation activities and preserve any native seedbank. • Stripping native vegetation topsoil prior to disturbance and stockpiling at a height deemed suitable to maintain seedbank viability outside the area of disturbance. • Protect stockpiles with native seedbank from wind erosion utilising mulch or similar. • Develop and maintain a topsoil inventory, detailing: <ul style="list-style-type: none"> • Original location of the topsoil • Expected seedbank (native versus exotic) properties within stockpiles • The volume of topsoil stockpiled • Stockpile location • Topsoil progressively distributed on rehabilitated surfaces where practical. Opportunities for immediate reuse to be identified in the final mining plan. • Avoid use of saline water for dust suppression during the stripping of topsoil containing native seedbanks where practicable to preserve any native seedbank that may occur. 	<p>Construction Operation Closure</p>
<p>Topsoil (both native and agricultural) and sub-soils containing native seedbank will be stockpiled for use on the IWL to assist with successful rehabilitation (see Chapter 13).</p>	<p>Construction Operation</p>
<p>As rapidly as practicable, progressively rehabilitate the IWL. Ecosystem Function Analysis used on rehabilitation areas to measure progress towards achieving critical thresholds for sustainability.</p>	<p>Construction Operation Closure</p>
Vegetation Management	
<p>Implement vegetation management actions (to be formalised in the PEPR for the proposed mine) to minimise degradation and loss of flora species and associated habitat, including:</p> <ul style="list-style-type: none"> • Progressive mapping of vegetation cover and condition on and off lease on areas that may be directly affected by mining or associated infrastructure and on areas where a significant indirect impact may occur. Mapping to be completed for relevant areas prior to any new disturbance. • All vegetation clearance restricted to the approved footprint. • Disturbance footprints will be minimised by using existing tracks and designated tracks established for the project only. • Clear marking (with pegs and flagging tape) of areas approved for vegetation clearance, or dozers to be equipped with GPS tracking systems with clearly delineated no-go zones. • Activities restricted in 'no-go areas' to reduce the likelihood of introduction and spread of weed species. • Supervision of clearance contractors and/or auditing of vegetation clearance to ensure no unauthorised vegetation clearance occurs. • Vegetation clearance will be staged and progressive rehabilitation undertaken where practicable, to minimise erosion and loss of flora habitat. 	<p>Construction Operation Closure</p>
<p>Implementation of erosion and surface water runoff measures and controls as outlined in Chapter 13 (Soil and Land Quality) and 20 (Surface Water) to reduce loss of topsoil and impacts to vegetation.</p>	<p>Construction Operation Closure</p>

Control and Management Strategies	Project Phase
Offsets	
Improvements to flora habitat in the local region will be made as part of the Significant Environmental Benefit (SEB) Offset for the project (and the SEB offset for the associated CEIP Infrastructure).	Operation Closure
Pest Management	
<p>Implement pest management activities to reduce indirect impacts to native flora, including weed spread, erosion and degradation of vegetation. Chapter 11 (Native Fauna and Pest Species) discusses strategies in further detail, including:</p> <ul style="list-style-type: none"> Incidental reporting of pest species and periodic monitoring of pest species populations at the site during construction and operation. Adaptive management practices to be implemented including identification of the cause of any increases in pest animal numbers and control measures which align with regional practices (e.g. Eyre Peninsula NRM Board Pest Management Program). See Chapter 11 for more detail. 	Operation Closure
Threatened Flora	
Collection of seed (from local populations) and / or transplanting individuals of species proposed to be cleared, for use in rehabilitation elsewhere in the site or region (e.g. Large-fruited <i>Crassula</i> (<i>Crassula exserta</i>) (State listing of Rare)).	Closure
Dust	
Minimise dust impacts to vegetation (flora species habitat) through implementation of management measures identified in Chapter 15 (Air Quality) and further developed in the PEPR.	Construction Operation Closure
Weeds	
<p>Implement weed management practices in consultation with Eyre Peninsula NRM Board and local landowners, to reduce impacts to native flora and associated habitat and align with regional practices and legislation (e.g. Weeds of National Significance, Declared weeds under the NRM Act, EP NRM Plan). Weed management strategies include:</p> <ul style="list-style-type: none"> Incorporation of existing and future baseline weed data to clearly identify areas with Declared weeds that need to be controlled or disposed of appropriately. Identify presence of regionally significant weeds on site and monitor extent of spread. Weed hygiene practices will be followed such as cleaning of plant, equipment and vehicles before construction and after access to known areas infested with Declared weeds. Maintain tracks and monitor for weed outbreaks. 	Construction Operation Closure
Implement incident reporting process for regular weed control and weed outbreak as part of broader environmental site management.	Construction Operation Closure
Adaptive management strategies to be implemented in response to new weed invasion or significant weed spread, including identification of the source of any weed outbreaks and development of control strategies in co-ordination with the Eyre Peninsula NRM Board.	Construction Operation Closure
Fire	
<p>A Bushfire Management Plan will be incorporated into the PEPR and will be developed in consultation with the CFS and other local authorities. Bushfire Management activities to reduce likelihood of fire would include:</p> <ul style="list-style-type: none"> Education of workforce during site inductions about local bushfire risk. Awareness of local restrictions, including hot works, particularly during fire danger season. 	Construction Operation Closure

Control and Management Strategies	Project Phase
<ul style="list-style-type: none"> • Use of diesel vehicles in areas where long dry grasses are present and restriction of vehicle movements to designated tracks. • Welding activities to be undertaken in accordance with Hot Works procedures. • Emergency response protocols and equipment in place. • Regular maintenance and clearance of vegetation around transmission line towers as per voltage and design requirements. • Restricting high risk activities during fire periods. • Smoking restricted to designated areas. • Provision of assistance to CFS (when required) if fires occur outside the mine site. • Annual review of Bushfire Management Plan status and activities. 	

12.7 Impact and Risk Assessment

The following section identifies and assesses impact and risk events associated with native vegetation and weeds as a result of the construction, operation and closure of the proposed mine. Impact events (confirmed by presence of a source, pathway and receptor) are those which are predicted to occur as a result of the development, whilst risk events would not be expected as part of the normal operation of the project, but could occur as a result of uncertainty in the impact assessment process. Although the risks may or may not eventuate, the purpose of the risk assessment process is to identify management and mitigation measures required to reduce the identified risks to a level that is ALARP. This assessment has been undertaken in accordance with the methodology outlined in Chapter 6.

Impacts and risks were identified through technical studies and stakeholder consultation. Impact events can include multiple sources, pathways or receptors and where practical have been grouped together to minimise duplication of information. Risks are events that would not be expected as part of the normal operation of the project, but could occur as a result of either uncertainties with the impact assessment, or as a result of faults, failures and unplanned events. A summary of impact and risk events relating to native flora is presented in Table 12-10 at the end of this section (with Impact IDs) and a complete register of impact and risk events by source, pathway and receptor is provided in Appendix C.

Impacts and risks are assessed following the application of the design measures outlined in Section 12.6. Where required, management measures are proposed to reduce the impact to a level that is considered ALARP. Through the adoption of design modification or specific mitigation measures, all identified impacts were categorised as low (or negligible) and all risks were categorised as medium or low and considered ALARP. The key environmental risks would be monitored through the environmental management framework.

12.7.1 Vegetation Clearance

Clearance of vegetation will be required for the establishment and maintenance of mine infrastructure, transport routes, ore extraction and development of the integrated waste landform.

Vegetation communities present across the mine site are common throughout the central Eyre Peninsula. This native vegetation is restricted to small and isolated patches within an agricultural landscape. In addition, there are areas of remnant native vegetation where saline groundwater is close to the surface and there is evidence of transition to salt tolerant communities. No EPBC listed flora of conservation significance flora or threatened flora communities were identified, with the exception of several individual plants of the Large-fruited Crassula (state listed). It is therefore likely that the already degraded nature of the habitat across most of the mine site does not provide quality habitat for many flora species, particularly fragile species and conservation significant species. Mining is unlikely to have a significant impact on the abundance, diversity, geographic distribution and productivity of flora and vegetation types at the species and ecosystem level.

Approximately 87 % of the proposed mine site is cleared agricultural land of no ecological value. Vegetation cover is limited to over 60 mallee patches of remnant vegetation (~1,118 ha in total) as shown in Figure 12-3 and previously described in Section 12.3.2.

Total native vegetation clearance within the mine site will be 669 ha, which assumes the following:

- All vegetation beneath the project footprint is cleared (infrastructure, stockpiles and IWL) including a 10 m buffer to allow for construction. The mine pit calculation includes a conservative 500 m buffer (that will not actually be cleared), in addition to the 10 m to allow for the safety zone, vehicle movements around the pit and any discrepancies from the modelled pit footprint.
- A 5 m clearance buffer has been allowed for road construction.
- A 500 m clearance buffer has been added to explosives infrastructure (e.g. stop house and store) although it is noted that this area will not require clearance of native vegetation.
- The proposed clearance area includes an earthworks footprint for the rail loop to account for required cut and fill for the railway line within the mine site, plus a 10 m buffer outside of the earthworks footprint to allow for construction.
- The transmission line footprint within the mine site allows for towers and associated pads every 300 m (a conservative estimate as the design indicates towers every 400 m). Clearance estimates have conservatively assumed no specific placement to avoid vegetation and assumed a tower footprint of 10 x 10 m with a 10 m buffer surrounding to allow for laydown of materials and construction (i.e. a 'clearance footprint of 30 x 30 m for each tower location). It is assumed that no vegetation clearance will be required between towers.

The location of native vegetation in relation to the clearance footprint is shown on Figure 12-6. The native vegetation within the mine site occurs within the Koongawa IBRA vegetation association which has 35% remnancy within the region (188,448 ha) and 49 % of which is protected within reserves. The maximum area of the Koongawa Association that would be cleared due to the mine site is 0.36% of the remaining broad vegetation association that occurs across the region. A summary of the clearance in a regional context is provided in Table 12-7.

Table 12-7 Summary of Clearance in Regional Context

Native Vegetation within Mine Site	Native Vegetation to be Cleared within Mine Site	Koongawa Association to be Cleared within Mine Site	Native Vegetation of the Eyre Peninsula to be cleared for Proposed Mine
1118 ha	669 ha	669 ha	669 ha
13% of ML	59% of NV within ML	0.36% of whole association ¹	0.03% of EP native vegetation ²

¹Based on 188,448 ha of Koongawa. ²Based on 2,188,000 ha (from EP Biodiversity Plan, DEH 2002).

Table 12-8 shows the area of vegetation to be cleared in relation to vegetation condition within the mine site. The majority of proposed clearance is of vegetation that is in poor to moderate condition. Any native vegetation that is cleared will be offset in accordance with the NV Act as discussed in Section 12.1. The offset ratios are shown, however, a weighting may be applied to clearance of vegetation within the Heritage Agreement area. Overall clearance of vegetation is expected to result in a **low** impact, since impacts are restricted to the mine site and will be of a short to moderate duration when the environmental offset is taken into consideration. Impacts to common and conservation significant flora are discussed below.

Table 12-8 Estimated Clearance of Native Vegetation within Mine Site

SEB Ratio ¹	Condition ²	Total Vegetation within Footprint (ha)	Maximum (ha) Clearance
10:1	Excellent	0	0
8:1	Good quality	32.9	24.9
6:1	Moderate quality	759.7	451.4
4:1	Poor	226.5	151.6
2:1	Very Poor	99.2	41.4
Totals		1118	669

¹ As per DLWBC categories based on disturbance levels and diversity.

² Vegetation condition estimate based on field assessment and knowledge of site, aerial imagery, vegetation cover, surrounding land use and inferred from ground-truthed patches (see Appendix J).

A risk remains that unauthorised clearance of native vegetation may occur if control measures fail, resulting in greater area of clearance than anticipated. This would ultimately result in greater impacts to native flora such as habitat removal or fragmentation and potential direct loss of common flora and / or conservation significant flora. Given that all clearance of native vegetation will be subject to approval under the NV Act (and a requirement for a commensurate SEB offset for any clearance), unauthorised clearance or disturbance could only occur if there is a breakdown in clearance protocols and associated compensations or equipment failure.

The consequences to flora and vegetation communities from habitat removal or fragmentation as a result of unauthorised vegetation clearance are considered to be **minor** given the proposed mine site is largely in a cleared area; localised short-term impacts that would be remediated in the future through the SEB offset programme. With strict clearance protocols in place based on the design and control measures outlined in Table 12-6 of Section 12.6 (e.g. clear delineation of clearance areas prior to commencing clearance, supervision of clearance contractors and the fact that conservation clearance approvals will be sought), it is considered (conservatively) **possible** that unauthorised clearance will occur during the life of the project. In the event that unauthorised clearance of native vegetation did occur, the risks to flora and associated habitat are therefore considered to be **low**.

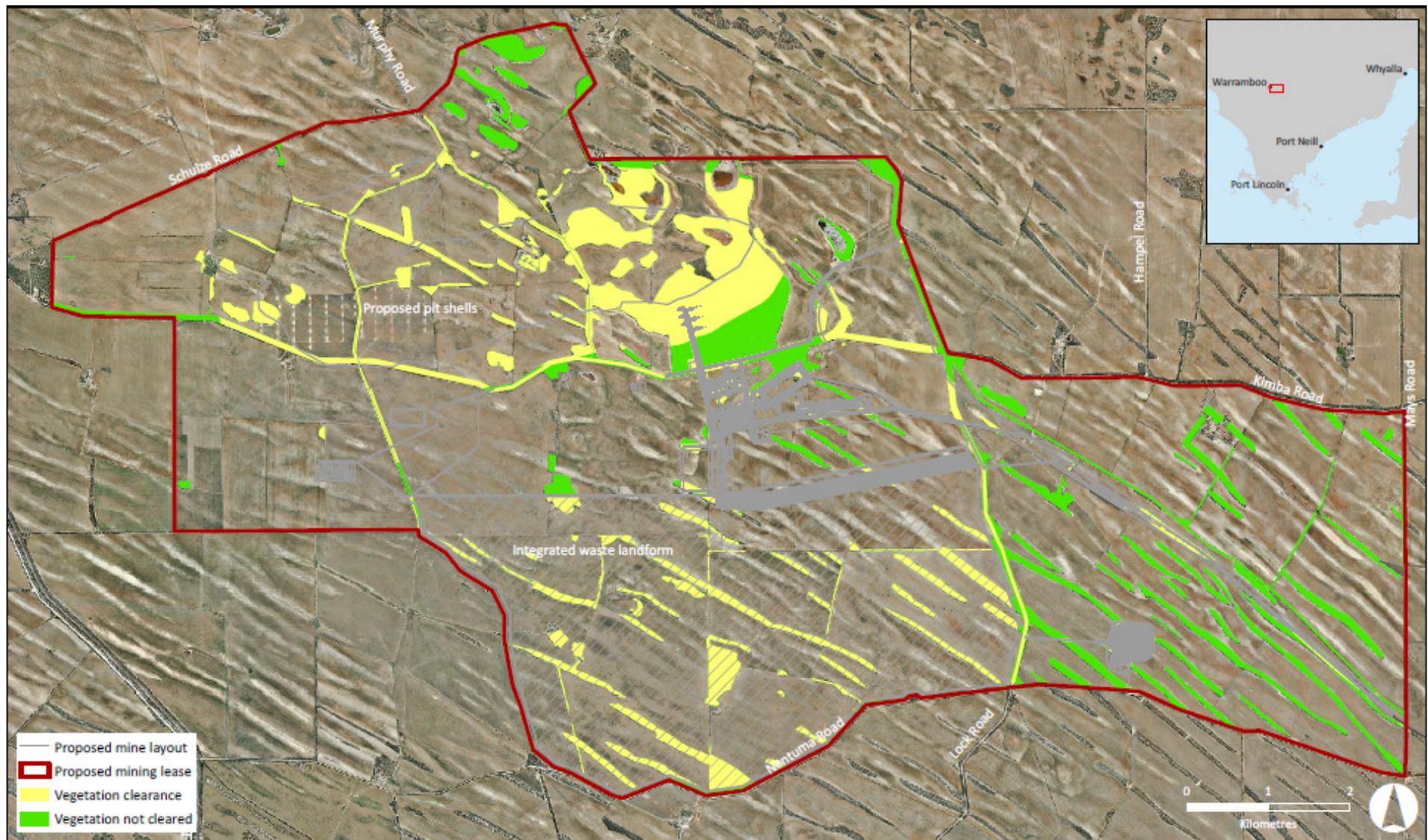


Figure 12-6 Vegetation Clearance within the Proposed Mining Lease Area

12.7.2 Direct or Indirect Loss of Conservation Significant Flora

During vegetation clearance activities, including earth disturbance, there is potential for direct or indirect loss of conservation significant flora. There may be short-term impacts to individual plants or populations of plants as vehicles and machinery move through vegetation, however it is considered unlikely that impacted plants will be those with conservation status.

Likelihood assessments determined that six conservation significant species possibly occur within the area of the mine site and one state listed species is known to occur (see Table 12-9). In general, short-term impacts may occur to individual plants; however impacts to species and viable regional populations are not anticipated as a result of the project, since the site is not expected to support key populations or species strongholds given the existing poor to moderate condition of most of the habitat.

The level of impact to conservation significant flora as a result of vegetation clearance activities has been determined based on assessments of the existing vegetation and habitat condition at the site and the interpreted presence and abundance of conservation significant flora at the mine site and surrounds. Given that the potential for EPBC listed flora species presence is low and only one SA rated flora species is present, it is considered that localised impacts are not likely to affect broader regional populations. Justification comments for the potential impacts to specific species are provided in Table 12-9. For conservation significant flora species that do occur, impacts are likely to be negative short-term changes or changes that will not be detectable on a regional scale, hence impacts to conservation significant flora as a result of the proposed mine are considered to be **low to negligible** depending on the species (see Table 12-9).

Based on the above it is acknowledged that vegetation clearance, vehicle movement, excavations for erection of fencing and trenches and movement and management of topsoil and subsoil would occur as part of normal operations and may result in impacts to conservation significant flora. There is a risk however that such activities may result in greater impacts to conservation significant flora than described above. This could occur if there is a breakdown in protocols or if numbers of conservation significant flora that occur on the site are higher than predicted. Although likelihood assessments of conservation listed species (i.e. likelihood of presence at the site) are based on field results, historical data, current reference information and ecological knowledge, some of these species are often difficult to detect and occur in far lower numbers than common flora. In addition, short-lived annuals such as Orchids and disturbance dependent species that lie dormant in topsoil and subsoil may emerge, e.g. when seasonal conditions change, following fire or when soil is disturbed (e.g. Yellow Swainson Pea, some acacia species). Loss of conservation listed species could have broader impacts to conservation and regional ecology.

Design and control measures outlined in Table 12-6 of Section 12.6 above, include conservative clearance approvals, inclusion of buffers in clearance areas for mobilisation of vehicles and equipment and education of site-staff. Based on this, along with the existing fragmented and degraded nature of the habitat within the mine site and confidence in the predictions about the conservation significant flora considered to occur at the site, the consequences to conservation listed flora are considered to be **minor**; localised short-term impacts to individuals without reduction in regional population viability. It is considered **possible** that Orchids and disturbance dependent flora that were not identified during flora surveys, may occur in the topsoil and subsoil and therefore there is the potential that the number of conservation listed species that occur in the area has been underestimated and protection of these species may be required, at some point during the life of the mine. Therefore, the risks to species of conservation significant flora in excess of impacts described above are considered to be **low**.

Table 12-9 Summary of Impacts to Conservation Significant Flora

Species Name	Common Name	EPBC Act ¹	NPW Act ³	Likely to Occur?	Impact Considerations	Impact
<i>Crassula exserta</i>	<i>Large-fruited Crassula</i>	-	R	Present	Confirmed at sites 1, 4 and 5 which all had low-lying saline depressions within or adjacent the site. There will therefore be impacts to individuals or small local populations, but significant impacts to regional populations of the species are not expected.	Low
<i>Acacia rheticarpa</i>	Resin Wattle	VU	V	Possible	No records within 5 km, historic record 14.7 km from mine site. Known populations do not occur within the mine site. If individuals occur within the study area, it is unlikely they are part of a significant population. If located, seed bearing topsoil would be useful site rehabilitation works.	Negligible
<i>Austrostipa echinata</i>	Spiny Spear-grass	-	R	Possible	No records within 5 km, but records within 20 km of site. If individuals occur within the study area, it is unlikely they are part of a significant population. If located, seed bearing topsoils and subsoils would be used in site rehabilitation works.	Negligible
<i>Austrostipa vickeryana</i>	Vickery's Spear-grass	-	R	Possible	No records within 5 km. Can be confused with Club Spear-grass (<i>A. nullanulla</i>). If species occurs, individual plants may be impacted or destroyed during vegetation clearance activities, but significant impacts to populations or the species as a whole are not anticipated.	Negligible
<i>Olearia picridifolia</i>	Rasp Daisy-bush	-	R	Possible	No records within 5 km, closest records 12.7 km from site. If species occurs, individual plants may be impacted or destroyed during vegetation clearance activities, but significant impacts to populations or the species as a whole are not anticipated.	Negligible
<i>Pterostylis sp. Hale</i>	Hale Dwarf Greenhood	EN	V	Possible	No records with 5 km, known to occur in Rudall Conservation Park, Darke Range Conservation Park and Carapee Hill Conservation Park and Hambidge WPA. Has potential to occur in undisturbed areas of HA 869. If species occurs, individual plants may be impacted or destroyed during vegetation clearance activities, but significant impacts to populations or the species as a whole are unlikely.	Negligible
<i>Poa drummondiana</i>	Knotted Poa	-	R	Possible	Occurs in similar habitat to Spiny Spear-grass. No records within 5 km, but records 16 km away, most recent records 69-76 km from study area. If species occurs, individual plants may be impacted or destroyed during vegetation clearance activities. Significant impacts to populations or the species as a whole are not anticipated.	Negligible
<i>Swainsona pyrophila</i>	Yellow Swainson-pea	VU	R	Possible	Short-lived shrub. No records within 5 km. Known records in Hambidge WPA. Although not observed in field study, may be present as dormant seed or plant. If located, seed bearing topsoil would be useful site rehabilitation works. If individuals occur, they are unlikely to be part of a significant and viable population. Also, given short life cycle, may not be detected.	Negligible

Species Name	Common Name	EPBC Act ¹	NPW Act ³	Likely to Occur?	Impact Considerations	Impact
<i>Acacia pinguifolia</i>	Fat-leaved Wattle	EN	E	Unlikely	No records within 5 km. Known populations on the Eyre Peninsula occur more than 50 km from the study area.	Negligible
<i>Caladenia tensa</i>	Greencomb Spider-orchid	EN	-	Unlikely	Known from south-east SA, rather than Eyre Peninsula. No records within 5 km.	Negligible
<i>Prasophyllum goldsackii</i>	Goldsack's Leek-orchid	EN	E	Unlikely	No <i>E. cladocalyx</i> woodland habitat in study area. No records within 5km. One record, 44.5 km from study area. Unlikely to occur in degraded agricultural setting.	Negligible
<i>Calochilus pruinosis</i>	Plains Beard-orchid	-	R	Unlikely	Historic old records within 1 km of study area. Most recent records 64-73 km from study area. Unlikely to occur in degraded agricultural setting.	Negligible

¹ Further justification and references provided in Table 12-4 above and Appendix J.

12.7.3 Impacts to Threatened Ecological Communities

There are no known threatened ecological communities (Commonwealth or State) that occur within the mine site, therefore impacts to threatened ecological communities are considered to be **negligible**.

A risk remains however, that information sources about regional ecological communities are incorrect or communities have yet to be identified and that there could be greater impacts to threatened ecological communities than anticipated as a result of the project. Given the existing degraded nature of the habitat, the consequences of additional impacts to any threatened ecological communities are considered to be **insignificant**; short-term decreases in abundance with no lasting effects on local flora populations. It is considered **unlikely** that the estimations about threatened ecological communities are incorrect. In the event that impacts to threatened ecological communities occur, the risks to such communities are considered to be **low**.

12.7.4 Direct or Indirect Loss of Common Flora Species

The existing degraded and isolated nature of the majority of the remnant vegetation across the mine site limits floral diversity for common flora. Given the standard environmental control and management strategies outlined in Section 12.6, impacts to common flora species will primarily be associated with habitat reduction as a direct result of vegetation clearance or indirect loss. There may be short-term impacts to individual species that have restricted dispersal mechanisms, primarily associated with habitat reduction as a direct result of vegetation clearance or indirect loss. There are unlikely to be long-term impacts to regional populations of common local flora. As such, reduction of habitat on the mine site through vegetation clearance and direct or indirect loss of species are considered to represent a **low** impact for common flora species.

Based on the above it is acknowledged that vegetation clearance and soil disturbance would occur as part of normal operations and may result in impacts to common flora. There is a risk however that such activities may result in greater impacts to common flora than described above. This could occur if there is a breakdown in protocols. In addition, short-lived annuals such as common Orchids and disturbance dependent species that lie dormant in topsoil and subsoil may emerge, e.g. when seasonal conditions change, following fire or when soil is disturbed (e.g. some acacia species). Loss of populations of common species could have broader impacts to conservation and regional ecology.

Design and control measures outlined in Table 12-6 of Section 12.6 above, include conservative clearance approvals, inclusion of buffers in clearance areas for mobilisation of vehicles and equipment and education of site-staff. Based on this, along with the existing fragmented and degraded nature of the habitat within the mine site, the consequences to common flora are considered to be **minor**; localised short-term impacts to individuals without reduction in regional population viability. It is considered **possible** that additional impacts beyond what was predicted may occur at some point during the life of the mine, if there was a breakdown in protocols. Therefore, the risks to common flora species in excess of impacts described above are considered to be **low**.

12.7.5 Establishment of Habitat Through Environmental Offsets

Clearance of native vegetation is prohibited under the NV Act without approval from the Native Vegetation Council (NVC), delegated to DSD for mining proposals. Approved clearance requires agreement of a commensurate SEB to offset the impacts of clearance.

Iron Road have been in discussions with the Eyre Peninsula NRM Board and the Nature Foundation about potential environmental programmes that would provide a suitable offset for the impact from clearance of native vegetation within the mine site (and the CEIP Infrastructure) for the establishment of the mine and associated infrastructure. The benefit to native vegetation and habitat values from the offset is that the removal of a series of low to moderate value isolated patches of vegetation would be replaced by more a regionally important and co-ordinated conservation programme or project which ideally aligns to regional NRM objectives.

The SEB offset for the project would be subject to final approval from DSD for the mine and the NVC for the CEIP Infrastructure. Ongoing discussions with the NVC are occurring parallel to the mining lease process and full details of the proposed project offsets will be provided in the Program for Environment Protection and Rehabilitation (PEPR).

Conceptual options being considered for the SEB offset include:

- Purchase of properties with existing native vegetation intact to protect and improve environmental values into the future. This would require a suitable property being available in the region to ensure equivalent value to that being impacted is protected and enhanced.
- Protection and enhancement of existing moderate condition remnant patches in the region via fencing, stock exclusions and / or weed control. Ideally to strengthen and create habitat linkages for flora dispersal and increasing habitat opportunities for threatened flora.
- Improving degraded and poor habitats through weed control, fencing and stock exclusion and supplementary revegetation of missing vegetation strata (site-specific for sustainability and success). Ideally these degraded habitats would provide linkages for flora to disperse throughout the region.
- Creating landscape linkages by prioritising areas to improve / rehabilitate based on condition and size of nearby remnant vegetation patches.
- Contributions to local weed and pest control programmes to reduce threats to native flora and enhance the ecological values of the region.
- Using local flora species to revegetate areas of the mine site to provide additional habitat opportunities for common and threatened flora species.

Based on the above, it is considered that the potential changes in the quality of native vegetation cover, reduction of threats (e.g. weeds), increase in habitat and increase in linkage between vegetation patches resulting from the proposed SEB activities would result in positive impacts for common and conservation significant flora species within and outside the project area. These changes represent a positive impact which is longer term and localised to the proposed mine site and surrounds, as such the benefit would be **medium**.

12.7.6 Poor Revegetation and Rehabilitation (Including on the IWL) Results in Planned Future Ecological Values not Being Realised

Rehabilitation activities associated with the proposed mine that will enhance local ecological values, as well as reducing or managing other impacts (e.g. visual screening / softening, landform and soil stabilisation). Any negative impacts associated with not realising future ecological values through rehabilitation are considered to be negligible, since vegetation clearance at the mine site will be offset with a significant environmental benefit. Failure to realise the benefit would mean the offset requirement has not been met.

A number of potential risks exist that could result in poor rehabilitation or revegetation success and therefore failure to realise a future ecological value. These include:

- Integrated waste landform design not providing adequate surface growth medium.
- Wind erosion of surface materials reducing surface growth medium (e.g. on the IWL).

- Surface water erosion reducing surface growth medium (e.g. on the IWL).
- Saline material in surface soils reducing rehabilitation and revegetation success (e.g. on the IWL).
- Poor germination success due to absence of natural fire regimes.
- Poor species / community selection results in poor revegetation success.
- Poor moisture retention as a result of poor landform design.
- Degradation of topsoils and seedbanks during stockpiling (e.g. agricultural or environmental weed presence).
- Geotechnical failure of the IWL.

The integrated waste landform design enables progressive trials of rehabilitation and revegetation as the landform is developed. This will allow the most effective species to be determined early to colonise the landform slopes, allow determination of the most effective revegetation methods (tube stock, direct seeding) and examination of other rehabilitation treatments. Whilst there is a risk that negative impacts (loss of future benefits) may occur, the consequences of such risks are considered to be minor, such that they will be remediated in the short-term, particularly given the rehabilitation activities will be staged and progressive. Based on the above and the control and management strategies that will be in place it is considered that the likelihood that negative impacts (failure to realise future benefits) from rehabilitation is possible, in that it may occur at some time during the life of the project. Therefore the risk of not realising planned future ecological values associated with rehabilitation within the mine site is considered to be **low**.

12.7.7 Introduction and Spread of Weeds

Control and management strategies will be in place to prevent weed introduction or exacerbation. Therefore, impacts on flora from weeds are expected to be **negligible**.

Weeds have the potential to degrade or replace native vegetation which results in a loss of habitat for native flora; including common flora and threatened flora. Regional weed priorities are determined by the NRM Act, where plants that are a significant threat to agriculture, native flora and fauna and public health and safety are 'Declared' and the jurisdiction the mine site falls within (e.g. Eyre Peninsula NRM Board region).

Priority weeds of concern are outlined in Section 12.2 above, including:

- Declared weeds with previous records or observed in the area, e.g. Bridal Creeper, Horehound and False Caper
- Red Alert Weeds or highly invasive weeds (as per Milne et al. 2008) and BushRAT Manual (DEWNR 2013)
- Community weed concerns, e.g. Caltrop (also a Declared weed for the Eyre Peninsula NRM Region)

In addition to existing weeds, new weeds can also be introduced in an area inadvertently. If not managed correctly, new weeds can become established in abundance that can be detrimental to the local environment.

During both construction and mining activities, weed introduction and spread could occur via transport of weed containing material (e.g. agricultural or other topsoils containing seeds, propagules), or via an increase in available habitat for weeds following vegetation clearance and ground disturbance (e.g. for rail tracks, infrastructure, stockpiles, maintenance tracks). Seeds and rhizomes can lie dormant in existing soil and exploit the increased availability to light and water where native vegetation is removed. Weed seeds and propagules can also be spread unintentionally through importation of soil and rock from other areas, or soil attached to machinery. In addition, weeds may also be spread inadvertently if adequate measures are not in place to dispose of the cleared native vegetation debris that may also contain exotic seeds and propagules. An increase in pest animal species can also exacerbate or increase weed spread in an area (e.g. foxes spread olives, rabbits and goats spread exotic grasses).

During the operational phase of the project, weeds may increase where there is a breakdown of weed control protocols, for example, if tracks were not maintained and monitored for new outbreaks. Weed dispersal methods vary depending on the weed, e.g. some spread by wind, some spread via native and pest fauna. If weeds are not controlled within the project area, they may spread to the remnant vegetation patches in the vicinity of the project area, leading for further degradation and fragmentation of the limited available habitat within the region.

Although construction and operation of the project do not plan on, or anticipate, the introduction and spread of weed species, there is a risk that this will occur. Given the design and control measures that will be followed during construction, operation and mine closure (see Section 12.5), spread of existing weeds (on site and off site) should only occur if there is a breakdown in protocols (e.g. weed, soil and waste management) or weed management protocols are not effective. The consequences of any such weed event are considered to be **minor**, localised short-term and able to be remediated. It is considered **possible** that spread of existing weeds or introduction of new weed species could occur either within or outside of the mine site during the life of the project. As such, the risk associated with the spread of existing weed issues is considered to be **low**.

Similarly, there is risk of introduction of new weed species during construction, operation and mine closure. This should only occur if there is a breakdown in protocols or management protocols are not effective. The consequences of the introduction of new weeds are considered to be **moderate**, localised, long term without lasting effects on the flora population. It is considered **possible** that introduction of new weeds could occur either within or outside of the mine site during the life of the project. As such, the risk associated with introduction of new weeds is considered to be **medium**.

12.7.8 Impacts to Native Vegetation as a Result of Pest and Feral Animals

On the Eyre Peninsula, the EP NRM Board assists the community in coordinating integrated pest management (between all stakeholders). Similarly, control and management strategies for this project will be in place to prevent pest and feral animal introduction or exacerbation. Therefore, impacts on native flora as a result of pest and feral animals are expected to be **negligible**.

Vertebrate animal pest species already exist within the mine site and surrounding areas. Some vertebrate pests can impact native flora (e.g. rabbits, goats and foxes) through weed spread and habitat degradation via trampling, digging and grazing. Foxes, in particular, are known to exacerbate existing weed problems given their omnivorous food requirements and den building habits. Increases in pest birds, as well as atypical numbers of native species (e.g. Silver Gulls, Galahs, Cockatoos, Corellas, Raven species) can also be detrimental to native flora via overgrazing and general habitat destruction.

Activities that may result in an increase in native and introduced pest and feral fauna, particularly scavenging species, include unmanaged waste collection areas and landfill sites; increases in road-kill; increased human activity in the region resulting in an increase in recreational activities (e.g. camping, off-road driving, sight-seeing and off-road bike riding).

Based on the above, there is a risk that construction and operation of the proposed mine may result in an increase in the number of vertebrate pests in the region. This has the potential to lead to subsequent degradation of vegetation communities and impact threatened flora through increases in grazing, weed spread and general habitat modification. Given the design and management measures outlined in Section 12.6, coupled with the existing management practices that occur in the region, if increases in vertebrate pests (exotic and native) are encountered, the consequences to native vegetation are considered to be **minor**; localised, at worst, able to be remediated in the long term. It is considered that the likelihood that an increase in vertebrate pests (exotic and native) results in degradation of flora is **possible**, in that it may occur at some time during the life of the project. Therefore the risk to native vegetation associated with increases in the existing vertebrate pest levels within the mine site is considered to be **low**.

12.7.9 Vegetation Stress or Loss Due to Dust Deposition from Mining Activities

Control and management strategies will be in place to prevent dust impacts to native vegetation. Therefore impacts to native vegetation as a result of dust deposition activities caused by construction and operation of the mine are expected to be **negligible**. There is however a risk that dust deposition as a result of mining may impact native vegetation and this is discussed below.

Dusts from excavation activities during construction and from mining activities during operation could potentially be deposited on vegetation to the extent that it can impede growth, threaten the survival of individual plants, resulting in degradation of habitat for native flora and fauna species. Other particulate matter (e.g. reactive dusts, such as cement dust) can alter nutrient balances within plants, resulting in adverse effects on plant growth rates (Doley 2003). Impacts to vegetation from dust can be variable, as the relationship between rate of deposition and dust load will vary depending on the type, size and colour of the dust and the size of leaf surfaces on which the dust falls (Doley 2003, Doley 2006). In addition, the position of the plant species within the plant community and the timing of rain events in relation to dust deposition can also affect the degree of impact from dust deposition on a species (Doley and Rossato 2010). Modelling by Doley and Rossato (2010) suggested that impacts from dust deposition are generally greater at the bottom of plant canopies than on vegetation exposed to sunlight.

As mentioned in Chapter 15 (Air Quality), existing dust levels within the study area relate to wheat-crop farming. Elevated particulate matter and dust levels resulting from dry windy conditions (especially during the dry summer and autumn periods) occur frequently in the project area.

Dust impacts on vegetation within the vicinity of the mine site may arise as a result of:

- Ground disturbance, excavation and stockpiling
- Increased truck movements on haul routes that are not bitumised or well maintained during construction
- Limited rainfall events so dust is not washed away
- Unplanned higher than predicted dust emissions
- Failure of dust controls (see Chapter 15)

Based on the above, a risk remains that even with the design and control measures outlined in Section 12.6 and those outlined in Chapter 15 (Air Quality), construction and operation of the proposed mine may result in increased impacts to vegetation from dust deposition. Dust impacts to vegetation above the existing conditions, may occur if there is a failure of dust controls or abnormal conditions resulted in unplanned (higher than predicted) dust emissions. It is considered that if increases in dust deposition on vegetation are encountered, the consequences to native vegetation would be **minor**; localised and at worst remediated in the short term or during rainfall events. The likelihood of this event occurring is considered **possible**, in that it may occur at some time during the life of the project (e.g. breakdown in protocols or unplanned dust emissions). Therefore the risk associated with an increase in dust deposition on vegetation as a result of the project is considered to be **low**.

12.7.10 Impacts to Regional Vegetation from Recreational Activities

Control and management strategies will be in place to prevent impacts to regional vegetation from recreational activities. Therefore, impacts on flora from an increase in regional recreational activities are expected to be **negligible**.

An increase in workers to the region as a result of the project could lead to an increase in regional recreational activities such as unauthorised off-road driving, off-road bike riding, bush camping and sightseeing. If uncontrolled, these activities can exacerbate existing degradation of the environment through incremental increases in littering, overflow of bins, increased erosion on tracks, wood collection and lighting of fires which could impact native vegetation.

These impacts could occur in regional conservation parks and coastal areas removed from the project area where there may also be an increase in 4WD driving and other recreational activities. Alternatively, an increase in informed people within the community could result in greater participation in community activities which support regional conservation activities (e.g. clean up Australia day, tree-planting day, bush care sites).

Based on the above, it is considered that construction and operation of the proposed mine will result in an increase in workers to the region and there is a risk that there may be direct and indirect impacts to vegetation associated with uncontrolled recreational activities. Given the design and control measures outlined in Section 12.5, this event should only occur if there is a breakdown in communication or education, or abnormal conditions result in higher than predicted recreational activities in the region. If increases in recreational activities result in direct or indirect impacts to vegetation, the consequences to native flora species as a whole are considered to be **minor**; local short-term decrease in abundance of some species resulting in little or no change to community structure. The likelihood of this event occurring is considered **possible**, in that it may occur at some time during the life of the project (e.g. through breakdowns in communication or education of workforce or abnormal conditions). Therefore the risk associated with an increase in regional recreational activity impacts to vegetation as a result of the project are considered to be **low**.

12.7.11 Bushfire

Control and management strategies will be in place to prevent bushfire impacts to native vegetation. Therefore impacts to native vegetation as a result of bushfire caused by construction and operation of the mine are expected to be **negligible**. There is however, a risk that bushfire may occur during the life of the proposed mine. Although bushfires are a natural occurrence, the increased incidence of bushfires as a result of human activity can have ongoing impacts on the ecology of an area, particularly where the habitat is already fragmented through adjacent land use practices such as farming. Uncontrolled bushfires can occur as a result of a number of construction and operation activities, for example: failure of management controls, system failure, inadequate emergency response, unmanaged height and proximity of vegetation near transmission line towers and wires, welding activities and other hot works during fire ban season, contractor or site visitor use of petrol vehicles close to pasture stubble, native or exotic grasses and improper storage of flammable materials. In addition, recreational activities as a result of increased workers to the region could result in bushfire that could impact native flora.

Given the degraded nature and low floral diversity within the mine site and immediate surrounds, if this event occurred, the consequences to native flora are considered to be **minor**; localised long-term decrease in abundance of some species resulting in little or no change to community structure. Noting that some native species are fire dependent and others are disturbance dependent, hence vegetation community structure can be enhanced following fire. With the design and control measures in place (as per section 12.6), it is considered **rare** that construction and operation of the proposed mine could result in a bushfire which results in 'worst case' impacts to remnant vegetation within the mine site, particularly given the degraded nature such vegetation. As such, the risks to flora species associated with bushfire caused by mining activities are considered to be **low**.

Similarly, in the event that a bushfire did occur as a result of construction and operation of the mine, the consequences to significant areas of native vegetation, such as Hambidge WPA would be **moderate to major**; localised long-term decrease in abundance of flora species and or local loss of species diversity depending on the size of the fire and the conservation significance of the species impacted. As mentioned earlier, some native flora species actually require fire as part of their lifecycle and fire can assist in reducing weed impacts. Even with design and control measures in place for this project, as well as existing regional management, it is **rare** that construction and operation of the proposed mine could result in a bushfire which impacts remnant vegetation within the nearest conservation reserve (e.g. Hambidge Wilderness Protection Area, approximately 4 km south of the mine site boundary). As such, it is considered that risk to the flora of Hambidge WPA as a result of bushfire would range from **low to medium**.

12.7.12 Groundwater Impacts upon Vegetation within Hambidge WPA

Groundwater modelling has been undertaken to determine impacts of the construction and operation of the proposed mine; e.g. drawdown from pit dewatering and evaporation from the pit with concurrent groundwater elevation due to seepage beneath the integrated waste landform (see Chapter 19). The groundwater modelling suggested there would be a negligible increase in groundwater beneath the IWL during operation and there would be no significant mounding beneath the IWL over the long term. In addition, modelling assessed a zone of influence surrounding the mine site. Impacts from drawdown are not predicted to extend beyond 7 km from the mine pits during operation.

The northwest corner of Hambidge WPA is located approximately 7 km from the mine site boundary. The groundwater beneath Hambidge WPA is currently approximately 15 mbgl – part of the same aquifer that lies beneath the IWL. Mallee vegetation within Hambidge, particularly mallee on dune crests, is unlikely to be groundwater dependent, given the depth and lack of visible evidence of stress from saline groundwater. Modelling predicts that groundwater levels may change by a maximum of 1 m beneath the mine site and its surrounding area over 25 to 1000 years following closure of the mine. Given the current depth to groundwater in the region, impacts to native vegetation are likely to be **negligible**, given that vegetation is not groundwater dependent, particularly shrubs and shallow rooted grass species (e.g. Spinifex) in a dunal environment.

There is a risk however, that the groundwater modelling is incorrect and that there could be habitat loss or degradation to the Hambidge WPA habitat as a result of changes in groundwater quality and quantity. However, given the existing depth of groundwater below the Hambidge WPA and lack of groundwater dependent vegetation in the northwest corner of Hambidge, the consequences of such impacts are considered to be **minor**; local short-term decreases in abundance with no lasting effects on local flora populations. Given the sensitivity testing that was undertaken in association with the groundwater modelling, it is considered unlikely that the predicted groundwater impacts are incorrect. As such, the risk of this event is considered to be **low**.

12.7.13 Summary of Impacts and Risks

With the implementation of design and management measures, all residual impacts have been categorised as low or negligible, with some impacts resulting in positive benefits following rehabilitation activities. Similarly, all risks have been reduced to a level of medium or lower. The impacts and risks are considered to be ALARP and not warrant further specific control measures, other than the standard environmental management controls and measures outlined here. A summary of each of the identified impacts and risks associated with native vegetation and weeds is provided in Table 12-10.

Table 12-10 Impact and Risk Summary: Vegetation

Impact ID	Impact Event	Level of Impact ^{1,2}	Level of Risk ³
IM_12-01	Clearance of vegetation resulting in loss of conservation listed species and communities.	Negligible to low ¹	Low
IM_12-02	Clearance of vegetation resulting in loss of locally indigenous species and communities.	Low	Low
IM_12-03	Introduction of new weeds on and off site as a result of mine development.	Negligible	Medium
IM_12-04	Spread of existing weeds on and off site as a result of mine development (e.g. due to use of agricultural topsoil salvaged from existing farmland).	Negligible	Low
IM_12-5, 6, 7, 8, 9, 11, 12	Poor revegetation and rehabilitation on the IWL results in planned future ecological values not being realised.	Negligible	Low
IM_12-10	Bushfire impacts to flora within the mine site and within areas of significant vegetation such as Hambidge.	Negligible	Low-medium
IM_12-13	Poor revegetation or regeneration success as a result of degradation of topsoils and seedbanks during stockpiling.	Low	Low
IM_12-14	Groundwater Impacts upon Hambidge WPA as a result of GW elevation due to seepage from the IWL.	Negligible	Low
IM_12-15	Revegetation success on proposed mining lease reduced as a result of unstable soils.	Negligible	Low
IM_12-16	Vegetation stress or mortality due to dust deposition from mining activities.	Negligible	Low
IM_12-17	Impacts to regional vegetation from recreational activities.	Negligible	Low
IM_12-18	Establishment of habitat through environmental offsets.	Medium Benefit	-
IM_12-19	Increase in vertebrate pests and / or abundance of native fauna species results in degradation of vegetation and threatened flora.	Negligible	Low
IM_12-20	Damage to revegetation and regeneration of vegetation on IWL caused by geotechnical failure of the IWL.	Negligible	Low

¹ For some events, the impact level has a range. This relates to species-specific impacts or differences in abundance or likelihood of occurrence for conservation significant flora.

² Impact events are expected to occur are part of the project. Level of impact is assessed post control strategies, as per the impact assessment methodology provided in Chapter 6.

³ Level of risk reflects the risk that the assessment of impact is incorrect due to uncertainties in the assessment method, the control strategies, or in assumptions used. Risk is assessed post control strategies, as per the risk assessment methodology provided in Chapter 6.

12.7.14 Justification and Acceptance of Residual Impact and Risk

With the implementation of design and operational management measures, all impacts associated with native flora and weeds are considered to be **low** (or **negligible**), with the establishment of habitat in the region from the SEB offset considered to represent a medium benefit. Similarly, all risks have been reduced to a level of **low**, with the exception of weed introduction that represents a **medium** risk. The impacts and risks are considered to be ALARP.

12.8 Proposed Outcome(s) and Criteria

In accordance with the methodology presented in Chapter 6, outcomes have been developed for all impact events with a confirmed linkage between source, pathway and receptor. Each outcome is supported by measurable assessment criteria that will be used to assess compliance against the proposed outcomes during the relevant phases (construction, operation, closure) of the project. Whilst outcomes may be the same for multiple impact events, separate measurement criteria and leading indicators are proposed to demonstrate compliance. Proposed outcomes and measurement criteria have been developed for each of the impact events identified with a confirmed linkage and these are presented in Table 12-11. Outcomes for the entire project are presented along with all impact events in Appendix C.

Table 12-11 Outcomes and Measurement Criteria: Vegetation and Weeds

Proposed Outcome	Impact ID	Impact Event	Draft Outcome Measurement Criteria	Draft Leading Indicator Criteria	
No loss of abundance or diversity of native vegetation on or off the mine site during construction, operation and post mine completion through clearance, dust/ contaminant deposition, fire, reduction in water supply, salinisation or other damage unless prior approval under the relevant legislation is obtained.	IM_12-01 IM_12-02	Clearance of vegetation resulting in loss of indigenous species and communities, including conservation listed species and communities.	Vegetation audit (on and off lease, as required) on areas potentially affected by current mining activities demonstrates the total area cleared or damaged does not exceed the approved clearance area in the SEB plan. Compliance with SEB plan.	None proposed	
	IM_12-10	Bushfire Impacts to native flora and significant patches of vegetation.			
	IM_12-17	Unauthorised off-road vehicle use impacts on vegetation (e.g. increased recreational activities).			
	IM_12-14	Impacts on Hambidge WPA as a result of saline GW elevation due to seepage from the landform.	Groundwater monitoring outside of the proposed mining lease boundary is in line with model predictions and seasonal variations.		Groundwater levels are in line with model expectations
	IM_12-16	Vegetation stress or mortality due to dust deposition from mining activities.	Average annual dust deposition, including background, not to exceed 4 g/m ² /month.		Monthly dust deposition from mining activities not to exceed 4 g/m ² /month.
No introduction of new species of weeds, plant pathogens or pests (including feral animals), or sustained increase in abundance of existing weed or pest species on the mine site.	IM_12-03 IM_12-04	Weed impacts to vegetation and flora habitat on and off the mine site.	Annual monitoring demonstrates: - No new weeds or feral animals have become established on the site. - There has not been a statistically significant increase in abundance of existing weed or pest species in the mine site	None proposed	
	IM_12-19	Increase in feral and pest animal impacts to native vegetation.			

Proposed Outcome	Impact ID	Impact Event	Draft Outcome Measurement Criteria	Draft Leading Indicator Criteria
			area, compared to baseline studies and accounting for seasonal variation (regional trends) and pit/IWL areas.	
Designated rehabilitation sites are established self sustaining systems.	IM_12-05	Poor revegetation and regeneration as a result of IWL design not providing adequate surface growth medium.	Ecosystem Function Analysis (or similar) of rehabilitation areas demonstrates they will achieve critical thresholds for sustainability	Evidence of establishment of native plant species on designated rehabilitation areas 12 months after progressive rehabilitation. Evidence of recruitment of key plant species demonstrated at rehabilitation sites within five years of progressive rehabilitation.
	IM_12-06	Poor revegetation and regeneration on IWL as a result of wind erosion of surface materials reducing surface growth medium.		
	IM_12-07	Poor revegetation and regeneration on IWL as a result of surface water erosion reducing surface growth medium.		
	IM_12-08	Poor revegetation and regeneration on IWL due to saline material in landform.		
	IM_12-09	Poor germination reduces rehabilitation success on IWL due to absence of natural fire regimes.		
	IM_12-11	Loss of revegetation on IWL due to poor species / community selection.		
	IM_12-12	Poor revegetation and regeneration as a result of IWL design not providing adequate moisture retention.		
	IM_12-13	Poor revegetation or regeneration success as a result of degradation of topsoils and seedbanks during stockpiling.		
	IM_12-15	Revegetation success on proposed mining lease reduced as a result of unstable soils.		
	IM_12-20	Damage to revegetation and regeneration of vegetation on IWL caused by geotechnical failure of the IWL.		

12.9 Findings and Conclusions

Impacts to native vegetation and flora species within the mine site are expected as part of the development and relate primarily to vegetation clearance (e.g. loss of habitat, direct loss of flora species and vegetation communities), weed introduction or spread, groundwater modifications and impacts from dust, bushfire or increase in pest animals. Given the limited environmental values present across the site, residual impacts were considered to be 'negligible' or 'low'.

Risks to native vegetation will be alleviated wherever possible through implementation of control and management strategies. **Low** level risks include the potential to underestimate the presence of listed flora species, potentially leading to an underestimate of impacts to conservation significant flora. Other risks that were considered to be **low** were unauthorised vegetation clearance, spread of weeds, dust deposition, impacts from pest and feral animals and increases in uncontrolled recreational activities. This risk of bushfire as a result of the proposed mine is considered to represent a **low** risk to native flora in that it may result in a regional reduction or loss of population viability or a regional long-term decrease in abundance of listed flora species. Noting that a number of native flora species are disturbance dependent and can actually thrive following a fire event (depending on the intensity of the fire). Weeds can also respond favourably depending on the intensity of the fire. Introduction of new weeds as a result of the project were considered to represent a **medium** risk.

Low level benefits of the project include the predicted reduction in groundwater level at the nearby salt pans which form part of the Lake Warrambo complex. A **medium** benefit of the project would be the establishment of the SEB offset which would have a regional positive affect ideally aligning with regional objectives for native flora and weeds.

The outcomes proposed ensure that Iron Road will manage aspects related to vegetation and weeds in a proactive and responsible manner.



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