APPENDIX C

Biodiversity Offset Increase Flora Report

GINKGO MINERAL SANDS MINE

SOUTHERN EXTENSION MODIFICATION

OFFSET INCREASE FLORA REPORT

PREPARED BY
FLORASEARCH

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EXECUTIVE SUMMARY

This flora report was conducted as part of the Ginkgo Mineral Sands Mine (Ginkgo Mine) Southern Extension Modification (the Modification). The Ginkgo Mine is located approximately 85 kilometres (km) north-east of Wentworth and approximately 170 km to the south-east of Broken Hill in western New South Wales (NSW).

This report provides an assessment on an approximate 1,255 hectare (ha) extension to the existing Ginkgo Mine Crayfish Deposit Offset to offset approximately 333 ha of surface development at the Ginkgo Mine that has not been accounted for in previous Ginkgo Mine offset area calculations (the Subject area).

Cristal Mining Australia Limited (Cristal Mining) currently has a number of existing offset areas in the surrounding locality, two of which have been established for the Ginkgo Mine, totalling approximately 2,603 ha. Cristal Mining proposes to extend the existing Ginkgo Mine Crayfish Deposit offset area, located within the Mallara property approximately 19 km east of the Ginkgo Mine. The extensions to the existing offset areas are herein referred to as the proposed offset areas.

Detailed flora surveys of areas covering the proposed offset areas were undertaken by FloraSearch in 2012 and 2014. The flora surveys involved collection of flora data via standard methods (quadrats, random meanders and targeted searches for threatened species). In addition, the BioMetric methodology was used to assess the condition of the vegetation in the proposed offset areas in both the 2012 and 2014 surveys.

The proposed offset areas were then located in order to best represent the flora values that occurred in the Subject area (e.g. vegetation communities) as well as capture flora with higher conservation values. The proposed offset areas are located immediately adjacent to the existing Ginkgo Mine Crayfish Deposit offset area thereby resulting in a larger, single area of vegetation being conserved.

Overall, the proposed offset areas contain better flora conservation values than those of the Subject area. No threatened flora or ecological communities listed under the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) are known to have occurred in the Subject area but the proposed offset areas include a portion of a large population of the Endangered Winged Peppercress (*Lepidium monoplocoides*) listed under the TSC Act and EPBC Act.

The Mallara property is a NSW Western Lands Lease currently used for grazing livestock so there is an opportunity to improve the flora values by removing grazing. The same method of conservation security, management and monitoring for the existing Ginkgo Mine Crayfish Deposit offset area would be applied to the proposed offset areas, such that flora conservation values would be maintained and enhanced. As such, the proposed offset areas would achieve the objective of maintaining and improving flora conservation in the region (and local area) in the medium to long-term.

1 INTRODUCTION

Cristal Mining Australia Limited (Cristal Mining) operates the Ginkgo Mine, which is located approximately 85 kilometres (km) north-east of Wentworth and approximately 170 km to the south-east of Broken Hill in western New South Wales (NSW) (Figure 1).

Cristal Mining is preparing an Environmental Assessment (EA) to support applications to modify the Ginkgo Mine Development Consent (DA 251-09-01). The Modification would include two components:

1. extensions (approximately 32 hectares [ha]) to the existing/approved surface development area for additional development areas for the mine path, overburden emplacement, topsoil stockpile areas and other supporting infrastructure; and
2. an increase in the Ginkgo Mine biodiversity offset area to account for existing surface development (approximately 333 ha) that has not been accounted for in previous Ginkgo Mine biodiversity offset area calculations.

This report covers the second component, an increase in the Ginkgo Mine biodiversity offset area to account for existing surface development. As part of this Modification, Cristal Mining propose an extension to the existing Ginkgo Mine Crayfish Deposit Offset area to offset approximately 333 ha of surface development at the Ginkgo Mine that has not been accounted for in previous Ginkgo Mine offset area calculations (the Subject area).

A separate report, titled the *Ginkgo Mineral Sands Mine Southern Extension Modification – Southern Extension Flora Assessment* (FloraSearch, 2015), covers the flora assessment for the additional 32 ha surface development area.

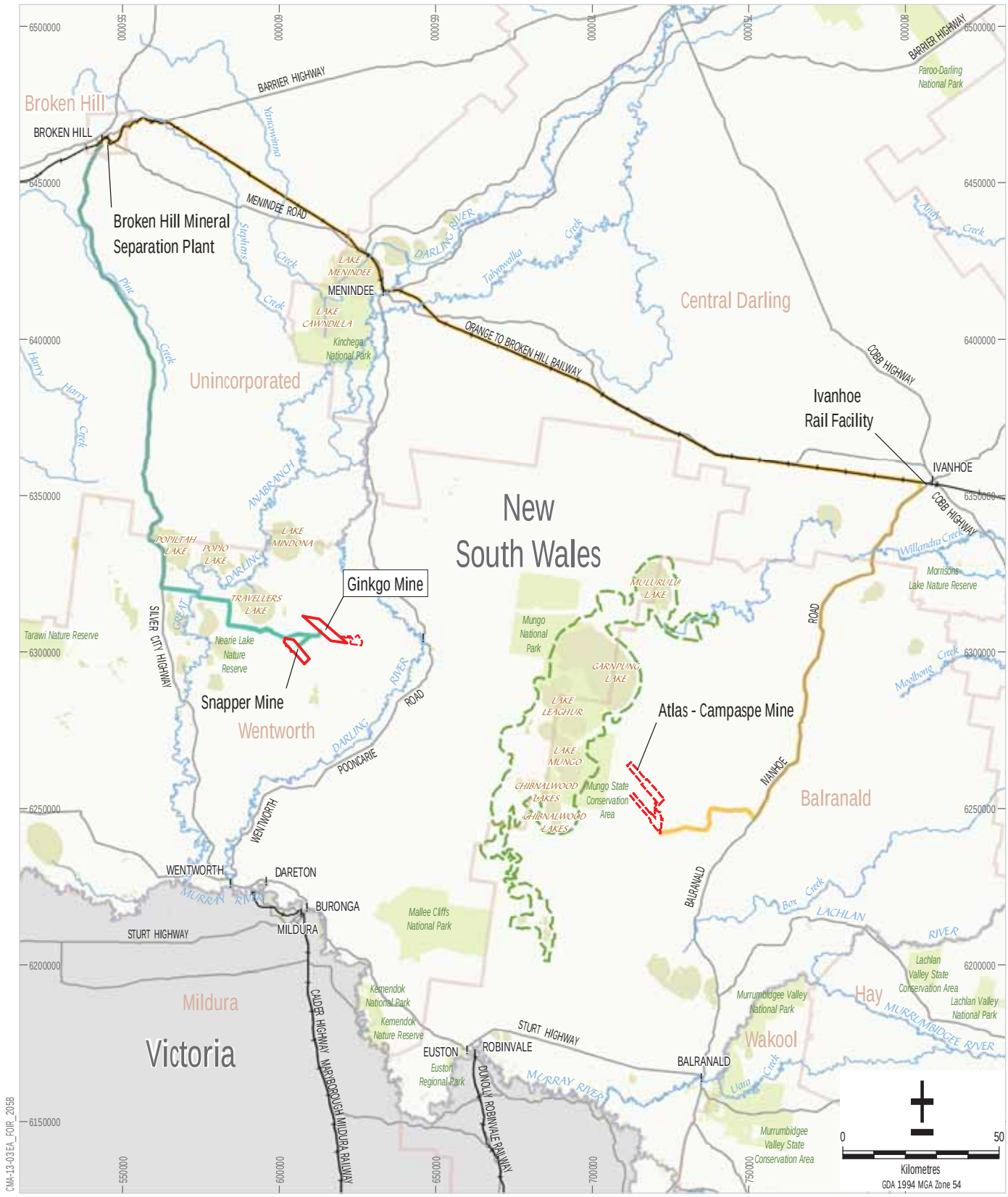
The existing/approved general arrangement is shown on Figures 2a and 2b (including both processing options approved as part of the *Ginkgo Mineral Sands Mine November 2012 Modification Modified Request* [Cristal Mining, 2013]). The Subject area is shown on Figure 3.

1.1 OBJECTIVES

The objective of this report is to present the flora characteristics of the proposed offset areas in comparison to the flora characteristics of the Subject area. To do this, the following characteristics, of both the proposed offset areas and the Subject area, are discussed in this report:

- relationship to existing offset areas and proximity to the Subject area;
- quality and quantity of vegetation communities;
- occurrence of threatened species, populations, ecological communities and critical habitat of the proposed offset areas listed under NSW and Commonwealth legislation (NSW *Threatened Species Conservation Act, 1995* [TSC Act] and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act]);
- ecosystem resilience and condition; and
- hollow-bearing trees and fallen timber.

Separate reports were prepared which document flora surveys of the proposed offset areas (FloraSearch, 2012, 2014).



LEGEND

- National Park, Regional Park or State Conservation Area
- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Local Government Area Boundary
- Willandra Lakes Region World Heritage Area
- Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Atlas-Campaspe Mineral Sands Project Mineral Concentrate Transport Route and MSP Process Waste Transport Route*

CRISTAL

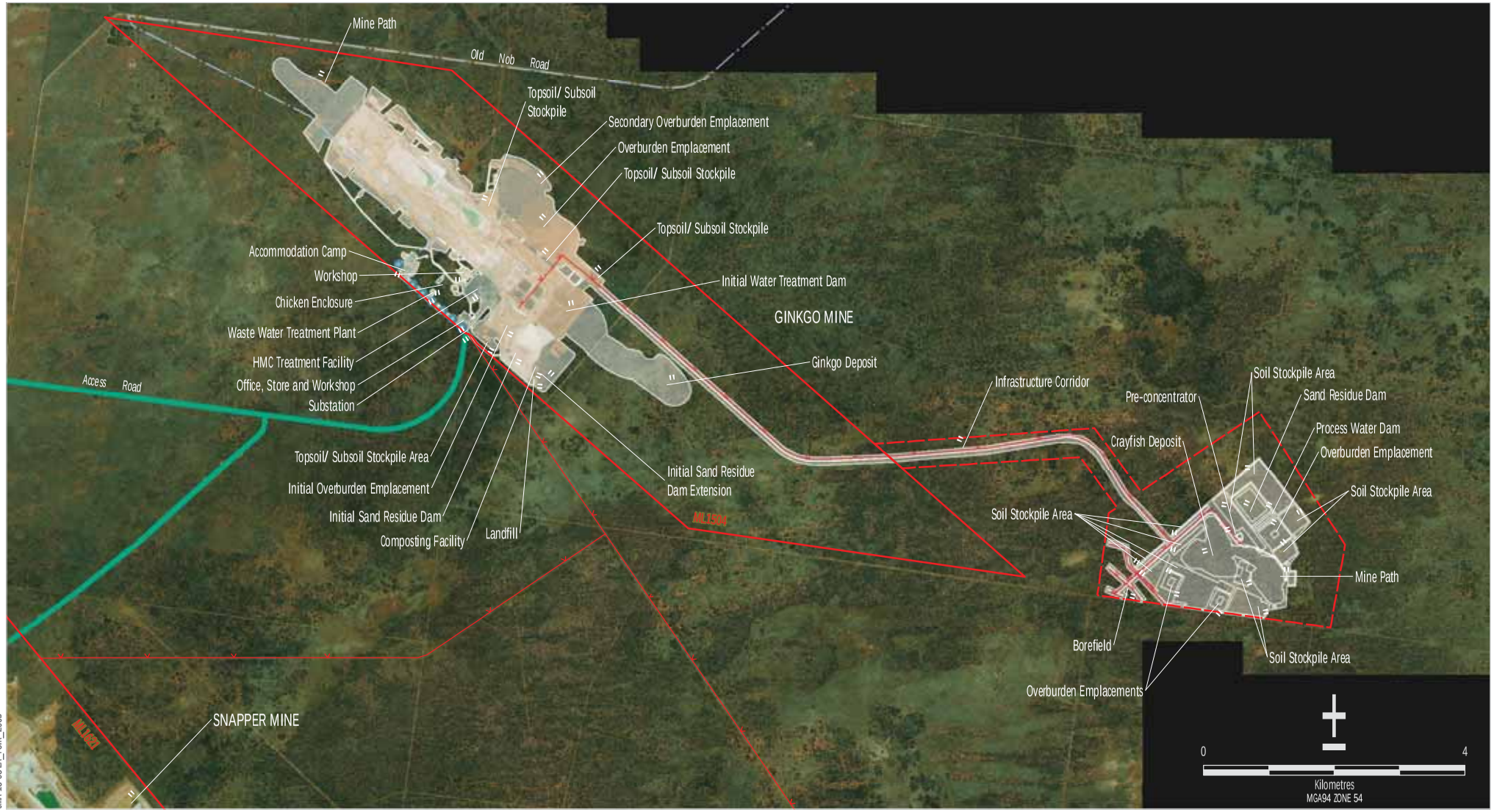
G I N K G O M I N E

Regional Location

** MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines*

Source: DPI-C&L (CLD) (2011) and Cristal Mining (2013).

Figure 1



CMA-13-03 EA_FOR_206D

LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Ginkgo Mine Potable Water Pipeline (Not Constructed)
- Electricity Transmission Line
- Water Bore
- Existing/Approved Approximate Extent of Surface Development (Processing Option 1)

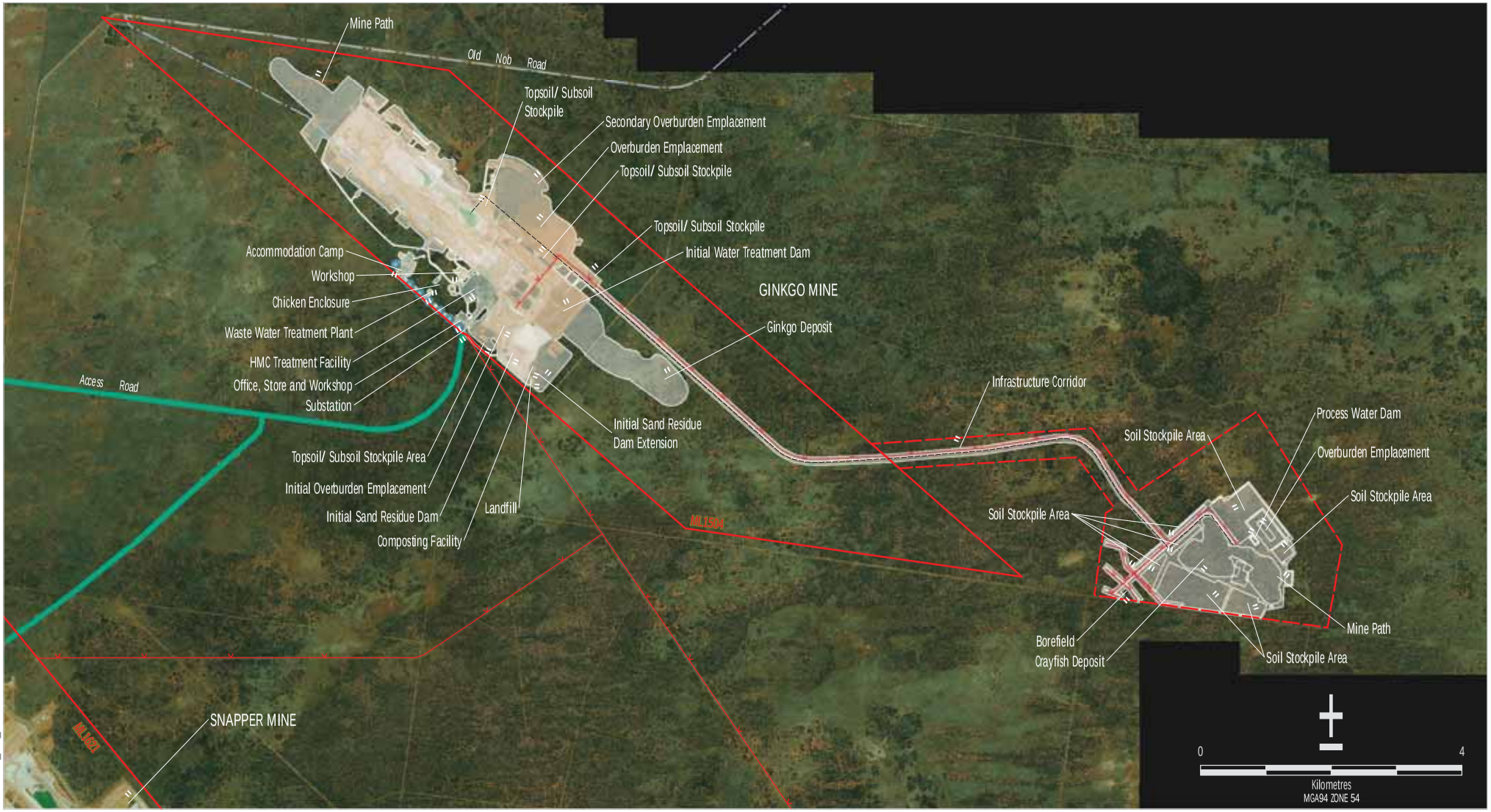
CRISTAL

GINKGO MINE

Existing/Approved Ginkgo Mine (Processing Option 1)

Source: Bemax Resources Limited (2010) and Cristal Mining (2013); Orthophoto: Cristal Mining (2012)

Figure 2a



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LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Ginkgo Mine Potable Water Pipeline (Not Constructed)
- Ore Pipeline (Processing Option 2) (Not Constructed)
- Electricity Transmission Line
- Water Bore
- Existing/Approved Approximate Extent of Surface Development (Processing Option 2)

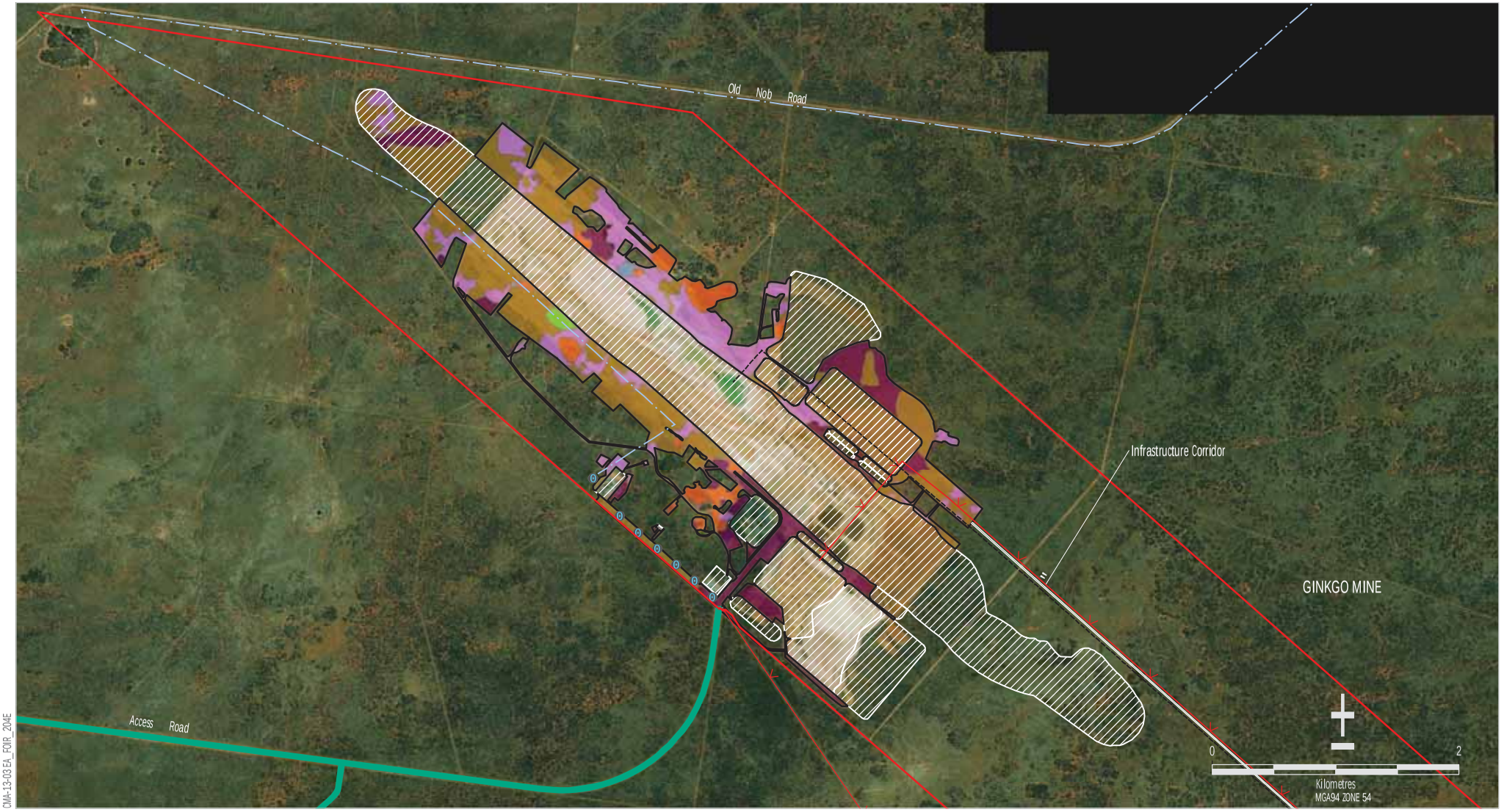
Source: Bemax Resources Limited (2010) and Cristal Mining (2013); Orthophoto: Cristal Mining (2012)

CRISTAL

GINKGO MINE

Existing/Approved Ginkgo Mine (Processing Option 2)

Figure 2b



CMA-13-03 EA_FOR_204E

LEGEND

- Mining Lease Boundary
- Ore Pipeline (Processing Option 2) (Not Constructed)
- Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Ginkgo Mine Potable Water Pipeline (Not Constructed)
- Electricity Transmission Line
- Water Bore

Source: Bemax Resources Limited (2010) and Cristal Mining (2013)
Orthophoto: Cristal Mining (2012)

- Ginkgo Mine General Arrangement (2010)
- Subject Area

Vegetation Community

- 2 Black Oak - Western Rosewood
- 3 Black Oak - Pearl Bluebush Woodland
- 4 Chenopod Mallee Woodland/Shrubland
- 6 Pearl Bluebush Shrubland
- 7 *Austrostipa - Sida* Grassland/Low Shrubland
- 9 *Eragrostis* Depression Grassland

Note: Vegetation Communities 1, 5 and 8 do not occur in the Subject Area.

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GINKGO MINE

Vegetation Communities in the Subject Area

Figure 3

1.2 EXISTING BIODIVERSITY OFFSET STRATEGY

Cristal Mining currently has a number of existing offset areas in the surrounding locality. These existing offset areas can be seen in Figure 4. Cristal Mining has established two existing offset areas for the Ginkgo Mine, totalling approximately 2,603 ha.

One offset area for the Ginkgo Mine (the Southern Mallee Offset) encompasses approximately 521 ha of vegetation communities, including 4 ha of Chenopod Mallee Woodland/ Shrubland vegetation communities, and is surrounded by a larger offset area which was established for the Snapper Mine, (Figure 4). The Southern Mallee Offset is adjacent to the south-western section of the Snapper Mine on the Trelega property (Figure 4).

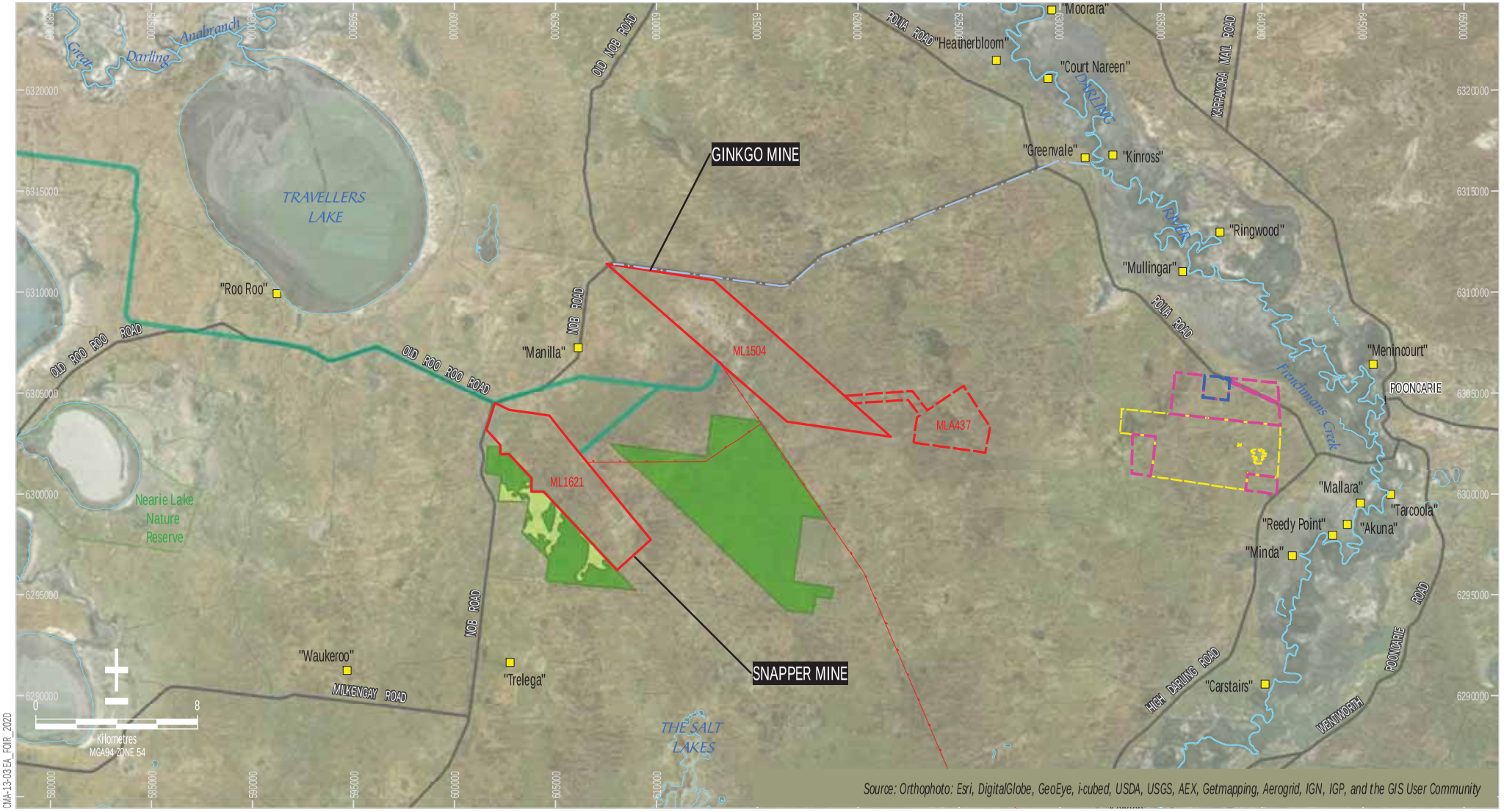
The second offset area for the Ginkgo Mine is located within the Mallara property, located on a Western Lands Lease, leased to Cristal Mining (Figure 4). This existing Ginkgo Mine Offset is 2,082 ha and is dominated by mosaics of Chenopod Mallee Woodland/Shrubland, Black Oak – Western Rosewood Woodland and Dune Mallee Woodland/Shrubland.

Cristal Mining currently has two existing offset areas for the Snapper Mine (Figure 4). The existing Snapper offset areas encompass a total of approximately 5,470 ha.

Cristal Mining has made arrangements to provide appropriate long term security for the Southern Mallee Offset by changing the purpose of the Western Lands Lease for conservation. Cristal Mining will also lodge a conservation bond with the NSW Department of Planning and Environment (DP&E).

Management of the Southern Mallee Offset began following approval of Modification 4 in 2006 under an Offset Management Plan. The existing Offset Management Plan was updated to include the Ginkgo Mine Crayfish Deposit Offset and submitted to DP&E for approval in September 2015. The management measures described in the Offset Management Plan include:

- fencing to exclude grazing;
- incremental destocking;
- removal of unnecessary fencing;
- erosion control;
- signage of the offset areas;
- revegetation of unnecessary access tracks;
- animal pest control;
- weed management;
- fire management;
- threatened species management;
- closure of artificial water sources such that they can no longer hold water;
- vehicle access management;
- an environmental induction for employees and contractors; and.
- auditing/monitoring.



LEGEND

- Mining Lease Boundary (ML)
- Mining Lease Application Boundary (MLA)
- Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Ginkgo Mine Potable Water Pipeline (Not Constructed)
- Electricity Transmission Line
- Dwelling
- Existing Snapper Mine - Biodiversity Offset Area
- Existing Ginkgo Mine - Southern Mallee Offset Area
- Existing Ginkgo Mine - Crayfish Deposit Offset Area
- Proposed Additional Biodiversity Offset Area (1-3)
- Proposed Southern Extension Biodiversity Offset Area (4)

CRISTAL

GINKGO MINE

Existing Biodiversity Offset Areas

Figure 4

1.3 PROPOSED BIODIVERSITY OFFSET STRATEGY

Cristal Mining proposes to extend the existing Ginkgo Mine Crayfish Deposit Offset area (Figures 4 and 5), to include an additional 1,255 ha of native vegetation to accommodate for the Subject area. The proposed offset areas comprise three parcels of land as outlined in Table 1.

Table 1
Proposed Biodiversity Offset Areas

Area	Size
Area 1	926
Area 2	125
Area 3	204
Total	**1,255**

The additional Biodiversity Offset Area 4 (Figure 5) is proposed to account for the proposed Southern Extension area (i.e. subject to a separate report, titled the *Ginkgo Mineral Sands Mine Southern Extension Modification – Southern Extension Flora Assessment* [FloraSearch, 2015]).

The physical attributes and key characteristics of the proposed offset areas are discussed in Section 3. A reconciliation of the offset strategy against the Office of Environment and Heritage (OEH) Offset Principles (OEH, 2014) is provided in Section 3.7 and the ecological gains of the proposed offset areas is summarised in Section 3.8.

The sub-sections below outline the proposed method of conserving the proposed offset areas in perpetuity, proposed management and monitoring.

1.3.1 Long-term Security

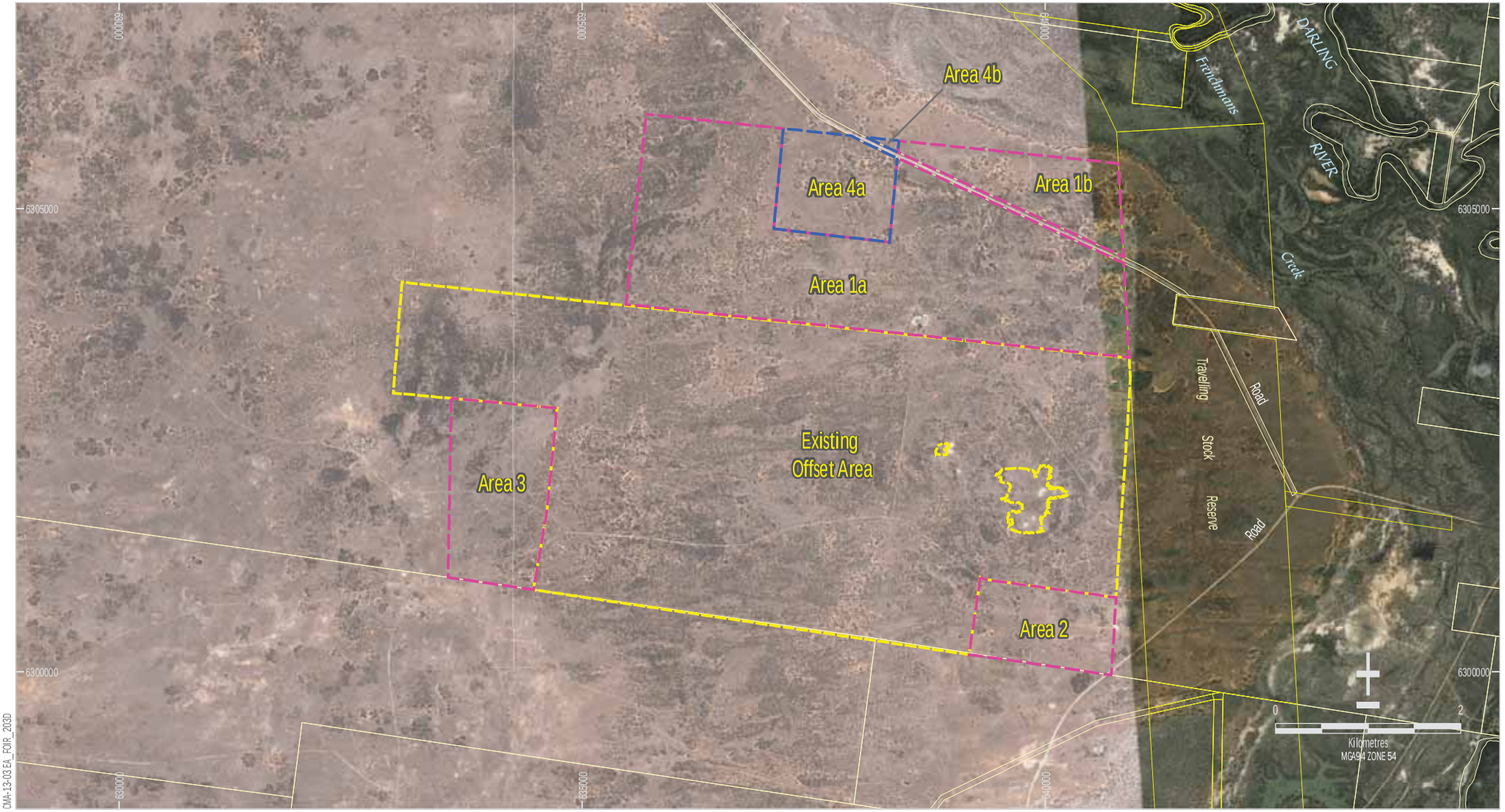
The existing offset areas are located on Western Land Leases held by Cristal Mining. The same method of conservation security for the existing Crayfish Deposit offset area (change in purpose of the Western Lands Lease) would be applied to the proposed offset areas. Suitable arrangements would be made for the long-term security of the Offset areas within a timeframe to the satisfaction of the NSW Secretary of the DP&E.

1.3.2 Proposed Management and Management Plan

The management of the proposed offset areas would be described within an updated Offset Management Plan. Management measures include:

- management of livestock grazing;
- control of weeds;
- management of exotic animal pests;
- bushfire management;
- management of access to water;
- revegetation; and
- control of vehicular access.

Brief summaries of these management strategies are given below.



LEGEND
Existing Ginkgo Mine - Crayfish Deposit Offset Area
Proposed Additional Biodiversity Offset Area (1-3)
Proposed Southern Extension Biodiversity Offset Area (4)

CRISTAL

GINKGO MINE

Proposed Biodiversity Offset Areas

Source: NSW L&PI (2012) and Ortophoto: Google (2013)

Figure 5

1.3.2.1 Management of Livestock Grazing

Uncontrolled livestock and feral goat grazing would be prevented by appropriate fencing of the proposed offset areas.

Fencing works would be undertaken in a manner so as to minimise impacts on a large population of the Endangered Winged Peppercress (*Lepidium monoplocoides*) listed under the TSC Act and EPBC Act (Section 3.6.4).

1.3.2.2 Control of Weeds

One flora species, White Horehound (*Marrubium vulgare*) listed as Noxious in the Wentworth Shire under the *Noxious Weeds Act, 1993* was recorded in the proposed offset areas (Attachment A) and surrounds (FloraSearch, 2012). It is listed as a Category 4 weed and would be controlled by appropriately qualified personnel using standard environmentally safe mechanical or chemical control methods. Regular site inspections would identify the need for further control.

1.3.2.3 Animal Pest Management

Two introduced pest animal species listed as Key Threatening Processes were observed during the survey of the proposed offset areas, namely the Feral Goat (*Capra hircus*) and the European Rabbit (*Oryctolagus cuniculus*) (Biodiversity Monitoring Services, 2015). These, and other noxious and feral species that may be present, would be controlled and monitored by appropriately qualified personnel using standard and ethical methods.

1.3.2.4 Bushfire Management

Bushfire prevention is required under the *Rural Fires Act, 1997*. Appropriate access tracks throughout the proposed offset areas would be maintained for fire management. Fuel loads would be monitored annually and hazard reduction burns conducted in consultation with the Rural Fire Service, as necessary. The Offset Management Plan would establish a bushfire management strategy to reduce the risk of bushfire outbreaks and to establish emergency responses (including fires lit by lightning).

1.3.2.5 Management of Access to Water

Artificial watering points (dams) would be closed such that they can no longer hold water.

1.3.2.6 Revegetation

Unnecessary access tracks are those which are not used for stock movement between Agricultural Areas, access or used for fire management. Unnecessary access tracks will be progressively decommissioned.

1.3.2.7 Controlling Vehicular Access

Vehicular access would be controlled by fencing, signing the proposed offset areas, locking gates and restricting access to authorised personnel.

1.3.3 Monitoring

The existing offset monitoring program on Cristal Mining offset areas would be expanded to the proposed offset area to monitor and report on the effectiveness of offset management measures. The monitoring would be undertaken by a suitably qualified person(s).

2 DATA SOURCES

To present the flora characteristics of the proposed offset areas in comparison to the flora characteristics of the Subject area, a number of data sources were reviewed as outlined below.

2.1 DATABASE SEARCHES

A desktop survey was undertaken to determine the threatened ecological communities, populations, species and critical habitats that are known to occur within the wider region (including the Subject area and the proposed offset areas). Lists of threatened flora that may potentially occur on the Subject area were compiled from searches of the following databases:

- Atlas of NSW Wildlife search (40 x 40 km polygon surrounding the Subject area [OEH, 2015a]).
- EPBC Act Protected Matters Search Tool (40 x 40 km polygon surrounding the Subject area [Department of the Environment, 2015]).

The results of the above searches are detailed in the attached reports which describe the vegetation on the proposed offset areas (FloraSearch, 2012, 2014).

2.2 FLORA SURVEYS IN THE SUBJECT AREA AND SURROUNDS

2.2.1 Flora and Vegetation Surveys for the Ginkgo Mineral Sands Project Environmental Impact Statement

Initial flora surveys of the Subject area were conducted by Ogyris Ecological Research (2000). The results of these surveys were included in the Environmental Impact Statement for the Ginkgo Mineral Sands Project (Bemax Resources and Resource Strategies, 2001). The reports are:

- *Preliminary Report on the Flora of the Ginkgo Sand Mine Prospect near Pooncarie, South West New South Wales.* Ogyris Ecological Research (2000).
- *Flora Assessment.* Appendix G of the *Ginkgo Mineral Sands Project Environmental Impact Statement*. Orchid Research and Marianne Porteners Environmental Consulting (2001).

2.2.2 Ginkgo Mineral Sands Project Pre-clearance Surveys (2005-2015)

Pre-clearance surveys for flora and fauna were conducted on all land that is the subject of this Modification request. Twelve pre-clearance surveys were conducted between 2005 and 2012 by Ogyris Ecological Research. The surveys identified and mapped the vegetation communities present and provided a list of flora species observed on survey plots and opportunistically on the clearance areas. The pre-clearance survey reports are:

- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 1) Ginkgo Sand Mine, Autumn-Winter 2005.* Ogyris Ecological Research (2005).
- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 2) Ginkgo Sand Mine - February 2006.* Ogyris Ecological Research (2006a).
- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 3) Ginkgo Sand Mine - September 2006.* Ogyris Ecological Research (2006b).

- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 4) Ginkgo Sand Mine, February 2007.* Ogyris Ecological Research (2007a).
- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 5) Ginkgo Sand Mine Stage 2 Extension, May 2007.* Ogyris Ecological Research (2007b).
- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 6) Ginkgo Sand Mine Stage 3 Extension and northern boundary fenceline. February 2009.* Ogyris Ecological Research (2009a).
- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 8) Ginkgo Sand Mine Stage 4 Northern Extension and expansion of overburden stockpile OB2. May 2009.* Ogyris Ecological Research (2009b).
- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 9) Ginkgo Sand Mine Stage 4 Northern Extension. Winter 2009.* Ogyris Ecological Research (2010).
- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 13) Ginkgo Mine. August 2011*. Ogyris Ecological Research (2011).
- *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 14) Ginkgo Mine. January 2012*. Ogyris Ecological Research (2012a).
- *Vegetation Pre-clearance Fauna Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin sand mine sites. Ginkgo Mine - Winter 2012*. Ogyris Ecological Research (2012b).
- *Vegetation Pre-clearance Vegetation and Soils Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin Mineral Sand Mine Sites. Ginkgo Mine - Winter 2012*. Ogyris Ecological Research (2012c).
- *Vegetation Pre-clearance Fauna Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin mineral sand mine sites. Ginkgo Mine. February 2013.* Ogyris Ecological Research (2013).
- *Vegetation Pre-clearance Vegetation and Soils Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin mineral sand mine sites. Ginkgo Mine – Winter 2014.* Ogyris Ecological Research (2014a).
- *Vegetation Pre-clearance Fauna Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin mineral sand mine sites. Ginkgo Mine – Autumn – Winter 2014.* Ogyris Ecological Research (2014b).
- *Vegetation Pre-clearance Vegetation and Soils Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin mineral sand mine sites. Ginkgo Mine – Autumn 2015.* Ogyris Ecological Research (2015a).
- *Vegetation Pre-clearance Fauna Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin mineral sand mine sites. Ginkgo Mine. July 2015.* Ogyris Ecological Research (2015b).

Vegetation condition in the Subject area was rated by Ogyris Ecological Research (2005) on a scale from 1 to 5 (Table 2).

Table 2
Criteria and Weighting for Assessment of Remnant Vegetation in the Murray Darling Depression Bioregion (Ogyris Ecological Research, 2005)

Qualitative Rating	Description	Descriptive Rating
5	Vegetation structurally and floristically **intact** or almost so; weed invasions **minimal** or weeds absent; disturbance **minimal** or absent.	Excellent
4	Vegetation structurally and floristically **substantially intact**; low levels of weed invasion; **low levels** of disturbance.	Very Good
3	Vegetation **partially intact** structurally and/or floristically; **moderate** levels of weed invasion and disturbance.	Good
2	Vegetation comprised of **less than 50% cover** of indigenous species and/or with **much reduced** species richness; in the case of woody vegetation the upper strata may provide moderate to high cover but the field layer is substantially exotic; **high** levels of disturbance.	Moderate
1	Vegetation **grossly modified** with scattered to rare dominants of upper strata only persisting; **very high cover** of weeds; current or former levels of disturbance **high** or **very high**.	Poor

2.2.3 Flora and Vegetation Surveys for the Crayfish Modification

Parts of Mining Lease (ML) 1504 were surveyed by FloraSearch in 2012 for the Crayfish Modification flora assessment. The area surveyed was the area of Mining Lease Application (MLA) 1504 to be traversed by the proposed route of the haul road from the Crayfish deposit to the processing area at the Ginkgo Mine. The relevant report is: *Ginkgo Mineral Sands Project – Crayfish Modification. Flora Assessment.* Prepared for Bemax Resources Ltd by FloraSearch (2012).

2.2.4 Flora Survey Effort on ML 1504 and the Subject Area

The flora survey effort on ML 1504 and the Subject area between 2000 and 2012 is summarised in Table 3. A total of 127 flora survey quadrats have been conducted within ML 1504, of which 67 have specifically targeted the Subject area. All flora species present were recorded on all quadrats. Attachment A is a compilation of the flora species recorded on the Subject area and ML 1504.

Table 3
Flora Survey Effort on ML 1504 and the Subject Area

Report (Year)[1]	No. of Quadrats[2]	Area Surveyed (ha)	Comment
Ogyris (2000)	60	3,500	Whole of ML 1504
Ogyris (2005)	12	50.1	-
Ogyris (2006a)	1	15.0	-
Ogyris (2006b)	0	5.6	Flora species list compiled
Ogyris (2007a)	2	43.9	-
Ogyris (2007b)	4	36.0	-
Ogyris (2009a)	8	151.0	-
Ogyris (2009b)	4	102.6	-
Ogyris (2010)	11	121.5	-
Ogyris (2011)	1	2.0	-

Table 3 (Continued)
Flora Survey Effort on ML 1504 and the Subject Area

Report (Year)[1]	No. of Quadrats[2]	Area Surveyed (ha)	Comment
Ogyris (2012a)	2	2.4	-
Ogyris (2012b)	11	66.9	-
Ogyris (2012c)	11	64.5	-
FloraSearch (2012)	11	-	Crayfish haul road within ML 1504
Total	138	4,161.5	-

[1] Ogyris reports from 2005 to 2012 are specific to the Subject area.

[2] All Ogyris quadrats are 50 × 20 metres (m); FloraSearch are 20 × 20 m.

3 CHARACTERISTICS OF THE PROPOSED BIODIVERSITY OFFSET AREAS

The overall aim of the offset strategy proposed is to prevent a decline in biodiversity values in the immediate region around the Subject area as a result of the Modification, and maintain and improve local biodiversity values (Department of Environment and Conservation and Department of Primary Industries, 2005, OEH, 2014). How the offset strategy achieves these aims is set out in this section.

3.1 CLIMATE

The Subject area and proposed offset areas are located in a persistently dry (mean average rainfall of approximately 260 millimetres [mm]), arid climatic zone with mostly uniform rainfall distribution throughout the year, when averaged over many years. Within and between years rainfall is highly variable. Mild winters, hot summers and warm spring and autumn weather are typically experienced.

3.2 HYDROLOGY

There are no watercourses in the Subject area or proposed offset areas. The aeolian soils readily absorb the generally low rainfall such that there is usually little run-off and no stream formation. Large playa depressions that may fill with water in occasional large rainfall events are scattered through the proposed offset areas. In addition, depressed claypans may occur in the swales between the larger sand dunes, often with numerous sink holes.

3.3 TOPOGRAPHY

ML 1504 is on a gently undulating aeolian sandplain. Elevations vary from approximately 65 to 85 metres (m) Australian Height Datum (Google Earth, 2015). The proposed offset areas' elevation ranges from 50 to 68 m, with the highest elevations on the east-west dunes that traverse the centre of the area and the lowest on the sand plain areas in the south west corner and along the eastern margin (Google Earth, 2015).

3.4 SOILS

The soil types in the proposed offset areas vary with landscape position. The solonised brown soils on sand plains often have high contents of limestone nodules, are sandy loams at the surface and clay loams at depth (Cunningham *et al.*, 1981). Playa or 'run-on' depressions tend to have high surface clay contents forming clay pans that hold water for relatively long periods after rain (Cunningham *et al.*, 1981). Dune soils (red earths) vary in composition with dune height; high dunes tend to have poorly consolidated sandy soils, while lower dunes and thinner sand masses tend to have higher clay contents and more soil coherence (Cunningham *et al.*, 1981).

3.5 LAND USE

The Subject area and proposed offset areas are both located on the Mallara property, a NSW Western Lands grazing lease. Prior to the commencement of the Ginkgo Mineral Sand Mine, ML 1504 (and the Subject area) was used for grazing domestic livestock, mainly sheep and cattle, and for harvesting feral goat populations.

3.6 FLORA CHARACTERISTICS OF THE PROPOSED OFFSET AREAS

The flora of the proposed offset areas is discussed in detail in FloraSearch (2012) and in FloraSearch (2014). The dominant vegetation communities in the proposed offset areas are shown on Figure 6.

FloraSearch (2012) conducted a total of forty five 20 x 20 m quadrat samples within a study area which contains proposed Offset Areas 2 and 3, with the aim to sample all the dominant plant communities present. Information recorded for each quadrat included the slope, aspect, position on the slope, geology, topsoil characteristics, vegetation structure including the height, dominant species and percentage ground cover of each stratum, and observations of any past or recent disturbance including fire, vegetation thinning, clearing or weed invasion. Within each quadrat a complete list of vascular plant species was made with a modified Braun-Blanquet rating of cover abundance for each recorded species.

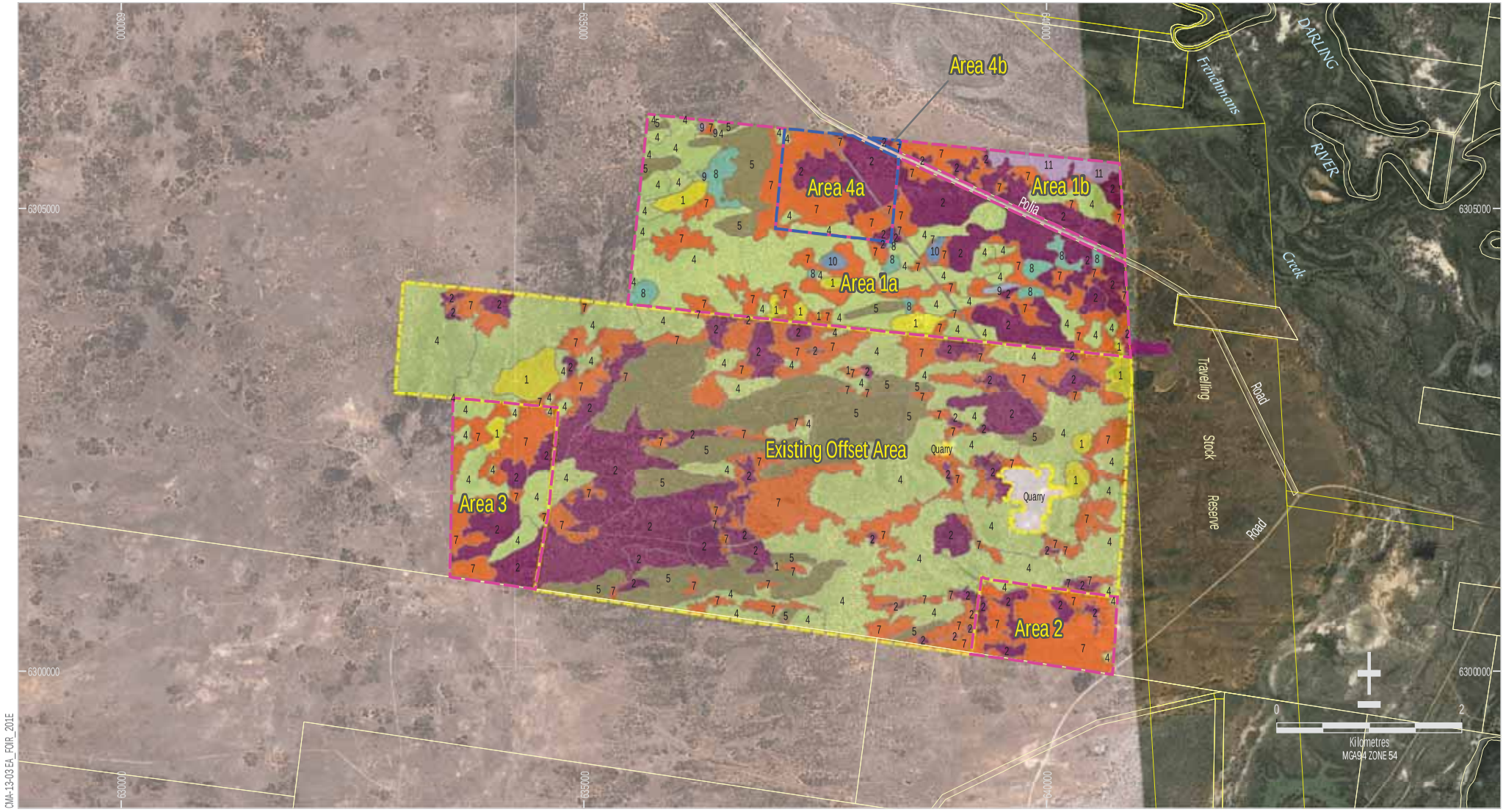
Four rapid assessment spot samples were also conducted on sites of interest within the FloraSearch (2012) study area. Rapid assessment samples involved listing the dominant vascular plants in each vegetation layer within an approximate 15 m radius of a central point. Notes were taken on site characteristics, the condition of the vegetation and any disturbance. Targeted searches for threatened flora species and ecological communities considered possible occurrences within the study area were conducted.

FloraSearch (2014) conducted a total of thirty one 20 x 20 m quadrat samples, distributed across a study area containing proposed Offset Areas 1 and 4. Quadrats were located in dominant climax vegetation communities in approximate proportion to community abundance. Quadrat data collection was consistent with the FloraSearch (2012) methodology. Seven random meanders were also conducted across the FloraSearch (2014) study area in derived vegetation communities, and targeted searches for threatened flora species and ecological communities with considered possible occurrences were conducted.

The condition of the vegetation in the FloraSearch (2014) study area was measured using the 'BioMetric' terrestrial biodiversity assessment methodology (Gibbons *et al.* 2005). The vegetation on the study area was zoned for sampling according to vegetation community and degree of disturbance. Three levels of disturbance based on vegetation clearance were recognised:

1. Complete clearance (i.e. loss of all the original tree cover).
2. Disturbed climax vegetation (canopy thinning by one third or more).
3. Undisturbed climax vegetation (unthinned or lightly thinned).

The above categories represented three broad condition classes for the study. The thirty one 20 × 20 m flora quadrats were extended to 50 × 20 m for 'Biometric' measurements. The 10 condition parameters used in BioMetric to assess site value were measured in each plot, as per Appendix 3 of the BioMetric Operational Manual (Gibbons *et al.*, 2005).



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LEGEND

Existing Ginkgo Mine - Crayfish Deposit Offset Area
Proposed Additional Biodiversity Offset Area (1-3)
Proposed Southern Extension Biodiversity Offset Area (4)

Threatened Flora

Lepidium monoplacoides

Vegetation Community

1 Black Box Woodland
2 Black Oak – Western Rosewood Woodland
4 Chenopod Mallee Woodland/Shrubland
5 Dune Mallee Shrubland
7 *Austrostipa* – Sida Grassland/Low Shrubland
8 Turpentine Tall Open Shrubland
9 *Eragrostis* Depression Grassland
10 *Acacia victoriae* Shrubland
11 Hopbush Shrubland*

Note: Vegetation Communities 3 and 6 do not occur in the Offset Area.

** Equivalent to the Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western Slopes Bioregions Endangered Ecological Community*

Source: NSW L&PI (2012) and Ortophoto: Google (2013)

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Vegetation in the Proposed Biodiversity Offset Areas and Surrounds

Figure 6

The proposed offset areas were selected in consideration of a range of factors:

1. Relationship to existing offset areas.
2. Proximity to the Subject area.
3. Regional conservation priorities and vegetation most in need of conservation.
4. The available land tenure on which to locate an offset area.
5. The vegetation composition of the Subject area relative to the proposed offset areas; meeting the 'like for like' criterion.
6. The size of the proposed offset areas relative to the Subject area.
7. The ecosystem resilience and condition of the proposed offset areas.

These factors are discussed below.

3.6.1 Relationship to Existing Offset Areas

Cristal Mining manages two large offset areas on Trelega Station to the east and west of the Snapper Mine (Figure 4). These offset areas have been placed to avoid known zones of mineralisation that may potentially be mined in the future. The presence of surrounding mineralisation precluded enlargement of these offset areas for the purpose of the Modification.

The proposed offset areas adjoin the existing Ginkgo Mine Crayfish Deposit Offset which was set aside to offset disturbance at the Ginkgo Mine. Expansion of the existing Ginkgo Mine Crayfish Deposit Offset with three new additions would increase its size and long term sustainability, and is preferable to establishing an entirely new, small offset area elsewhere.

3.6.2 Proximity to the Subject Area

The proposed offset areas are located within the same Local Land Services (LLS) region and Interim Biogeographic Regionalisation of Australia (IBRA) subregion as the Subject area (i.e. the Lower Murray Darling LLS Region and the South Olary Plains (Part D) subregion of the Murray Darling Depression Bioregion) and would therefore benefit biodiversity values in the same region as the Subject area.

3.6.3 Vegetation

3.6.3.1 Background

The characterisation of vegetation communities found on ML 1504 has changed since the Ginkgo Mineral Sands Project Environmental Impact Statement (EIS) was published in 2001. This change resulted from the publication in 2006 of the *NSW Vegetation Classification and Assessment: Part 1. Plant Communities of the NSW Western Plains* (Benson *et al.,* 2006) (NSWVCA). In addition, somewhat different community concepts were employed by Ogyris Ecological Research in their pre-clearance reports between 2005 and 2010. After 2010, Ogyris adopted the NSWVCA classification. The NSWVCA (Benson *et al.,* 2006) and OEH (2015b) classification is followed in this report.

The main differences between the approaches of the EIS, Ogyris Ecological Research and the NSWVCA are in the treatment of Belah (Black Oak) Woodlands and Mallee Shrublands:

- Two minor communities that are now known to occur on ML 1504 were not recognised in the EIS, Dune Mallee Woodland / Shrubland and Eragrostis Depression Grassland. The latter is more often dominated by herbs than Lovegrass (Eragrostis spp.) in the mining lease.
- A common community in the EIS, Mallee/Belah Woodland, was defined for landscape areas with mosaics of small Mallee and Belah patches. Mallee and Belah are now regarded as separate complexes of communities.
- In its early pre-clearance reports Ogyris Ecological Research treated the NSWVCA community, Black Oak – Pearl Bluebush Woodland as part of the Black Oak-Rosewood Woodland community.
- Similarly, the early Ogyris Ecological Research pre-clearance reports amalgamated *Austrostipa-Sida* Grassland/Low Shrubland and Pearl Bluebush Shrubland into a Bluebush Shrubland–Grassland/Copperburr Low Shrubland community. [*Austrostipa* Grassland on the MLA usually includes various Copperburr species as dominants. By contrast, *Sida* species are frequent co-dominants on the offset areas, where the equivalent community is referred to as *Austrostipa-Sida* Grassland/Low Shrubland. To avoid confusion, the latter name is used in this report hereon for both the Subject area and the offset area.]

3.6.3.2 Vegetation Communities

The vegetation communities previously in the Subject area have been mapped using Air Photo Interpretation and previous data collected in ML 1504 (Section 2) (Figure 3). Six vegetation communities occurred in the Subject area (Table 4). Community numbers in Table 4 correspond to numbers used for equivalent vegetation communities in the proposed offset areas.

The two dominant communities in the Subject area were Black Oak – Pearl Bluebush Woodland (135 ha) and Pearl Bluebush Shrubland (106 ha). Black Oak – Western Rosewood Woodland was also prominent (65 ha). Smaller areas of *Austrostipa-Sida* Grassland/ Low Shrubland (23 ha), Chenopod Mallee Woodland/Shrubland (3 ha) and *Eragrostis* Depression Grassland (1 ha) were also present.

The proposed offset areas share similar sandplain vegetation with the Subject area (Figures 3 and 6). Table 4 compares the vegetation types in the proposed offset areas with those in the Subject area. However, there are some differences due mainly to the lower altitudes of the proposed offset areas and their close proximity to the Darling River floodplain.

The best fitting Biometric Vegetation Types (OEH, 2015b) are noted in Table 4.

Table 4
Quantification of Vegetation Types in the Subject Area and Proposed Biodiversity Offset Areas

Vegetation Community	Biometric Vegetation Type (OEH, 2015b)	Ginkgo Mine Subject Area (ha)	Proposed Additional Biodiversity Offset Areas (1-3) (ha)	% of the Biometric Vegetation Type Remaining in the Lower Murray Darling CMA (OEH, 2015b)
Inland Floodplain Woodlands				
1. Black Box Woodland	LM104	0	37.5	80%
Semi-arid Sand Plain Woodlands				
2. Black Oak – Western Rosewood Woodland	LM108	65	288	80%
3. Black Oak – Pearl Bluebush Woodland	LM107	135	0	80%
Aeolian Chenopod Shrublands				
6. Pearl Bluebush Shrubland	LM138	106	0	90%
Sand Plain Mallee Woodlands				
4. Chenopod Mallee Woodland / Shrubland	LM116	3	406.5	70%
Dune Mallee Shrubland				
5. Dune Mallee Shrubland	LM130	0	61.5	95%
Derived Vegetation				
7. *Austrostipa – Sida* Grassland/Low Shrubland*	LM116	23	383	-
8. Turpentine Tall Open Shrubland*	LM108	0	43	-
9. *Eragrostis* Depression Grassland*	LM104	1	3.5	-
10. *Acacia victoriae* Shrubland*	LM108	0	7.5	-
11. Hopbush Shrubland*^	LM134	0	24.5	-
	Total (ha)	**333**	**1,255**	

* Secondary vegetation community.

^ May be a part of the *Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western Slopes Bioregions* Endangered Ecological Community (Sandhill Pine Woodland EEC).

CMA = Catchment Management Authority

Two climax vegetation communities with occurrences in the Subject area, Black Oak – Pearl Bluebush Woodland (135 ha) and Pearl Bluebush Shrubland (106 ha), do not occur in the proposed offset areas (Table 4). It is considered that the vegetation of the proposed offset areas, although not exactly 'like for like' in terms of vegetation communities, nevertheless represents similar good quality vegetation of high conservation value (Sections 3.6.3.3 and 3.6.4) because:

- Black Oak – Pearl Bluebush Woodland is in the same vegetation class as Black Oak – Western Rosewood Woodland, of which there is 288 ha in the offset areas (i.e. both are Semi-arid Sand Plain Woodlands).
- All of the climax communities in the offset areas are inadequately protected in the conservation reserve system (as of 2006). Once combined, the overall offset area would make a significant contribution to the conservation of these communities.
- According to OEH (2015b) data, the Chenopod Mallee Woodland / Shrubland (LM116) has been subject to more clearing in the Lower Murray Darling CMA (70% remains) compared to the other Biometric Vegetation Types in Table 4 (all greater than 80% remaining).

- The proposed offset areas contain five additional vegetation communities which are not present in the Subject area:
  - Black Box Woodland;
  - Dune Mallee Shrubland;
  - Turpentine Tall Open Shrubland;
  - *Acacia victoriae* Shrubland; and
  - Hopbush Shrubland.

3.6.3.3 Regional Conservation Priorities

The proposed offset areas would contribute to the conservation of a number of poorly conserved vegetation communities in the Lower Murray Darling Catchment Management Authority region. Table 5 gives the conservation status of vegetation communities in the proposed offset areas as assessed by Benson *et al*. (2006).

Table 5
Conservation Status of the Proposed Biodiversity Offset Areas' Vegetation Communities

Vegetation Community[1]	Community No. (Benson *et al*., 2006)	Community Name	Conservation Status (Benson *et al*., 2006)
1. Black Box Woodland	16	Black Box Woodland	Inadequately protected
2. Black Oak – Western Rosewood Woodland	58/221	Black Oak – Western Rosewood Woodland	Inadequately protected
4. Chenopod Mallee Woodland/Shrubland	170	Chenopod Mallee Woodland/Shrubland	Inadequately protected
5. Dune Mallee Shrubland	171	Linear Dune Mallee	Adequately protected

[1] Communities 3 and 6 are not present in the Proposed Biodiversity Offset Areas.

Table 5 indicates that all of the climax communities in the offset areas are inadequately protected in the conservation reserve system (as of 2006). Accordingly, the proposed offset areas would make a significant contribution to the long term protection of these communities.

3.6.4 Threatened Species and Communities

No threatened flora species listed under the TSC Act was found in any of the surveys that have been conducted on ML 1504. None of the vegetation communities in the Subject area (Table 4) is listed as threatened under the TSC Act.

Community 11, Hopbush Shrubland, may have been part of the Sandhill Pine Woodland Endangered Ecological Community (EEC) (FloraSearch, 2014). Approximately 24.5 ha of this community occur in the north-eastern corner of the largest proposed offset area's parcel (Figure 6). The presence of this community considerably enhances the biodiversity values of the proposed offset areas.

In addition, the proposed offset areas have part of a very large population of the Winged Peppercress (*Lepidium monoplocoides*) in the south-eastern corner of the larger proposed offset area's parcel (Figure 6, FloraSearch, 2014). Winged Peppercress is listed as Endangered under both the TSC Act and the EPBC Act.

No threatened flora species or ecological communities listed under the EPBC Act have been previously recorded in the Subject area or immediate surrounds. It is, therefore, considered unlikely that the clearance of the native vegetation in the Subject area had a significant impact on any threatened flora species or ecological communities. As described above, the Winged Peppercress occurs in the offset area and is listed under the EPBC Act.

3.6.5 Size

The proposed offset areas total 1,255 ha while the Subject area is 333 ha (Table 4). Although the proposed offset areas are in three parcels, their addition to the eastern Ginkgo Mine offset area creates a larger and more viable conservation area overall.

3.6.6 Ecosystem Resilience and Condition

The vegetation communities in the proposed offset areas are similar or better in condition than those in the Subject area (Table 6, Figures 7 and 8). The condition of the vegetation in the proposed offset areas was determined using the BioMetric methodology (Gibbons *et al.,* 2005) (Attachment B). The proposed offset areas generally compared favourably with BioMetric condition benchmarks for each vegetation community, with the exceptions of mid-storey cover and groundcover shrubs (FloraSearch, 2012, 2014). In particular, the proposed offset areas showed much higher numbers of hollow-bearing trees and fallen logs than for the corresponding BioMetric benchmarks (FloraSearch, 2012, 2014).

Table 6
Comparison of Condition of Climax Vegetation Communities in the Subject Area and the Proposed Biodiversity Offset Areas

Vegetation Community		Subject Area		Proposed Biodiversity Offset Areas
		Mean Rating	Descriptor	Descriptor
1	Black Box Woodland	-	-	Poor to Moderate
2	Black Oak – Western Rosewood Woodland	2.5	Moderate to Good	Poor to Moderate to Good
3	Black Oak – Pearl Bluebush Woodland	2.6	Good	Not present.
4	Chenopod Mallee Woodland/Shrubland	2.5	Moderate to Good	Moderate to Good
5	Dune Mallee Shrubland	Not present.		Good
6	Pearl Bluebush Shrubland	2.1	Moderate to Good	Not present.

Condition rankings for the Subject area were assigned during pre-clearance surveys by Ogyris Ecological Research (Ogyris, 2005 to 2012c) using the criteria in Table 2 (Attachment B). The two methods have produced similar condition descriptions for both areas. This is understandable since the Subject area and proposed offset areas are part of the same Western Lands Lease and consequently have been managed in a similar way over a very long period of time.

The condition of the vegetation in the Subject area is influenced by a number of factors including the occasional use of fire by land holders (FloraSearch, 2012).

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LEGEND

- Mining Lease Boundary
- Ore Pipeline
- Mineral Concentrate Transport Route and MSP Process Waste Transport Route
- Ginkgo Mine Potable Water Pipeline (Not Constructed)
- Electricity Transmission Line
- Water Bore

Ginkgo Mine General Arrangement (2010)

Subject Area

Vegetation Condition

- Good
- Moderate
- Poor
- Very Poor

Source: Bemax Resources Limited (2010) and Cristal Mining (2013)
Orthophoto: Cristal Mining (2012)

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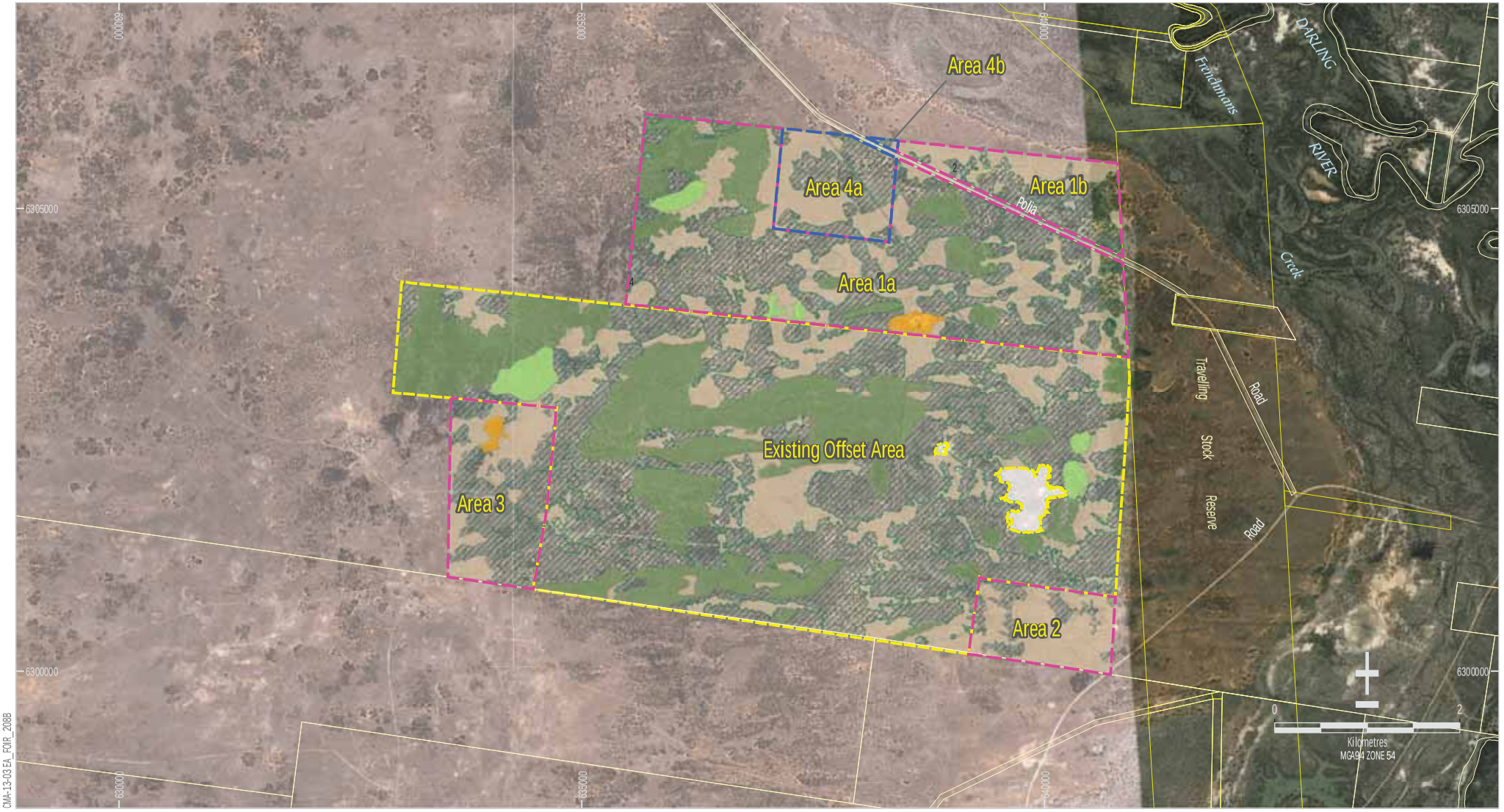
Condition of Vegetation in the Subject Area

Figure 7



LEGEND

Existing Ginkgo Mine - Crayfish Deposit Offset Area
Proposed Additional Biodiversity Offset Area (1-3)
Proposed Southern Extension Biodiversity Offset Area (4)

Vegetation Condition

- Good
- Moderate
- Poor to Moderate
- Poor
- Very Poor
- Quarry

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Condition of Vegetation in the Proposed Biodiversity Offset Area and Surrounds

Figure 8

Source: NSW L&PI (2012) and Ortophoto: Google (2013)

Within the proposed offset areas, FloraSearch (2012 and 2014) documented any evidence of recent or historical disturbance as a result of fire. FloraSearch (2012) documented some evidence of burning within the Dune Mallee Shrubland in the Offset Areas 2 and 3 (possibly to suppress Porcupine Grass [*Triodia scariosa*]), but the burns were not extensive. Despite localised fire induced dieback of some Mallees, the vegetation was considered healthy in generally good condition (FloraSearch, 2012).

No evidence was found of recent fire anywhere in the FloraSearch (2014) study area (which included Offset Areas 2 and 3). Charred stumps, fire-scarred trunks or dead trees associated with fire were observed on only two of 31 plots investigated during the study; one in disturbed Belah-Rosewood Woodland and the other in climax Chenopod Sandplain Mallee Woodland/Shrubland. In both cases it was considered the fire occurred at least several decades ago. These occurrences were very isolated in the FloraSearch (2014) study area suggesting the localised use of fire by landowners, rather than a widespread wildfire.

3.6.7 Hollow-bearing Trees and Fallen Timber

The data from Ogyris Ecological Research from the Subject area in Attachment C indicates a lower mean number of habitat trees per ha than for the proposed offset areas in Table 7. However, the data on habitat trees in Attachment C is not broken down by vegetation community, so cannot be presented in Table 7. In any event, it is clear that good numbers of trees with hollows occur on both areas and that the proposed offset areas represent 'like-for-like' in terms of tree hollows.

Table 7
Data on Tree Hollows, Habitat Trees and Fallen Logs in Climax Vegetation Communities in the Subject Area and Proposed Biodiversity Offset Areas

Vegetation Community	Subject Area	Proposed Biodiversity Offset Areas	
	Mean Hollows/ha	Mean Habitat Trees/ha	Mean Fallen Logs (m)/ha
1. Black Box Woodland	N/A	90	768
2. Black Oak – Western Rosewood Woodland	45.6	56	446
3. Black Oak – Pearl Bluebush Woodland	74	N/A	N/A
4. Chenopod Mallee Woodland/Shrubland	160	105	236
5. Dune Mallee Shrubland	N/A	50	105
6. Pearl Bluebush Shrubland	0	N/A	N/A

Similarly, the data for fallen logs is not comparable between the two studies since Ogyris Ecological Research reports only the numbers of fallen logs and not their length as required by BioMetric. In addition, Ogyris only began reporting log numbers in the last few pre-clearance reports, so data is limited. Nevertheless, Ogyris reports high numbers of logs per ha in the Subject area. This is mirrored by high lengths of logs in the proposed offset areas (Table 7; FloraSearch, 2012, 2014).

The vegetation in the proposed offset areas is considered to have retained much of its original floristic diversity, albeit considerably affected by past clearing and intensive grazing (FloraSearch, 2012, 2014). It is considered likely that the natural vegetation in the proposed offset areas would regenerate close to its original condition, provided grazing by domestic stock, including goats, is withdrawn and that rabbits are controlled to low numbers. It is highly likely that some flora species that have been reduced to low numbers by grazing would recover and recolonise much of the proposed offset areas. Many examples of shrubs chewed down to ground level were observed during the flora survey, including some that were rarely recorded as adults. Species such as these would recover once grazing is removed.

3.7 RECONCILIATION OF THE PROPOSED OFFSET STRATEGY AGAINST OEH OFFSET PRINCIPLES

The OEH has developed principles for the use of offsets for Projects other than those that are State significant (OEH, 2014). The proposed biodiversity offset strategy for the Modification provides for residual significant impacts to biodiversity resulting from approximately 333 ha which was disturbed outside of the currently approved surface development area, and the proposed extension (approximately 32 ha) to the currently approved surface development area. The offset strategy incorporates four potential offset areas (Offset Areas 1 to 4). A reconciliation of the proposed biodiversity offset strategy (Offset Areas 1 to 4) against the *Principles for the Use of Biodiversity Offsets in NSW* (OEH, 2014) is provided in Table 8.

Table 8
Reconciliation of the Proposed Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2014)	How the Proposed Offset Addresses the OEH Offset Principles
1. *Impacts must be avoided first by using prevention and mitigation measures.*	The offset strategy addresses residual impacts associated with the Modification.
2. *All regulatory requirements must be met.*	Cristal Mining is required to meet all statutory requirements and the offset strategy is not proposed to substitute other licence/approval requirements.
3. *Offsets must never reward ongoing poor performance.*	The offset strategy addresses residual impacts associated with the Modification.
4. *Offsets would complement other government programs.*	The proposed offset areas (1-4) would complement other lands already conserved by the State government (resulting in a greater area of vegetation conserved in NSW).
5. *Offsets must be underpinned by sound ecological principles.*	The proposed offset areas (1-4) expand the existing Ginkgo Mine Crayfish Deposit Offset area (Figure 5), thereby resulting in a larger conservation area. The structure, function and compositional elements of biodiversity (including threatened species) have been considered in the selection of the proposed offset areas (Section 3.6). Biodiversity is likely to be enhanced at a range of scales due to the proposed management measures, particularly the exclusion of livestock grazing and closure of artificial watering points such that they can no longer hold water. The proposed enhancement of the habitat would contribute towards protecting the long-term viability and functionality of local biodiversity.
6. *Offsets should aim to result in a net improvement in biodiversity over time.*	The offset strategy targets vegetation communities and high conservation priorities in the Subject and Modification areas. It is considered that the vegetation of the proposed offset areas (1-4), although not exactly 'like–for-like' in terms of vegetation communities, nevertheless represents good quality vegetation of high conservation value, for the following reasons: • Five of the vegetation communities, three climax and two derived, are considered to be inadequately protected in the region at present. • The proposed offset areas (1-4) adjoin and enhance the existing Ginkgo Mine Crayfish Deposit Offset area, improving its long term viability. • The Offset Area 1 includes part of a large population of the Endangered (TSC Act and EPBC Act) Winged Peppercress (*Lepidium monoplocoides*).
	In relation to Offset Area 4: • The condition of the vegetation in the proposed offset area (Offset Area 4) is equivalent to that in the Subject and Modification areas. • The Subject Area, Modification Area and proposed offset area (Offset Area 4) contain comparable densities of old growth vegetation rich in tree hollows and with a large amount of fallen timber on the ground.

Table 8 (Continued)
Reconciliation of the Proposed Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2014)	How the Proposed Offset Addresses the OEH Offset Principles
7. *Offsets must be enduring. They must offset the impact of the development for the period that the impact occurs.*	The purpose of the Western Land Lease associated with the proposed offset areas (1-4) would be changed to reflect its conservation purpose at the same time as the existing Ginkgo Mine Crayfish Deposit Offset area (i.e. by 30 June 2016), or within a timeframe to the satisfaction of the NSW Secretary of DP&E.
8. *Offsets should be agreed prior to the impact occurring.*	The offset strategy addresses residual impacts associated with the Modification.
9. *Offsets must be quantifiable. The impacts and benefits must be reliably estimated.*	The impacts and benefits have been reliably assessed as follows: • The area of impact and proposed offset is quantified in Table 4 and shown on Figures 3 and 6. • The types of vegetation communities and habitat to be conserved are described and mapped. • The potential gain in connectivity of woodland habitat from the proposed offset areas (1-4). • The existing condition of the vegetation has been assessed and is mapped. • The conservation status of vegetation communities and threatened species has been assessed, mapped and quantified, where relevant.
10. *Offsets must be targeted.*	The offset strategy addresses residual impacts associated with the Modification. The proposed offset areas were selected in consideration of a range of factors, including: 1. Relationship to existing offset areas. 2. Proximity to the Subject and Modification areas. 3. Regional conservation priorities and vegetation most in need of conservation. 4. The vegetation composition of the Subject and Modification areas relative to the proposed offset areas; meeting the 'like-for-like' criterion. 5. The ecosystem resilience and condition of the proposed offset areas. 6. The presence of similar threatened species records and/or potential habitat to those within the Subject and Modification areas.
11. *Offsets must be located appropriately.*	The proposed offset area is located in the same region as the Ginkgo Mine in a similar topographic, climatic and geographic environment.
12. *Offsets must be supplementary.*	The implementation of the offset strategy is beyond existing requirements, in that it is not part of any conservation reserve system.
13. *Offsets and their actions must be enforceable through Development Consent conditions, licence conditions, conservation agreements or a contract.*	The offset requirement is likely to be a condition of Project approval.

3.8 ECOLOGICAL GAINS OF THE PROPOSED OFFSET

It is considered that the Modification meets the standard in the requirements of the Director-General of the NSW DP&E that flora biodiversity values in the region would be maintained and improved in the long-term. The proposed offset areas contain a similar array of natural vegetation types (and vegetation communities) to those in the Subject area, which are also in similar condition.

The proposed offset areas have a number of features which meet the 'maintain or improve' test. These include:

- The proposed offset areas have a greater diversity of vegetation communities than occur in the Subject area.
- The proposed offset areas include threatened biodiversity; the Sandhill Pine Woodland EEC and the Winged Peppercress. No threatened biodiversity has been located in the Subject area or ML 1504 despite numerous surveys.
- The proposed offset areas adjoin and enhance the large offset for the existing Ginkgo Mine Crayfish Deposit Offset, thereby improving its long term viability.
- The proposed offset areas are bordered on all sides by similar vegetation and consequently are not isolated in the landscape. That is, they have high connectivity allowing a free flow of biodiversity between them and surrounding large areas of native habitat. This high connectivity helps to validate the long-term viability of the offset. Conversely, the addition of the offset as a new protected area enhances nature conservation over the whole region.

4 CONCLUSION

Overall, the proposed offset areas contain better flora conservation values than those of the Subject area. For example, the proposed offset areas include approximately 24.5 ha of Sandhill Pine Woodland EEC and a portion of a large population of the Endangered Winged Peppercress (*Lepidium monoplocoides*). It has also been unburnt for many decades and has a high representation of old growth hollow-bearing trees.

The Mallara property is a NSW Western Lands Lease currently used for grazing livestock so there is an opportunity to improve the flora values by removing grazing. The same method of conservation security, management and monitoring for the existing Ginkgo Mine Crayfish Deposit Offset area would be applied to the proposed offset areas, such that flora conservation values would be maintained and enhanced. As such, the proposed offset areas would achieve the objective of maintaining and improving flora conservation in the region (and local area) in the medium to long-term.

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ATTACHMENT A

FLORA SPECIES LIST FOR ML 1504 AND THE SUBJECT AREA

Table A-1
Flora Species List for ML 1504 and the Subject Area

Scientific Name	Common Name	Survey		
		EIS[1]	Modification[2]	Haul Road[3]
CLASS FILICOPSIDA				
Marsileaceae				
Marsilea drummondii	Common Nardoo	●		●
Marsilea sp.			●	
CLASS MAGNOLIOPSIDA				
SUBCLASS MAGNOLIIDAE				
Aizoaceae				
**Psilocaulon tenue*	Wiry Noon-flower	●	●	●
Tetragonia eremaea				●
Tetragonia moorei	Annual Spinach	●	●	
Amaranthaceae				
Ptilotus exaltatus var. *exaltatus*	Tall Mulla Mulla	●		
Ptilotus polystachyus var. *polystachyus*	Long Tails	●		
Ptilotus seminudus	Rabbit Tails	●		
Apiaceae				
Daucus glochidiatus	Native Carrot	●		
Apocynaceae				
Marsdenia australis	Doubah	●	●	
Parsonsia eucalyptophylla	Gargaloo	●	●	
Rhyncharrhena linearis	Purple Pentatrope	●	●	
Asteraceae				
Actinobole uliginosum	Flannel Cudweed	●	●	
Angianthus tomentosus	Hairy Cup Flower	●		
**Arctotheca calendula*	Capeweed		●	
Brachyscome ciliaris	Variable Daisy	●	●	
Brachyscome lineariloba	Hard-headed Daisy	●	●	
Calotis erinacea	Tangled Burr-daisy	●		
Calotis hispidula	Bogan Flea	●	●	●
**Carthamus lanatus*	Saffron Thistle	●	●	
**Centaurea melitensis*	Maltese Cockspur	●	●	●
Centipeda crateriformis subsp. *compacta*		●		
Centipeda cunninghamii	Common Sneezeweed			●
Centipeda thespidioides	Desert Sneezeweed	●	●	●
**Cirsium vulgare*	Spear Thistle	●		
**Conyza sumatrensis*	Tall Fleabane	●		
Elachanthus pusillus	Elachanth			●
Epaltes australis	Spreading Nut-heads			●
Euchiton sphaericus	Annual Cudweed	●		
Hyalosperma glutinosum subsp. *glutinosum*	Golden Sunray	●		
**Hypochaeris glabra*	Smooth Catsear	●		
Isoetopsis graminifolia	Grass cushions	●	●	
**Lactuca serriola*	Prickly Lettuce		●	
Lemooria burkittii	Wires-a-wool	●	●	●
Minuria cunninghamii	Bush Minuria	●	●	
Myriocephalus rhizocephalus	Woolly-heads	●		

Scientific Name	Common Name	Survey		
		EIS[1]	Modification[2]	Haul Road[3]
Olearia calcarea	Limestone Daisy Bush	●		
Olearia muelleri	Mueller's Daisy Bush		●	
Olearia pimeleoides		●	●	
**Onopordum acaulon*	Stemless Thistle	●	●	●
Podolepis capillaris	Invisible Plant	●		
Polycalymma stuartii	Poached Eggs	●		
Pseudognaphalium luteoalbum	Jersey Cudweed	●		
Pterocaulon sphacelatum	Fruit-salad Plant		●	
Pycnosorus pleiocephalus	Soft Billy Button	●	●	
**Reichardia tingitana*	False Sowthistle	●	●	●
Rhodanthe corymbiflora	Small White Sunray		●	
Rhodanthe moschata		●	●	
Rhodanthe pygmaea	Pigmy Sunray	●	●	
Rhodanthe stuartiana	Clay Sunray	●	●	●
Senecio glossanthus	Slender Groundsel	●		
Senecio runcinifolius	Tall Groundsel	●		
**Sonchus oleraceus*	Common Sowthistle	●	●	●
Stuartina muelleri	Spoon Cudweed	●		
Triptilodiscus pygmaeus	Common Sunray	●		
Vittadinia cervicularis	Annual New Holland Daisy	●	●	●
Vittadinia condyloides	Club-hair New Holland Daisy	●		
Vittadinia cuneata	Fuzzweed	●		
Vittadinia cuneata var. *hirsuta*	Fuzzweed			●
Vittadinia cuneata var. *morrisii*				●
Vittadinia dissecta	Dissected New Holland Daisy	●	●	
Vittadinia eremaea		●		●
Vittadinia gracilis	Woolly New Holland Daisy	●	●	●
Waitzia acuminata	Orange Immortelle	●		
Xerochrysum bracteatum	Golden Everlasting	●		
Boraginaceae				
Halgania cyanea	Rough Halgania	●		
**Heliotropium europaeum*	Potato Weed		●	
**Neatostema apulum*	Hairy Sheepweed		●	
Omphalolappula concava	Burr Stickseed	●		
Brassicaceae				
**Alyssum linifolium*	Flax-leaf Alyssum	●	●	●
Arabidella trisecta	Shrubby Cress	●	●	●
**Brassica tournefortii*	Mediterranean Turnip	●	●	●
**Carrichtera annua*	Ward's Weed	●	●	●
Geococcus pusillus	Earth Cress		●	
Harmsiodoxa blennodioides			●	
Harmsiodoxa brevipes var. *brevipes*	Short Cress	●		
Lepidium fasciculatum	Bundled Peppercress	●		
Lepidium papillosum	Warty Peppercress	●	●	
Phlegmatospermum cochlearinum	Oval-podded Cress			●
**Sisymbrium erysimoides*	Smooth Mustard	●	●	●
Stenopetalum lineare	Threadcress	●	●	●

Scientific Name	Common Name	Survey		
		EIS[1]	Modification[2]	Haul Road[3]
Stenopetalum sphaerocarpum	Pea Thread-petal	●		
Campanulaceae				
Wahlenbergia communis	Tufted Bluebell	●		
Wahlenbergia gracilenta	Annual Bluebell	●		
Wahlenbergia littoricola		●		
Wahlenbergia multicaulis	Tadgell's Bluebell	●		
Wahlenbergia sp.		●		
Wahlenbergia tumidifructa				●
Caryophyllaceae				
Gypsophila tubulosa	Chalkwort	●	●	
**Herniaria cinerea*	Hairy Rupturewort	●	●	
**Silene nocturna*			●	
**Spergularia rubra*	Sandspurry			●
Spergularia sp.		●	●	
Casuarinaceae				
Casuarina pauper	Black Oak	●	●	●
Chenopodiaceae				
Atriplex acutibractea subsp. *acutibractea*	Pointed Saltbush	●		
Atriplex conduplicata	Baldoo		●	
Atriplex eardleyae	Small Saltbush	●		
Atriplex lindleyi	Flat-top Saltbush		●	
Atriplex stipitata	Bitter Saltbush	●	●	●
Atriplex vesicaria	Bladder Saltbush	●	●	
Chenopodium cristatum	Crested Goosefoot	●	●	
Chenopodium curvispicatum	Cottony Saltbush	●		
Chenopodium desertorum subsp. *desertorum*	Desert Goosefoot	●	●	●
Chenopodium desertorum subsp. *rectum*	Frosted Goosefoot	●		
Chenopodium melanocarpum	Black Crumbweed	●	●	
**Chenopodium murale*	Nettle-leaf Goosefoot	●		
Chenopodium nitrariaceum	Nitre Goosefoot			●
Dissocarpus paradoxus	Cannonball Burr	●	●	●
Einadia nutans subsp. *nutans*	Climbing Saltbush	●		●
Enchylaena tomentosa	Ruby Saltbush	●	●	●
Maireana brevifolia	Small-leaf Bluebush	●	●	●
Maireana erioclada	Rosy Bluebush		●	
Maireana georgei	Slit-wing Bluebush	●	●	●
Maireana pentatropis	Erect Mallee Bluebush	●	●	●
Maireana pyramidata	Black Bluebush	●	●	●
Maireana radiata	Grey Saltbush	●		
Maireana sclerolaenoides	Woolly-fruit Bluebush	●	●	●
Maireana sedifolia	Pearl Bluebush	●	●	●
Maireana trichoptera	Pink-seeded Bluebush	●	●	●
Maireana triptera	Three-wing Bluebush	●	●	
Maireana turbinata	Satiny Bluebush	●	●	●
Rhagodia spinescens	Spiny Saltbush	●	●	
Rhagodia ulicina	Spiny Goosefoot	●	●	
Salsola australis	Prickly Stalwort	●	●	
Sclerolaena diacantha	Grey Copperburr	●	●	●

Scientific Name	Common Name	Survey		
		EIS[1]	Modification[2]	Haul Road[3]
Sclerolaena lanicuspis	Woolly Copperburr	●		
Sclerolaena obliquicuspis	Limestone Copperburr	●	●	●
Sclerolaena parviflora	Mallee Copperburr	●		
Sclerolaena patenticuspis	Spear-fruit Copperburr		●	
Convolvulaceae				
Convolvulus clementii	Desert Bindweed	●	●	
Convolvulus microsepalus	Small-flower Bindweed		●	
Convolvulus remotus	Grass Bindweed	●	●	
Convolvulus sp.			●	●
Crassulaceae				
Crassula colorata		●	●	
Crassula sieberiana	Australian Stonecrop	●	●	
Cucurbitaceae				
**Citrullus colocynthis*	Colocynth		●	●
**Cucumis myriocarpus* subsp. *leptodermis*	Paddy Melon	●	●	
Euphorbiaceae				
Chamaesyce drummondii	Caustic Weed	●	●	●
Fabaceae : Caesalpinioideae				
Senna artemisioides subsp. X *coriacea*	Broad-leaf Desert Senna		●	●
Senna artemisioides subsp. *petiolaris*	Woody Cassia	●		
Fabaceae: Faboideae				
Lotus cruentus	Red-flowered Lotus		●	
**Medicago laciniata*	Cut-leaved Medic	●	●	
**Medicago minima*	Woolly Burr Medic	●	●	●
**Medicago polymorpha*	Burr Medic	●	●	●
**Medicago truncatula*	Barrel Medic			●
Swainsona phacoides	Dwarf Swainson-pea	●		
Templetonia egena	Desert Broombush	●	●	
Fabaceae: Mimosoideae				
Acacia aneura	Mulga	●		
Acacia colletioides	Spine Bush	●	●	●
Acacia ligulata	Small Cooba	●		
Acacia oswaldii	Umbrella Wattle	●	●	
Acacia rigens	Needle Wattle	●		
Acacia wilhelmiana	Wilhelm's Wattle	●		
Gentianaceae				
**Centaurium tenuiflorum*	Branched Centaury	●		
Geraniaceae				
**Erodium cicutarium*	Common Storksbill	●	●	
Erodium crinitum	Blue Storksbill	●	●	●
Goodeniaceae				
Goodenia pinnatifida	Cut-leaf Goodenia	●	●	
Goodenia pusilliflora	Small-flower Goodenia	●	●	●
Haloragaceae				
Haloragis odontocarpa	Toothed Raspwort	●		
Lamiaceae				
Ajuga australis	Austral Bugle	●		
**Marrubium vulgare*	White Horehound	●		

Scientific Name	Common Name	Survey		
		EIS[1]	Modification[2]	Haul Road[3]
**Salvia verbenaca*	Wild Sage	●	●	●
Teucrium albicaule	Scurfy Germander	●		
Teucrium racemosum	Forest Germander	●	●	
Westringia rigida	Stiff Westringia	●		
Loranthaceae				
Amyema linophylla subsp. *orientalis*	Slender-leaf Mistletoe	●	●	
Amyema miquelii	Box Mistletoe	●		
Amyema miraculosum subsp. *boormanii*		●	●	
Amyema preissii	Wire-leaf Mistletoe		●	
Lysiana exocarpi subsp. *exocarpi*	Harlequin mistletoe	●	●	
Malvaceae				
Abutilon fraseri	Dwarf Lantern-flower		●	
**Malva parviflora*	Small Flowered Mallow			●
Sida corrugata	Corrugated Sida	●	●	
Sida intricata	Twiggy Sida	●	●	●
Sida spodochroma	Limestone Sida		●	
Myrtaceae				
Eucalyptus dumosa	Congoo mallee	●	●	
Eucalyptus gracilis	Yorrell	●		
Eucalyptus largiflorens	Black Box	●		●
Eucalyptus socialis	Pointed Mallee	●	●	
Oleaceae				
Jasminum lineare	Desert Jasmine		●	
Oxalidaceae				
Oxalis perennans		●	●	●
Pittosporaceae				
Pittosporum angustifolium	Weeping Pittosporum	●	●	
Plantaginaceae				
Plantago drummondii	Dark Plantain	●		
Plantago turrifera	Crowned Plantain	●		
**Veronica peregrina*	Wandering Speedwell	●		
Plumbaginaceae				
**Limonium lobatum*	Winged Sea Lavender	●	●	
Polygonaceae				
Rumex crystallinus	Shiny Dock	●		
Portulacaceae				
Calandrinia eremaea	Small Purslane	●	●	
Proteaceae				
Grevillea huegelii	Comb Grevillea	●		
Hakea tephrosperma	Hooked Needlewood	●		
Rubiaceae				
Synaptantha tillaeacea	Native Madder	●		
Ranunculaceae				
Ranunculus sessiliflorus var. *pilulifer*	Annual Buttercup	●		
Rutaceae				
Geijera parviflora	Wilga	●	●	
Santalaceae				
Exocarpos aphyllus	Leafless Ballart	●	●	

Scientific Name	Common Name	Survey		
		EIS[1]	Modification[2]	Haul Road[3]
Sapindaceae				
Alectryon oleifolius subsp. *canescens*	Western Rosewood	●	●	●
Dodonaea viscosa subsp. *angustissima*	Narrow-leaved Hopbush	●		
Scrophulariaceae				
Eremophila glabra	Tarbush	●		
Eremophila longifolia	Emubush	●		
Eremophila oppositifolia subsp. *oppositifolia*	Weeooka	●	●	
Eremophila sturtii	Turpentine Bush	●	●	●
Myoporum platycarpum subsp. *perbellum*	Sugarwood	●	●	
Myoporum platycarpum subsp. *platycarpum*	Sugarwood	●	●	
Stemodia florulenta	Blue-rod	●		●
Stemodia glabella	Smooth Bluerod		●	
Solanaceae				
Duboisia hopwoodii	Pituri	●		
Lycium australe	Australian Boxthorn	●	●	●
**Nicotiana glauca*	Tree Tobacco		●	
Nicotiana goodspeedii	Small-flower Tobacco	●	●	●
Solanum coactiliferum	Western Nightshade	●		
Solanum esuriale	Quena	●		●
**Solanum nigrum*	Black-berry Nightshade	●	●	
Thymelaeaceae				
Pimelea microcephala subsp. *microcephala*	Mallee Rice Flower	●		
Pimelea trichostachya	Annual Rice Flower	●		
Urticaceae				
Parietaria debilis	Native Pellitory		●	
Verbenaceae				
**Verbena supina*	Trailing Verbena	●	●	
Zygophyllaceae				
**Tribulus terrestris*	Catshead		●	
Zygophyllum ammophilum	Sand Twinleaf	●		●
Zygophyllum angustifolium	Scrambling Twinleaf	●	●	
Zygophyllum apiculatum	Gallweed	●		
Zygophyllum crenatum	Lobed Twinleaf	●	●	
Zygophyllum eremaeum	Climbing Twinleaf	●	●	●
Zygophyllum glaucum	Pale Twinleaf			●
Zygophyllum iodocarpum	Violet Twinleaf	●	●	●
Zygophyllum ovatum	Dwarf Twinleaf	●	●	●
Zygophyllum simile	White Twinleaf	●	●	●
SUBCLASS LILIIDAE				
Anthericaceae				
Thysanotus baueri	Mallee Fringe Lily	●	●	
Asphodelaceae				
**Asphodelus fistulosus*	Onion Weed	●		
Bulbine semibarbata	Native Leek	●		●
Lomandraceae				
Lomandra leucocephala subsp. *robusta*	Woolly Mat-rush	●		
Phormiaceae				
Dianella revoluta	Blueberry Lily	●		

Scientific Name	Common Name	Survey		
		EIS[1]	Modification[2]	Haul Road[3]
Poaceae				
Austrostipa drummondii	Cottony Speargrass	●		
Austrostipa elegantissima	Feather Speargrass		●	
Austrostipa eremophila	Desert Speargrass	●	●	
Austrostipa nitida	Balcarra Spear Grass	●	●	●
Austrostipa nodosa	Knotty Speargrass	●		
Austrostipa platychaeta	Flatawn Speargrass		●	
Austrostipa scabra subsp. *falcata*	Rough Spear Grass	●	●	
**Bromus rubens*	Red Brome	●		
Enneapogon avenaceus	Bottle Washers	●	●	●
Enneapogon nigricans	Dark Bottle-washers		●	
Eragrostis dielsii	Mallee Lovegrass	●	●	●
Eragrostis setifolia	Bristly Love-grass	●	●	
**Hordeum sp.*		●	●	
Lachnagrostis filiformis	Common Blown Grass	●		●
Paspalidium constrictum	Knottybutt Grass		●	
**Rostraria pumila*	Roughtail	●		
Rytidosperma caespitosum	Ringed Wallaby Grass	●	●	●
Rytidosperma setaceum	Smallflower Wallaby Grass	●		
**Schismus barbatus*	Arabian Grass	●	●	
Triodia scariosa	Porcupine Grass	●		
**Vulpia myuros*	Rat's Tail Fescue	●		
Total Native Species	**205**	**174**	**115**	**62**
Total Introduced Species	**46**	**32**	**31**	**16**
Total Species	**251**	**206**	**146**	**78**

[1] Results from sixty 1000 m^2 across all of ML 1504 for the 2001 EIS

[2] Results from fifty-six 1000 m^2 quadrats in preclearance surveys on the Modification area.

[3] Results from eleven 400 m^2 quadrats on the proposed Crayfish haul road.

* Denotes introduced species;

● Denotes presence of species in survey.

ATTACHMENT B

RATINGS FOR VEGETATION CONDITION OF CLIMAX COMMUNITIES GIVEN IN PRE-CLEARANCE SURVEYS BY OGYRIS ECOLOGICAL RESEARCH

Table B-1
Ratings for Vegetation Condition of Climax Communities given in Pre-clearance Surveys by Ogyris Ecological Research

Ogyris Report	Community[1]							
	2		3[2]		4		6[3]	
	Rating	ha	Rating	ha	Rating	Ha	Rating	ha
2005	2.9	50.1	-	-	-	-	-	-
2006a	3	15.0	-	-	-	-	-	-
2006b	1.7	5.6	-	-	-	-	-	-
2007a	3	25.5	-	-	-	-	2.5	18.4
2007b	3	26.0	-	-	-	-	2.5	10.0
2009a	2.5	71.0	-	-	2.5	7.0	3	73.0
2009b	2.5	74.2	-	-	-	-	1.5	28.4
2010	2.5	91.6	-	-	-	-	1.5	29.9
2011	1	2.0	3	6.6	-	-	-	-
2012a	-	-	2	1.4	-	-	1	0.4
2012c	3	16.5	3	43.7	-	-	3	4.3
Total	**-**	**377.5**		**51.7**		**7.0**		**164.4**
Mean rating/ha	**2.51**	**-**	**2.6**	**-**	**2.5**	**-**	**2.1**	**-**

[1] Communities 7 (*Austrostipa* Grassland) and 9 (*Eragrostis* Depression Grassland) are derived communities and not considered here.

[2] Community 3 was included as part of Community 2 by Ogyris Ecological Research until 2011.

[3] Community 6 includes significant areas of *Austrostipa* Grassland, which are likely to have reduced the mean condition rating for Pearl Bluebush Shrubland.

ATTACHMENT C

ESTIMATES OF NUMBERS OF TREE HOLLOWS AND HABITAT TREES PER HECTARE IN THE SUBJECT AREA IN PRE-CLEARANCE SURVEYS (OGYRIS, 2005 TO 2012)

Estimates of the numbers of tree hollows suitable for wildlife were made by Ogyris Ecological Research in their pre-clearance surveys between 2005 and 2012. These data are summarised in Table C-1. In the later years Ogyris Ecological Research also provided estimates of the numbers of habitat trees per ha.

The data indicate that in survey areas of 15 ha or greater, the numbers of hollows per hectare vary between approximately 20 and 80 for Black Oak – Western Rosewood Woodland (Community 2). The estimates of 130 hollows per hectare for Community 3 (Black Oak - Pearl Bluebush Woodland) in 2011 and 160 hollows per hectare for Chenopod Mallee Woodland/Shrubland (Community 4) in 2009 appear high (Table C-1). Alternatively, the estimates of habitat trees per hectare are low in these cases.

It is clear that the Subject area has high habitat value for wildlife such as microbats, mammals, birds and reptiles that depend on tree hollows and decorticating bark.

Ogyris Ecological Research only supplied quantitative data on fallen timber in 2011 and 2012 (Ogyris, 2011; 2012c) in the form of numbers of logs/ha. This indicated that 110 logs/ha were recorded in a Pearl Bluebush Shrubland sample, 190 logs/ha in Black Oak – Rosewood Woodland and 200 and 920 logs per ha in two samples in Black Oak Bluebush Woodland. These data indicate that quite numbers of fallen logs were present in parts of the Subject area.

The Subject area was shown by Ogyris Ecological Research (2005 to 2012c) to have significant numbers of hollow-bearing trees and fallen timber on the ground. The habitat trees were shown to support a diverse fauna of microbats, including two threatened species, as well as sheltering mammals, birds and reptiles. BioMetric measurements in the proposed offset areas showed that it also supports old growth Black Oak and Mallee eucalypts with numerous hollows, and that significant amounts of fallen timber are present.

Table C-1
Estimates of Numbers of Tree Hollows and Habitat Trees per Hectare in the Subject area in Pre-clearance Surveys (Ogyris, 2005 to 2012)

Ogyris report	Community[1]									
	2		3[2]		4		6		Overall	
	Hollows /ha	ha	Hollows /ha	ha	Hollows /ha	ha	Hollows /ha	ha	Habitat trees/ha	ha
2005	69	45.7	-	-	-	-	-	-	-	-
2006a	~80[3]	15	-	-	-	-	-	-	-	-
2006b	Very low	5.6	-	-	-	-	-	-	-	-
2007a	~20	25.5	-	-	-	-	0	18.4	-	-
2007b	~20	26	-	-	-	-	0	10	-	-
2009a	~60	71	-	-	160[4]	7	0	73	7.3	151
2009b	68	74.2	-	-	-	-	0	28.4	11.3	74.2
2010	52	91.6	-	-	-	-	0	29.9	17.5	76.2
2011			130[5]	6.6	-	-	-	-	13.2	6.6
2012a	6	1.4	-	-	-	-	-	-	12.2	1.8
2012b	35	26	18	30	-	-	0		22.7	66.9
Total	**410**	**382**	**148**	**36.6**	**160**	**7**	**0**	**159.7**	**84.2**	**376.7**
Mean[6]	**45.6**	**38.2**	**74**	**18.3**	**160**	**7**	**0**	**31.9**	**14.03**	**62.8**

1 Communities 7 (*Austrostipa-Sida* Grassland/Low Shrubland) and 9 (*Eragrostis* Depression Grassland) are derived communities and not considered here.

2 Community 3 was included as part of Community 2 by Ogyris Ecological Research until 2011.

3 ~ = approximate.

4 This estimate of 160 hollows per hectare implies 22 hollows per tree when taken in conjunction with the estimate of 7.3 habitat trees per hectare, which seems high, possibly by a factor of 10.

5 This estimate of 130 hollows per hectare implies 10 hollows per tree when taken in conjunction with the estimate of 10 habitat trees per hectare, which seems high, possibly by a factor of 10.

6 Means weighted according to the area in hectares.