JANUARY 2016

Ginkgo Mineral Sands Mine Southern Extension Modification Environmental Assessment

CRISTAL

EXECUTIVE SUMMARY

Background

This document is an Environmental Assessment (EA) for a proposed modification to the Ginkgo Mineral Sands Mine (the Ginkgo Mine) located in the Murray-Darling Basin, in western New South Wales (NSW).

The Ginkgo Mine operates in accordance with Development Consent (DA 251-09-01) issued under Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) in 2002.

Cristal Mining Australia Limited (Cristal Mining) is the owner and operator of the Ginkgo Mine.

The Ginkgo Mine is located approximately 85 kilometres (km) north-east of Wentworth and approximately 170 km south-east of Broken Hill in western NSW and is currently approved to:

- undertake mining operations to 2023;
- extract up to 19.9 million tonnes per annum (Mtpa) of mineral sands ore from the Ginkgo and Crayfish deposits, producing a maximum 576,000 tonnes per annum (tpa) of mineral concentrate for processing at Cristal Mining's Broken Hill Mineral Separation Plant (MSP); and
- receive MSP process waste for designated stockpiling, prior to depositing on the sand residue beach and/or with overburden.

Description of the Modification

Cristal Mining has conducted a review of geological testwork and mine planning for the remaining life of the Ginkgo deposit to identify options to maximise resource recovery and to improve operational efficiency.

The review identified the need for proposed extensions to the existing/approved surface development area (the southern extension areas).

The southern extension areas would be required for additional development areas for the mine path, topsoil stockpile areas and other supporting infrastructure.

The Southern Extension Modification (the Modification) would also include an increase in the Ginkgo Mine biodiversity offset area to account for existing surface development that has not been accounted for in previous Ginkgo Mine biodiversity offset area calculations.

The Modification is sought under section 75W of the EP&A Act.

The Modification would not include any other significant changes to the existing/approved Ginkgo Mine.

Table ES-1 provides a comparative summary of the existing/approved and proposed modified Ginkgo Mine.

Environmental Review

The key potential impacts of the Modification are related to the proposed changes to the approved surface development area at the Ginkgo Mine. The potential impacts would be related to the following environmental aspects: land resources; biodiversity; Aboriginal cultural heritage; historic heritage; and groundwater and surface water resources.

In order to assess the potential environmental impacts of the Modification, environmental reviews have been completed. A summary of the key findings of these environmental reviews is provided below:

- The southern extension areas involve a 32 hectare (ha) extension to the existing/approved surface development area. Therefore, additional potential impacts on land resources have been assessed and it is considered that the additional surface development would not be material in the context of the existing/approved Ginkgo Mine surface development area (approximately 1,500 ha). Notwithstanding, existing land resource mitigation and management measures would continue to be implemented for the Modification.
- Potential impacts on potentially occurring threatened flora species were assessed and it was concluded that the Modification would be unlikely to significantly impact threatened flora species.
- Potential impacts on threatened fauna species were assessed and it was concluded that the Modification would be unlikely to significantly impact threatened fauna species known or predicted to occur.

Table ES-1
Comparison of the Existing/Approved and Modified Ginkgo Mine

Project Component	Existing/Approved	Modified
Project Life	• Mining operations approved until March 2023.	No change.
Tenement	• Mining operations conducted within Mining Lease 1504 and the Crayfish deposit Mining Lease Application area.	No change.
Surface Development Infrastructure	• Approximately 1,567 ha (Processing Option 1) or 1,511 ha (Processing Option 2)[1].	Approximate 32 ha increase to the existing/approved surface development area.
Mining	• Ginkgo deposit – double-pass dredge mining operation producing approximately 13 Mtpa of ore and moving up to approximately 24 Mtpa of overburden. • Crayfish deposit – dry mining (i.e. dozers and/or loaders and excavators) operation producing approximately 6.9 Mtpa of ore and moving approximately 7.4 Mtpa of overburden.	A minor extension to the Ginkgo deposit mine path (approximately 2 ha beyond the existing/approved surface development area). No change to other mining components.
Mineral Concentration	• Ginkgo deposit ore is concentrated in the primary gravity concentration unit (comprising a screen, surge bin and wet concentrator). • Crayfish deposit ore is concentrated in either a pre-concentrator or the primary gravity concentration unit. • The heavy mineral concentrate (HMC) produced is then treated at either of the Ginkgo Mine, the Snapper Mine or the MSP (dependent on the location of the wet intensity magnetic separation). • Maximum annual mineral concentrate production rate of approximately 576,000 tpa.	No change.
Mineral Concentrate/HMC Transport to the MSP	• NSW Roads and Maritime Services approved vehicles (i.e. AB-triple or double road trains) are used to transport mineral concentrate/heavy mineral concentrate from the Ginkgo Mine to the MSP via the mineral concentrate and MSP process waste transport route. • Up to 975,000 tpa of mineral concentrates from the Ginkgo and Snapper Mines to be transported to the MSP.	No change.
Overburden Management	• Replacement of overburden is undertaken by an overland conveyor system or dry mine fleet. Overburden will be progressively backfilled in mine voids behind the advancing ore extraction area or in overburden emplacements.	No change.
Sand Residue and Coarse Reject Management	• Sand residues and coarse rejects from the primary gravity concentration unit or pre-concentrator are placed in the sand residue dams or in the active mining area (behind the advancing ore extraction area).	No change.
MSP Process Waste Management	• MSP process waste from the processing of Ginkgo and Snapper Mines mineral concentrates are transported to the Ginkgo and Snapper Mines for disposal.	No change.
Water Supply	• Water requirements will be supplied by the Ginkgo deposit borefield (Loxton-Parilla Sands aquifer) and Crayfish deposit borefield (either the Loxton-Parilla Sands aquifer or the Lower Renmark aquifer).	No change.
Access	• Access to the Ginkgo Mine is via the 64 km Highway Access Road to the Silver City Highway.	No change.
Employment	• Operational workforce of approximately 340 personnel (including 117 Cristal Mining employees and 223 contractors).	No change.
Hours of Operation	• 24 hours per day, seven days per week.	No change.

[1] Includes approximately 333 ha of existing surface development that has not been accounted for in previous Ginkgo Mine biodiversity offset area calculations.

Table ES-1 (Continued)
Comparison of the Existing/Approved and Modified Ginkgo Mine

Project Component	Existing/Approved	Modified
Rehabilitation Works	• Progressive rehabilitation undertaken as mining advances. Rehabilitation trials and investigations undertaken to assess the effectiveness of rehabilitation techniques, cover depths and the performance of different plant species over the life of the Ginkgo Mine.	No change.
Biodiversity Offset Area	• Approximately 2,603 ha will be established to offset native vegetation communities cleared at Ginkgo Mine.	Approximately 1,411 ha of additional biodiversity offset area proposed.

- Biodiversity values in the region are likely to be maintained and improved in the medium to long-term with proposed extensions to the existing offset area (totalling 1,411 ha). The proposed additional offset areas account for the 32 ha of proposed surface disturbance and 333 ha of existing surface disturbance which has not been accounted for previously.
- Potential impacts on Aboriginal cultural heritage have been assessed, including a survey of the southern extension areas. No Aboriginal cultural heritage sites were identified within the southern extension areas, and therefore the Modification would not have an impact on any known Aboriginal heritage sites, items or values.
- The Modification would not result in additional potential historic heritage impacts as no historic heritage sites are located within the southern extension areas.
- Potential groundwater impacts associated with the proposed minor extension to the Ginkgo deposit mine path (i.e. approximately 2 ha beyond the existing/approved surface development area) were assessed. Overall changes to impacts on groundwater resources were considered negligible and within the Minimal Impact Considerations of the *NSW Aquifer Interference Policy*. Groundwater resources would continue to be monitored and managed in accordance with the *Borefield Impact Management Plan*.
- The complex landform and semi-arid climate combine to provide conditions in which the risk of off-site surface water resource impacts is minimal.

As no significant changes to the approved mining and mineral processing operations at the Ginkgo Mine are proposed for the Modification, there would be no material alteration to the approved noise, air quality, greenhouse gas and economic impacts or to the existing/approved risks and hazards.

There would be no change to existing/approved road transport impacts due to the Modification as there would be no change to the mineral concentrate/MSP process waste transport or other Ginkgo Mine-related traffic (e.g. employee movements).

As no change to the approved Ginkgo Mine workforce is proposed for the Modification, there would be no material alteration to the approved community infrastructure impacts.

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1 INTRODUCTION

This document is an Environmental Assessment (EA) for a proposed modification to the Ginkgo Mineral Sands Mine (the Ginkgo Mine) located in the Murray-Darling Basin, in western New South Wales (NSW) (Figures 1 and 2).

The Ginkgo Mine operates in accordance with Development Consent (DA 251-09-01) issued under Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) in 2002.

Cristal Mining Australia Limited (Cristal Mining) is the owner and operator of the Ginkgo Mine.

The Southern Extension Modification (the Modification) is sought under section 75W of the EP&A Act.

1.1 OVERVIEW OF THE EXISTING/APPROVED GINKGO MINE

The Ginkgo Mine is located approximately 85 kilometres (km) north-east of Wentworth and approximately 170 km south-east of Broken Hill in western NSW (Figure 1) and is currently approved to:

- undertake mining operations to 2023;
- extract up to 19.9 million tonnes per annum (Mtpa) of mineral sands ore from the Ginkgo and Crayfish deposits, producing a maximum 576,000 tonnes per annum (tpa) of mineral concentrate for processing at Cristal Mining's Broken Hill Mineral Separation Plant (MSP); and
- receive MSP process waste for designated stockpiling, prior to depositing on the sand residue beach and/or with overburden.

The existing/approved Ginkgo Mine general arrangement is shown in Figures 3a and 3b.

1.2 OVERVIEW OF THE SOUTHERN EXTENSION MODIFICATION

Cristal Mining has conducted a review of geological testwork and mine planning for the remaining life of the Ginkgo deposit to identify options to maximise resource recovery and to improve operational efficiency.

The review identified the need for proposed extensions to the existing/approved surface development area (the southern extension areas).

The southern extension areas would be required for additional development areas for the mine path, topsoil stockpile areas and other supporting infrastructure.

The Modification would also include an increase in the Ginkgo Mine biodiversity offset area to account for existing surface development that has not been accounted for in previous Ginkgo Mine biodiversity offset area calculations.

The Modification would not include any other significant changes to the existing/approved Ginkgo Mine.

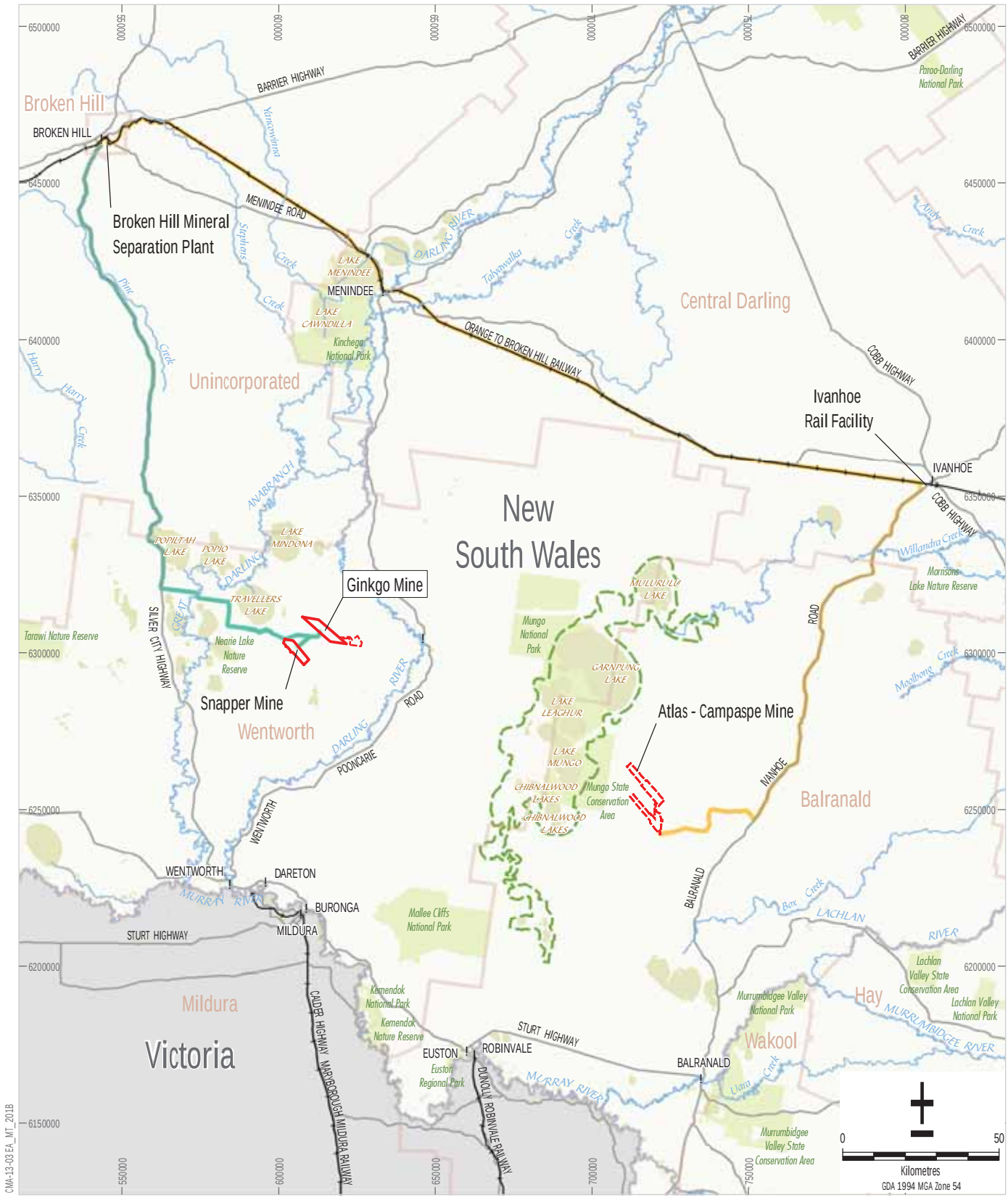
Table 1 provides a comparative summary of the existing/approved and proposed modified Ginkgo Mine.

A more detailed description of the Modification is provided in Section 2.

1.3 CONSULTATION

Consultation has been conducted with key state government agencies and the Wentworth Shire Council (WSC) during the preparation of this EA. A summary of this consultation is provided below.

It is anticipated that consultation with key state government agencies and the WSC will continue during the public exhibition of this EA and the assessment of the proposal by the NSW Government.



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*

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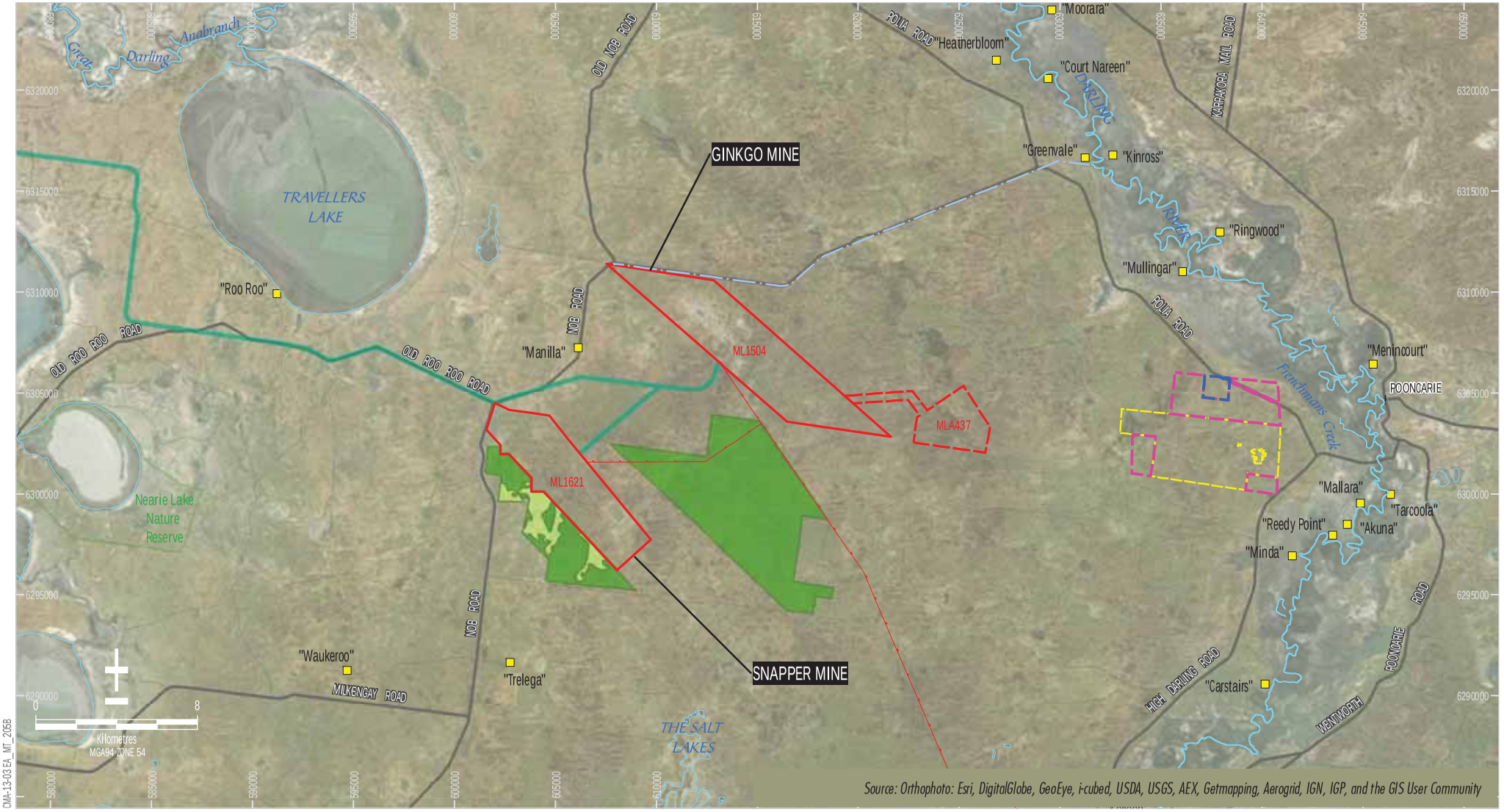
GINKGO MINE

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



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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)

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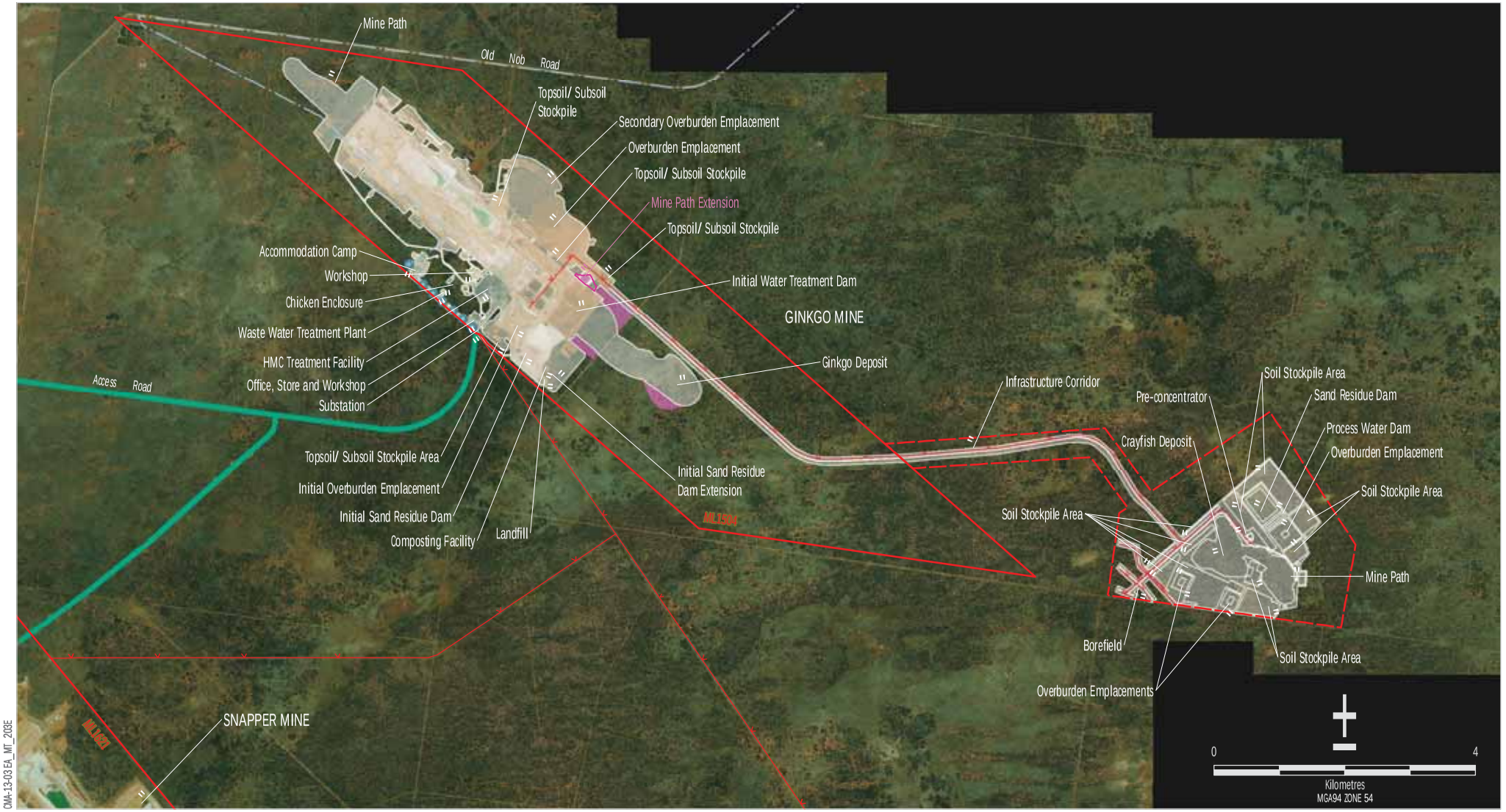
GINKGO MINE

Location of the Ginkgo Mine

Figure 2



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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)
- Electricity Transmission Line
- Water Bore
- Existing/Approved Approximate Extent of Surface Development (Processing Option 1)
- Modified Approximate Extent of Surface Development

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

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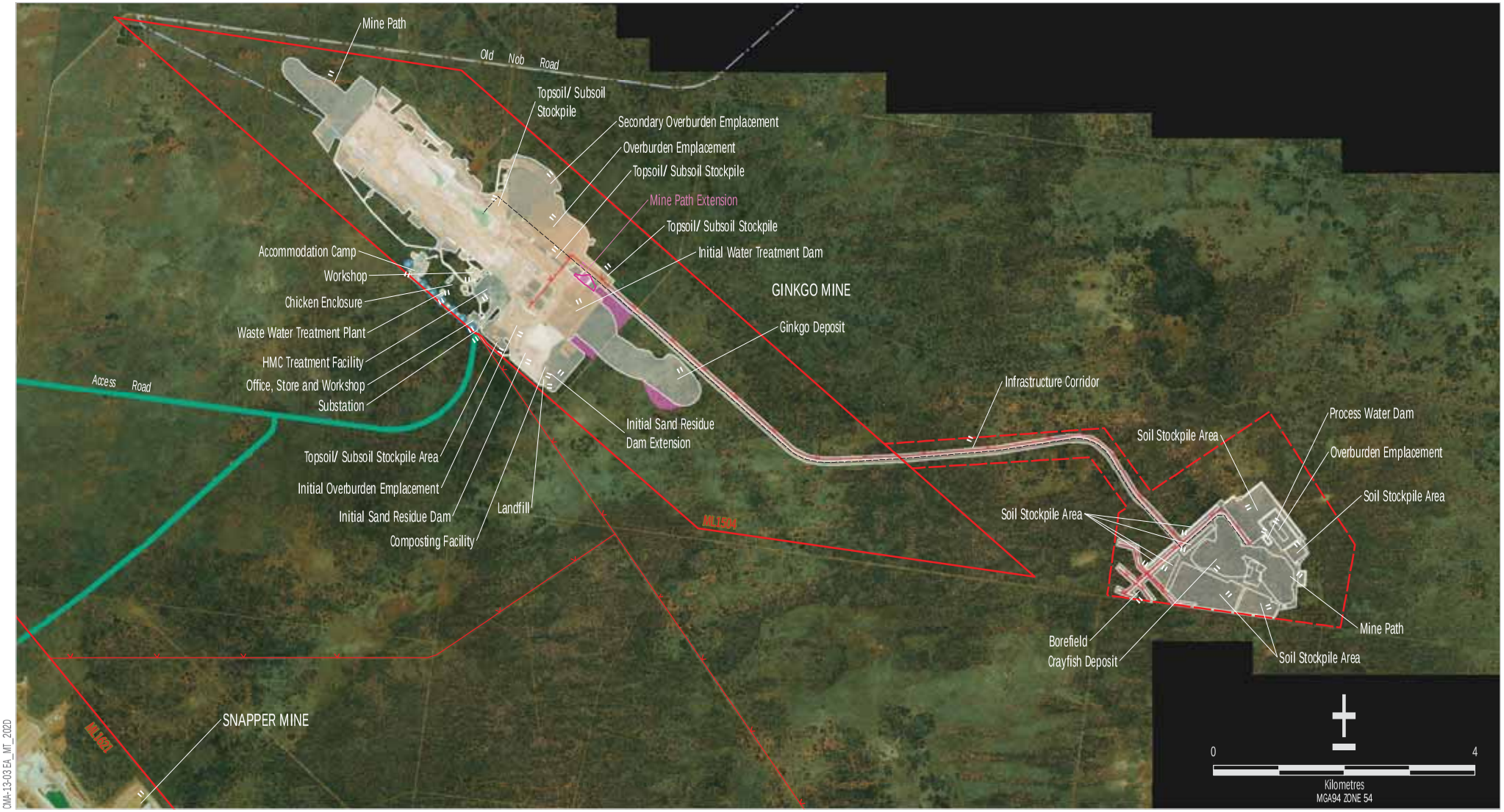
GINKGO MINE

Existing/Approved and Modified Ginkgo Mine (Processing Option 1)

Figure 3a



CMA-13-03 EA_MT_202D

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)
- Modified Approximate Extent of Surface Development

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

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GINKGO MINE

Existing/Approved and Modified Ginkgo Mine (Processing Option 2)

Figure 3b

Table 1
Comparison of the Existing/Approved and Modified Ginkgo Mine

Project Component	Existing/Approved	Modified
Project Life	• Mining operations approved until March 2023.	No change.
Tenement	• Mining operations conducted within Mining Lease (ML) 1504 and the Crayfish deposit Mining Lease Application (MLA) area.	No change.
Surface Development Infrastructure	• Approximately 1,567 hectares (ha) (Processing Option 1) or 1,511 ha (Processing Option 2)[1].	Approximate 32 ha increase to the existing/approved surface development area.
Mining	• Ginkgo deposit – double-pass dredge mining operation producing approximately 13 Mtpa of ore and moving up to approximately 24 Mtpa of overburden. • Crayfish deposit – dry mining (i.e. dozers and/or loaders and excavators) operation producing approximately 6.9 Mtpa of ore and moving approximately 7.4 Mtpa of overburden.	A minor extension to the Ginkgo deposit mine path (approximately 2 ha beyond the existing/approved surface development area). No change to other mining components.
Mineral Concentration	• Ginkgo deposit ore is concentrated in the primary gravity concentration unit (comprising a screen, surge bin and wet concentrator). • Crayfish deposit ore is concentrated in either a pre-concentrator or the primary gravity concentration unit. • The heavy mineral concentrate (HMC) produced is then treated at either of the Ginkgo Mine, the Snapper Mine or the MSP (dependent on the location of the wet intensity magnetic separation [WHIMS]). • Maximum annual mineral concentrate production rate of approximately 576,000 tpa.	No change.
Mineral Concentrate/HMC Transport to the MSP	• NSW Roads and Maritime Services approved vehicles (i.e. AB-triple or double road trains) are used to transport mineral concentrate/HMC from the Ginkgo Mine to the MSP via the mineral concentrate and MSP process waste transport route. • Up to 975,000 tpa of mineral concentrates from the Ginkgo and Snapper Mines to be transported to the MSP.	No change.
Overburden Management	• Replacement of overburden is undertaken by an overland conveyor system or dry mine fleet. Overburden will be progressively backfilled in mine voids behind the advancing ore extraction area or in overburden emplacements.	No change.
Sand Residue and Coarse Reject Management	• Sand residues and coarse rejects from the primary gravity concentration unit or pre-concentrator are placed in the sand residue dams or in the active mining area (behind the advancing ore extraction area).	No change.
MSP Process Waste Management	• MSP process waste from the processing of Ginkgo and Snapper Mines mineral concentrates are transported to the Ginkgo and Snapper Mines for disposal.	No change.
Water Supply	• Water requirements will be supplied by the Ginkgo deposit borefield (Loxton-Parilla Sands aquifer) and Crayfish deposit borefield (either the Loxton-Parilla Sands aquifer or the Lower Renmark aquifer).	No change.
Access	• Access to the Ginkgo Mine is via the 64 km Highway Access Road to the Silver City Highway.	No change.
Employment	• Operational workforce of approximately 340 personnel (including 117 Cristal Mining employees and 223 contractors).	No change.
Hours of Operation	• 24 hours per day, seven days per week.	No change.

[1] Includes approximately 333 ha of existing surface development that has not been accounted for in previous Ginkgo Mine biodiversity offset area calculations.

Table 1 (Continued)
Comparison of the Existing/Approved and Modified Ginkgo Mine

Project Component	Existing/Approved	Modified
Rehabilitation Works	• Progressive rehabilitation undertaken as mining advances. Rehabilitation trials and investigations undertaken to assess the effectiveness of rehabilitation techniques, cover depths and the performance of different plant species over the life of the Ginkgo Mine.	No change.
Biodiversity Offset Area	• Approximately 2,603 ha will be established to offset native vegetation communities cleared at Ginkgo Mine.	Approximately 1,411 ha of additional biodiversity offset area proposed.

NSW Government Agencies

Cristal Mining continues to consult with relevant State Government agencies on a regular basis in relation to the current Ginkgo Mine operations.

Department of Planning and Environment

Cristal Mining met with the NSW Department of Planning and Environment (DP&E) on 10 December 2015 to provide an overview of the proposed Modification and key assessment outcomes.

Office of Environment and Heritage

A meeting was held with the NSW Office of Environment and Heritage (OEH) on 27 November 2015 to provide an overview of the Modification and to discuss the proposed biodiversity offset areas.

Other NSW Government Agencies

In November 2015, Cristal Mining provided a briefing package that included information on the Modification and offered further information if requested to the following NSW Government agencies:

- Environment Protection Authority;
- Department of Primary Industries – Water;
- Department of Primary Industries – Crown Lands;
- Division of Resources and Energy (within the New South Wales Department of Industry, Skills and Regional Development); and
- Roads and Maritime Service (within the NSW Department of Transport).

Wentworth Shire Council

The Ginkgo Mine is located within the Wentworth local government area (Figure 1).

Cristal Mining holds regular meetings with the WSC in relation to existing Ginkgo Mine operations. Cristal Mining has provided updates on the Modification at each of these meetings since June 2015.

In addition, Cristal Mining provided a briefing package to the WSC on 15 December 2015 and scheduled another meeting for January 2016 when an update on the Modification will be provided.

1.4 STRUCTURE OF THIS DOCUMENT

This EA comprises a main text component and supporting studies. An overview of the main text sections is presented below:

Section 1	Provides an overview of the existing/approved Ginkgo Mine, the Modification and the consultation undertaken in relation to the Modification.
Section 2	Provides a description of the Modification.
Section 3	Provides an environmental assessment of the Modification and describes the existing environmental management systems and measures available to manage and monitor any potential impacts.
Section 4	Describes the general statutory context of the proposed Modification.
Section 5	References.

Appendices A and G provide supporting information as follows:

Appendix A	Southern Extension Areas Flora Assessment.
Appendix B	Southern Extension Areas Fauna Assessment.
Appendix C	Biodiversity Offset Increase Flora Report.
Appendix D	Biodiversity Offset Increase Fauna Report.
Appendix E	Biodiversity Offset Baseline Flora Report.
Appendix F	Biodiversity Offset Baseline Fauna Report.
Appendix G	Aboriginal Cultural Heritage Assessment.

2 MODIFICATION OVERVIEW

A description of the Modification is provided in this section, including a comparison of the modified Ginkgo Mine with the existing/approved Ginkgo Mine.

As only minor changes are proposed to the existing/approved Ginkgo Mine as part of the Modification (Table 1), this section focuses on the components of the Ginkgo Mine that would change as a result of the Modification.

A complete description of the existing/approved Ginkgo Mine is provided in the environmental approval documentation listed in the Development Consent (DA 251-09-01).

2.1 GENERAL ARRANGEMENT

The existing/approved general arrangement varies depending on the Crayfish deposit ore processing option selected:

- **Processing Option 1** – pump ore slurry to a pre-concentrator near the Crayfish open pit for primary gravity concentration; or
- **Processing Option 2** – pump ore slurry to the existing Ginkgo Mine primary gravity concentration unit for primary gravity concentration.

The existing/approved Ginkgo Mine includes the following major site components:

- Ginkgo deposit dredge pond (including dredge, primary gravity concentration unit and associated equipment);
- Crayfish open pit (including dry mining unit [DMU] and associated equipment);
- overburden emplacements;
- sand residue dams;
- pre-concentrator[1];
- HMC treatment facility including the reverse osmosis plant, salt washing facility and a WHIMS circuit[2];
- towers and stackers for stockpiling HMC/mineral concentrates;
- HMC/mineral concentrate stockpiles;
- infrastructure corridor consisting of an internal access road, electricity transmission line (ETL) and ore pipeline[3] between Ginkgo Mine and the Crayfish deposit MLA area;
- two borefields including associated pump and pipeline systems;
- process water dams, water treatment dam, sediment dams, pumps, pipelines and other water management equipment and structures;
- office, workshop and store buildings and car parking facilities;
- fuel and consumables storage facilities;
- accommodation camp;
- on-site landfill, composting facility and chicken enclosure;
- wastewater (including sewage) treatment plant;
- laydown areas;
- soil stockpile areas;
- highway access road, internal access roads and haul roads;
- ETL, electricity distribution station and associated internal ETLs; and
- other associated minor infrastructure, plant, equipment and activities.

The existing/approved Ginkgo Mine (Processing Options 1 and 2) general arrangement is shown on Figures 3a and 3b.

The Modification would include an approximate 32 ha increase in the extent of the existing/approved surface development area at the southern end of the Ginkgo deposit (the southern extension areas) (Figures 3a and 3b).

The southern extension area would be required to allow for:

- a minor extension to the Ginkgo deposit mine path (approximately 2 ha beyond the existing/approved surface development area); and
- additional surface development areas for topsoil stockpiles and other supporting infrastructure (e.g. internal access roads, internal ETLs and other associated minor infrastructure, plant, equipment and activities).

No other changes are proposed to the existing Ginkgo Mine general arrangement.

[1] Processing Option 1 only.

[2] The HMC treatment facility is currently approved to be located at either the MSP or at the Ginkgo and Snapper Mines. The HMC treatment facility is currently located at the Ginkgo Mine.

[3] Processing Option 2 only.

2.2 WATER MANAGEMENT

Site water management at the Ginkgo Mine is conducted in accordance with the *Murray Basin Mines Water, Erosion and Sediment Control Plan*.

Water Management Objectives

The Ginkgo Mine water management objectives are (Cristal Mining, 2013):

- separation of undisturbed area runoff from disturbed area runoff;
- collection and re-use of surface runoff from disturbed areas (including mining areas and overburden replacement);
- capture and on-site containment of potentially contaminated mine site waters; and
- priority re-use of captured and contained water for dust suppression or process requirements.

To meet these objectives, the water management system is developed progressively over the life of the Ginkgo Mine.

The existing/approved Ginkgo Mine water management objectives would remain unchanged for the Modification.

Water Management System

The existing/approved water management system varies depending on the Crayfish deposit ore processing option selected (Section 2.1).

A description of the components of the water management system is provided below.

Up-catchment Runoff Control and Sediment Control

Both temporary and permanent up-catchment diversion bunds/drains will be constructed over the life of the Ginkgo Mine to divert runoff from undisturbed areas around the mine path, overburden emplacements, soil stockpiles, sand residue dams and other fixed infrastructure areas.

Drainage from disturbance areas within the Ginkgo Mine surface development area is directed to the evaporation/sediment sumps for containment.

The design criteria for up-catchment diversion works and evaporation/sediment sumps are outlined in the *Murray Basin Mines Water, Erosion and Sediment Control Plan*.

Dredge Pond

The water level in the dredge pond varies according to the level of the existing groundwater table relative to the orebody. In order to maintain dredge access to the orebody and minimise dilution, the dredge pond level is altered as required by adjusting the supply from the water supply bores.

Water Storages

The approved water management system includes a number of water storages (e.g. process water dam). These water storages are used to manage and buffer process water supply.

Sand Residue Dams

An initial sand residue dam adjacent to the Ginkgo deposit (Figures 3a and 3b) was used to store sand residues and to facilitate the settling and removal of fines material from the process water.

An additional sand residue dam will be required for the Crayfish deposit (Processing Option 1 only) (Figure 3a).

To minimise the potential for seepage from the Ginkgo deposit sand residue dam, the following control measures have been implemented (Bemax Resources, 2012):

- A clay liner was compacted to minimise seepage through the base of the emplacement. The clay liner was covered with clean sand material (track rolled) to prevent cracking or drying out of the liner prior to deposition of slurried overburden.
- The low permeability embankment was constructed of clay, sandy clay, gravely clay and selected stockpiled material and placed in layers. The embankment was compacted with the moisture content at placement chosen to optimise the permeability outcome.
- A toe drain/trench was constructed on the downstream face of the embankment to collect runoff and/or seepage.

These seepage control measures will be implemented for the Crayfish deposit sand residue dam.

Water Disposal Dams

Water disposal dams may be required during the mine life, if the water balance indicates that excess water would be above the water supply requirement is present at the Ginkgo Mine (Cristal Mining, 2013).

On completion of mining, and once the dam has been drained, it would be decommissioned and rehabilitated (Cristal Mining, 2013).

Final Depressions

Two final depressions will remain at the cessation of mining at the Ginkgo Mine. The final depressions will be located at the south-eastern extent of the Ginkgo and Crayfish deposits.

The final depressions will be partially backfilled with overburden material pushed down from the depression batters and adjacent overburden replacement areas within the mine paths (Cristal Mining, 2013).

The depth of the final depressions will remain at least 5 metres (m) above natural groundwater table level (i.e. a permanent water body would not be formed in the depression), however, incident rainfall and local surface water runoff following rainfall events will temporarily pond in the depressions prior to evaporating or infiltrating to the groundwater table (Cristal Mining, 2013).

The surface catchment of the final depressions will be reduced to a practicable minimum by maximising backfilling with overburden material pushed down from the depression batters and adjacent overburden replacement areas within the mine path and the use of upslope diversions and contour drains around their perimeter (Cristal Mining, 2013).

Modified Water Management System

The existing/approved Ginkgo Mine water management system would remain generally unchanged for the Modification.

Minor changes to existing/approved up-catchment runoff control and sediment control structures would be required as a result of the Modification to reflect the modified surface development area.

The Modification may also result in minor changes to the size and location of the Ginkgo deposit final depression. The final depression would however continue to be managed as described above.

Mine Dewatering

Water captured in the mine path areas comprising incident rainfall, runoff, infiltration from active mining areas and groundwater inflows are allowed to settle in in-pit collection sumps for dewatering and re-use by pumping to process water storages.

Localised dewatering systems (including bores, spearfields and trenches) are used to dewater the orebody where it lies below the groundwater table (i.e. the south-eastern extent of the Crayfish deposit mine path) (Cristal Mining, 2013).

The Modification would not change mine dewatering at the Ginkgo Mine.

Water Supply

Water is approved to be supplied from mine dewatering activities and from the Ginkgo deposit and Crayfish deposit borefields.

Groundwater is approved to be extracted from either the Loxton-Parilla Sands aquifer or the Lower Renmark aquifer (Cristal Mining, 2013).

Water extracted from the borefields will be reticulated by pump and pipeline systems via services corridors.

The Modification would not change the Ginkgo Mine water supply.

Water Consumption

The maximum make-up water demand at the Ginkgo Mine is 368 litres per second (L/s) (Processing Option 1) and 468 L/s (Processing Option 2).

The Modification would not significantly change mining or processing operations at the Ginkgo Mine and therefore no change to the make-up water demand would occur as a result of the Modification.

2.3 REHABILITATION STRATEGY

Rehabilitation Principles and Objectives

The following existing/approved rehabilitation principles are adopted at the Ginkgo Mine (Cristal Mining, 2013):

- preservation of existing vegetation and landforms where practicable;
- progressive campaign-based rehabilitation;
- passive drainage and flow diversion structures where required;
- revegetated landforms to be contiguous with existing vegetation where practicable;
- fencing and/or bunding to selectively exclude livestock from rehabilitation areas;

- flexible rehabilitation concepts to allow for adjustments, based on investigations, to improve the programme; and
- annual rehabilitation programmes and budgets to be approved by site management.

Existing/approved Ginkgo Mine rehabilitation objectives include (Cristal Mining, 2013):

- developing final landforms that are stable and generally consistent with the surrounding landscape;
- developing final landforms that are suitable for a final land use determined in consultation with relevant landholders and regulatory authorities;
- implementing practices demonstrated to be effective by investigations at the Ginkgo Mine;
- development of self-sustaining vegetation cover;
- managing mining and overburden handling to minimise reshaping, recontouring and material double handling; and
- progressive rehabilitation to make best use of favourable climatic conditions.

These rehabilitation principles and objectives would continue to be adopted for the Modification.

Final Land Use

The approved final land use (i.e. nature conservation or light intensity grazing) would remain unchanged as a result of the Modification.

Rehabilitation Management

The management of rehabilitation at the Ginkgo Mine is conducted in accordance with the *Mining Operations Plan* that includes:

- final landforms and rehabilitation domains;
- rehabilitation methods;
- rehabilitation monitoring program; and
- performance criteria.

The *Mining Operations Plan* would be updated to include the Modification. No significant changes to the *Mining Operations Plan* are expected to be required as a result of the Modification.

2.4 BIODIVERSITY OFFSET

The existing Ginkgo Mine biodiversity offset is approximately 2,603 ha. The management of the biodiversity offset is conducted in accordance with the *Offset Management Plan*.

A detailed description of the existing Ginkgo Mine biodiversity offset is provided in Section 3.3.

The Modification would also include an approximate 156 ha increase to the existing Ginkgo Mine biodiversity offset area to offset the southern extension area.

In addition, the Modification would include an additional 1,255 ha increase to the existing Ginkgo Mine biodiversity offset to offset approximately 333 ha of existing surface development at the Ginkgo Mine that has not been accounted for in previous Ginkgo Mine biodiversity offset calculations (the subject area).

A detailed description of the modified biodiversity offset area is provided in Section 3.3.

2.5 OTHER GINKGO MINE COMPONENTS

There would be no change to the following key components of the existing/approved Ginkgo Mine due to the Modification (Table 1):

- mine life and hours of operation;
- mining tenement;
- mining method (i.e. combination of dredge and dry mining methods) and fleet;
- maximum annual ore production rate;
- mineral concentration operations;
- maximum mineral concentrate/HMC production rate;
- overburden management;
- process waste materials management;
- waste and dangerous goods management;
- infrastructure and services;
- mineral concentrate/HMC and MSP process waste transport;
- workforce; and
- environmental management and monitoring.

3 ENVIRONMENTAL ASSESSMENT

3.1 IDENTIFICATION OF KEY ISSUES

The key potential impacts of the Modification are related to the proposed changes to the approved surface development area at the Ginkgo Mine. The potential impacts would be related to the following environmental aspects: land resources; biodiversity; Aboriginal cultural heritage; historic heritage; and groundwater and surface water resources.

A discussion of these potential impacts is provided in this section of the EA.

As no significant changes to the approved mining and mineral processing operations at the Ginkgo Mine are proposed for the Modification, there would be no material alteration to the approved noise, air quality, greenhouse gas and economic impacts or to the existing/approved risks and hazards.

There would be no change to existing/approved road transport impacts due to the Modification as there would be no change to the mineral concentrate/MSP process waste transport or other Ginkgo Mine-related traffic (e.g. employee movements).

As no change to the approved Ginkgo Mine workforce is proposed for the Modification, there would be no material alteration to the approved community infrastructure impacts.

The above environmental aspects are not considered further in this EA.

3.2 LAND RESOURCES

3.2.1 Background

Land Resources Management

Management of land resources at the Ginkgo Mine is conducted in accordance with the following:

- *Mine Land Management Plan*;
- *Murray Basin Mines Water, Erosion and Sediment Control Plan*; and
- *Ginkgo and Snapper Bushfire Management Plan*.

The *Mine Land Management Plan* includes:

- soil management measures;
- remnant vegetation management;
- livestock and pasture management; and
- feral animal and noxious weed control measures.

The *Murray Basin Mines Water, Erosion and Sediment Control Plan* includes the following:

- a summary of erosion and sediment control structures;
- erosion and sediment control management measures;
- soil-stripping management measures;
- salinity management measures;
- monitoring and reporting requirements; and
- contingency measures.

The *Ginkgo and Snapper Bushfire Management Plan* has been prepared in consultation with the WSC and the NSW Rural Fire Service and the bushfire management measures and hazard reduction strategies implemented include:

- procedures for the detection, response, co-ordination and reporting of bushfire events;
- details of fire fighting activities;
- an Emergency Response Plan for bushfire emergency response procedures and evacuation procedures;
- a Fuel Management Plan; and
- provision of adequate fire breaks/protection works and the fire fighting equipment on-site (including an Emergency Response team).

Potential land resource impacts associated with the existing Ginkgo Mine surface development area (including the subject area) (Figures 3a and 3b) have been managed generally in accordance with this existing land resource management regime.

Topography

The area around the Ginkgo Mine shows limited relief and comprises generally flat to undulating sandplains covered by a combination of grasslands, low woodland and shrublands.

Elevations range from approximately 55 m Australian Height Datum (AHD) at a natural depression in the south-east of the ML 1504 to approximately 85 m AHD in the north of ML 1504. Elevations in Crayfish deposit MLA area are similar and range from approximately 60 m AHD to approximately 85 m AHD.

The topography in the southern extension areas is generally flat with elevations ranging between approximately 65 m AHD to 70 m AHD.

Land Use and Agricultural Production

Land Use

Land use at the Ginkgo Mine site (including the subject and southern extension areas) comprises mining activities or light intensity rangeland grazing.

The Ginkgo Mine is located on the "Mallara" and "Aston" properties which are located on Western Land Lease 17 (Lot 4735 DP 767 963) and Western Land Lease 4083 (Lot 1924 DP 763902), respectively.

Rural Land Capability

Rural land capability assessments have been conducted for the Ginkgo Mine (Resource Strategies, 2001 and Ogyris Ecological Research [Ogyris], 2012d) in accordance with the standard NSW eight class system. This system is based on the assessment of biophysical characteristics categorising land in terms of its general limitations such as erosion hazard, climate and slope. Land is classed based on the limitations to a particular type of land use (Emery, 1985).

The only rural land capability class identified at the Ginkgo Mine (including the subject and southern extension areas) is Class VI (Ogyris, 2012d; Resource Strategies, 2001). Class VI Capability is defined as:

> *Land not capable of being cultivated but suitable for grazing with soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. This class may require some structural works (Cunningham et al., undated).*

Agricultural Suitability

Agricultural suitability assessments have been conducted for the Ginkgo Mine (Resource Strategies, 2001 and Ogyris, 2012d) in accordance with the five class system (Riddler, 1996), which classifies land according to its productivity for a wide range of agricultural activities.

The only class identified at the Ginkgo Mine (including the subject and southern extension areas) is Class 4 (Ogyris, 2012d; Resource Strategies, 2001). Class 4 Agricultural Suitability is defined as:

> *Land suitable for grazing but not cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be high seasonally but the overall level of production is low as a result of a number of major constraints, both environmental and edaphic (NSW Agriculture 2002).*

Bushfire Regime

The Ginkgo Mine (including the subject and southern extension areas) is located in the *Lower Western Zone Bush Fire Management Committee Bush Fire Risk Management Plan* area. The bushfire season generally runs from October to March and the main sources of bushfire ignition in this fire management committee zone include (Lower Western Zone Bush Fire Management Committee, 2010):

- lightning;
- loss of fire control during legal burning-off;
- incomplete extinguishment of camp fires; and
- road ignition (vehicle accidents).

Visual Amenity

Public viewpoints providing opportunity to view the existing Ginkgo Mine are available along the Highway Access Road, although views are limited due to the generally flat to undulating topography and intervening vegetation. In addition, the number of potential viewers is limited due to the sparse settlement in the region and the low use of local public roads.

The "Manilla" homestead is the closest residence to the Ginkgo Mine and is located within a slight topographical depression some 5 km west of the Ginkgo Mine. The "Trelega" homestead is located approximately 20 km south-west of the Ginkgo Mine (Figure 2).

The glow produced by night-lighting at the Ginkgo Mine is visible at nearby residences and along transport routes, while direct views of mobile machinery lights and operational lighting are not available.

3.2.2 Environmental Review

Potential Impacts

The Modification would include an approximate 32 ha increase in the extent of the existing/approved Ginkgo Mine surface development area (Figures 3a and 3b) and has the potential to alter:

- topographic features;
- soils and erosion potential;
- land use and capability;
- the potential for land contamination;
- the level of bushfire hazard; and
- visual amenity impacts.

These potential impacts and how they relate to the existing/approved Ginkgo Mine are described in the following sub-sections. Measures to mitigate these potential impacts are also provided in this sub-section.

Topographic Features

The main modifications to the existing topography that would result from the Modification when compared to the existing/approved Ginkgo Mine comprise:

- a minor extension to the Ginkgo deposit mine path (approximately 2 ha beyond the existing/approved surface development area);
- minor changes to the size and location of the Ginkgo deposit final depression; and
- other supporting infrastructure (e.g. internal access roads, internal ETLs and other associated minor infrastructure, plant, equipment and activities).

Some of these topographic changes would be temporary (e.g. soil stockpiles) and some would be permanent (e.g. minor changes to the size and location of the Ginkgo deposit final depression). In the context of the approved final landform and the existing generally flat to undulating topography of the Ginkgo Mine (which ranges from approximately 55 m AHD to approximately 85 m AHD), the landform alterations outlined above represent a minor modification to the existing topography.

The existing/approved mining method, which involves backfilling the majority of the mine path as mining proceeds, effectively limits the scale of topographic or landform change associated with the Modification.

Soils and Erosion Management

The potential soil and erosion-related impacts relevant to the Modification include:

- loss of *in situ* soil resources from beneath mine landforms;
- alteration of physical and chemical soil properties during stripping and stockpiling operations;
- reduced soil quality (structure, fertility and microbial activity) of long-term stockpiles;
- contamination of soil with saline water; and
- increased erosion and sediment movement due to increased exposure of soils during clearance and construction activities.

Potential soil and erosion-related impacts would be managed by:

- maintaining a stable and safe condition of the site;
- installation of soil erosion and drainage controls;
- revegetation of the disturbed areas to self-sustaining native vegetation communities;
- routine monitoring and maintenance of rehabilitated areas for the first three years and then every three years thereafter once mining and processing operations have ceased; and
- management of threatening processes to the vegetation (e.g. the spread of weeds and plant pathogens).

The low rainfall and lack of defined drainage channels in the region generally limit the potential for fluvial erosion and sedimentation.

Land Use and Capability

Land use at the Ginkgo Mine site comprises mining activities or light intensity rangeland grazing.

The Modification would result in the disturbance or alteration of an additional approximate 32 ha of potential agricultural lands.

Rehabilitation of the Ginkgo Mine incorporating the Modification would aim to restore self-sustaining ecosystems including native species characteristic of vegetation communities cleared by the development that could be used either for light intensity grazing or for nature conservation purposes.

The nature of grazing in the region primarily involves light intensity grazing by livestock on native vegetation. Therefore, by targeting the restoration of self-sustaining ecosystems including endemic native species in the first instance, Cristal Mining would not preclude either final land use option.

The proposed increase to the existing Ginkgo Mine biodiversity offset (Section 2.4) would result in the sterilisation of an approximate 1,411 ha of potential agricultural lands.

Land Contamination

Potential land contamination risks were identified as part of the Preliminary Hazard Analysis including leaks/spills, fires, explosions and failures (Resource Strategies, 2001).

The Modification would not change the potential impacts described in the Preliminary Hazard Analysis relevant to MSP process waste, saline water or other potential land contamination risks.

Bushfire Hazard

Fires moving on or off the Ginkgo Mine would present potentially serious impacts to surrounding pastoral properties and to Ginkgo Mine personnel and equipment. The degree of potential impact would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel (e.g. grasses and native vegetation).

The expansion of the existing/approved surface development area may increase the potential for fire generation. However, given the range of management measures outlined in the *Ginkgo and Snapper Bushfire Management Plan*, the overall risk of increased bush fire frequency due to the Modification is likely to be low.

Visual Amenity

Landscape impacts change the general fabric and pattern of the existing landscape and its component parts. Such impacts can result from landform modification, vegetation removal and modification to natural drainage patterns. Potential landscape impacts associated with the Modification would be either temporary or permanent.

Potential temporary landscape impacts would be associated with temporary structures required during operations that would be removed or decommissioned at various stages during and after the mine life (e.g. soil stockpiles).

Permanent landscape impacts would result from the development of mine landforms that would remain post-mining (i.e. final depression).

The landform changes associated with the Modification are minor and would not represent significant visual impacts as the relative elevation of the proposed landforms would be low in comparison to the surrounding natural vegetation that would limit potential views. The final depression and modified mine path would not be visible from public vantage points, due to their low elevation (i.e. below ground surface level) and the flat to undulating topography.

The Modification would not result in any material changes to night lighting requirements.

Given the limited number of viewers and generally flat to undulating sandplains, intervening vegetation and progressive revegetation of landforms, no additional specific visual impact management measures are proposed.

Management Measures

The *Mine Land Management Plan*, *Murray Basin Mines Water, Erosion and Sediment Control Plan* and *Ginkgo and Snapper Bushfire Management Plan* would continue to be implemented for the Ginkgo Mine incorporating the Modification.

In addition, these environmental management plans would be reviewed and, if necessary, revised for the Modification.

3.3 BIODIVERSITY

3.3.1 Background

A flora assessment for the southern extension areas was prepared by FloraSearch (2015a) (Appendix A) and a fauna assessment was prepared by Biodiversity Monitoring Services (2015a) (Appendix B). Two additional reports were prepared by FloraSearch (2015b) (Appendix C) and Biodiversity Monitoring Services (2015b) (Appendix D) which evaluate an increase in the Ginkgo Mine biodiversity offset area to account for an approximate 333 ha of existing surface development that has not been accounted for in the offset calculations (i.e. the subject area).

Previous Flora and Fauna Studies

The original flora and fauna surveys for the Ginkgo Mine were undertaken by Bower and Porteners (2001) and Mount King Ecological Surveys (2001) in 2000. Additional surveys were undertaken for the Crayfish deposit in 2011 and 2012 (FloraSearch, 2012a; Biodiversity Monitoring Services, 2012a).

During operation of the Ginkgo Mine (including the subject area), pre-clearance surveys have been undertaken by Ogyris (Ogyris, 2005; 2006a; 2006b; 2007a; 2007b; 2008; 2009a; 2009b; 2010; 2011; 2012a; 2012b; 2012c; 2013; 2014a; 2014b; 2015a; 2015b) and the University of Ballarat has been conducting fauna surveys within rehabilitation areas at the Ginkgo Mine.

Nearby surveys have been undertaken for the Snapper Mine site (FloraSearch and Resource Strategies, 2007; Western Research Institute and Resource Strategies, 2007) and parts of Trelega Station (Western Research Institute, 2007; FloraSearch, 2007). Flora and fauna surveys have also been undertaken for the existing Crayfish deposit offset area (FloraSearch, 2012b; Biodiversity Monitoring Services, 2012b).

Existing Mitigation Measures at the Ginkgo Mine

The *Flora and Fauna Management Plan* details existing flora and fauna impact mitigation measures for the Ginkgo Mine (including the subject area). The *Flora and Fauna Management Plan* would be revised in consultation with the OEH and the DP&E to incorporate the Modification. All relevant measures would continue to be implemented for the Modification (Table 2).

Existing Biodiversity Offset Strategy

Cristal Mining currently has a number of existing offset areas in the surrounding locality, comprising two offset areas for the Ginkgo Mine and two offset areas for the Snapper Mine (Figure 2). The Ginkgo Mine offset areas total approximately 2,603 ha, and the Snapper Mine offset areas total approximately 5,470 ha (i.e. a combined area of 8,072 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 2; Table 3). The Southern Mallee offset is adjacent to the south-western section of the Snapper Mine on the Trelega property (Figure 2).

The second offset area for the Ginkgo Mine (the Crayfish deposit offset) is located within the Mallara property, located on a Western Lands Lease, leased to Cristal Mining (Figure 2). This offset area is 2,082 ha and is dominated by mosaics of Chenopod Mallee Woodland/Shrubland, Black Oak – Western Rosewood Woodland and Dune Mallee Woodland/Shrubland (Table 3).

The *Offset Management Plan* describes the management of the existing Ginkgo Mine offset areas. 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;
- 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.

Table 2
Existing Mitigation Measures at the Ginkgo Mine

Measure	Description
Vegetation Clearance Protocol	The Vegetation Clearance Protocol includes: • clear delineation of remnant native vegetation outside of the approved disturbance areas immediately adjacent to proposed clearing (e.g. marked or fenced on the ground prior to clearing activities and restriction of clearing to within these areas); • sign posts to alert personnel not to enter vegetation outside of the disturbance areas; • mine staff and contractors will be made aware of clearing limits and restricted access areas; • targeted pre-clearance surveys for threatened flora and a review of appropriate management measures if species are found; • targeted pre-clearance surveys for fauna in areas supporting *Triodia* sp. or hollow bearing trees and implementation of appropriate clearing strategies; • select vegetation cleared at the mine will continue to be reused as part of the rehabilitation programme for habitat enhancement; and • select sources of seed will be collected and propagated as part of the rehabilitation programme.
Re-establishment of Native Vegetation and Habitat	The general objectives of the existing rehabilitation program are to: • provide stable landforms with suitable vegetation cover for the proposed post mining land uses being a combination of grazing and the preservation of native flora and fauna; and • retain and link existing viable remnants. Management measures may include the placement of nesting boxes and bat roosting boxes in areas of suitable habitat for birds, bats and arboreal mammals and the inclusion of suitable ground cover species and forage resources in the rehabilitation program.
Threatened Species Management Measures	A Threatened Species Management Protocol has been prepared to facilitate the management and minimisation of potential impacts on threatened species. Key components of the Threatened Species Management Protocol which relate to fauna include site observations/surveys, threatened species management strategies and reporting.
Marble-faced Delma Management Measures	Cristal Mining will commission a suitably qualified person(s) to undertake further searches for the Marble-faced Delma (*Delma australis*). The searches will aim to delineate the distribution of the Marble-faced Delma and its population numbers. This information will be used to demonstrate the wider occurrence of the local population of Marble-faced Delma.
Measures to control weeds, feral pests and access	Control measures are implemented at the approved Ginkgo Mine to minimise the occurrence of weeds. Control measures include the mechanical removal of identified weeds and/or the application of approved herbicides in authorised areas. Control measures are implemented at the approved Ginkgo Mine to minimise the occurrence of feral goats and rabbits. Contractors are employed by Cristal Mining to complete pest controlling strategies. These can include poisoning, shooting and warren destruction (in the case of rabbits), in authorised areas. A clean, rubbish-free environment is kept to discourage scavenging and reduce the potential for further colonisation of the study area by non-endemic fauna (e.g. introduced rodents and foxes). The introduction of animals on to the site is prohibited. Domestic pets are not allowed at the mine site.
Salvage and Reuse of Material for Habitat Enhancement	Features identified for use in the rehabilitation program (e.g. habitat features, revegetation resources, soil erosion minimisation resources) will be salvaged (e.g. stumps, hollow branches) or collected (e.g. brush and seed stock) wherever possible.
Collection and Propagation of Seed	Seed will be collected from cleared vegetation for use in the rehabilitation program. Additionally, seasonal collection of seed on ML 1504 from remnant vegetation within proposed disturbance areas and other retained areas will be conducted.
Grazing Management	Appropriate fencing has been used to prevent the uncontrolled entry of livestock within the progressive work and rehabilitation areas for the life of the mine.
Vegetation Monitoring	A photographic monitoring programme has been developed to assess the performance of the rehabilitation areas and monitor the health of the vegetation surrounding the existing Ginkgo Mine path and initial overburden emplacement.
Dust Suppression	Dust suppression is undertaken on the Ginkgo Mine roads within ML 1504.

Table 2 (Continued)
Existing Mitigation Measures at the Ginkgo Mine

Measure	Description
Bushfire Risk Management	A *Bushfire Management Plan* has been developed to manage risk of bushfires. This establishes bushfire management strategies to reduce the risk of bushfire outbreaks and to establish emergency responses.
Vehicular Traffic Management	The number of roads constructed for the Ginkgo Mine has been minimised, employees and contractors have been instructed to only use the Ginkgo Mine roads, speed limits have been imposed on vehicles using roads and tracks and signposting has been installed to remind personnel of the danger of vehicles to wildlife.
Site Induction	An environmental education programme will be included in employee and contractor inductions.

Table 3
Existing Ginkgo Mine Biodiversity Offset Strategy

Area	Minimum Size/Amount (ha)	Source
Southern Mallee Offset	521	Modification 4 Offset
Crayfish Deposit Offset	2,082	Modification 9 Offset
Total	**2,603**	

Source: Ginkgo Mine Consent Condition 18.

Notes:

- *The Applicant may release 230 hectares of the Southern Mallee Offset if it can demonstrate the long-term success of woodland rehabilitation on the northern initial overburden emplacement, and those areas of the mine path subject to capping of less than five metres of non-slurried overburden, to the satisfaction of the Director-General.*
- *The success of native vegetation rehabilitation shall be based on agreed rehabilitation criteria to be included within the MOP and Flora and Fauna Management Plan. Criteria shall include vegetation condition and salinity.*

3.3.2 Environmental Review

Supplementary Flora and Fauna Studies

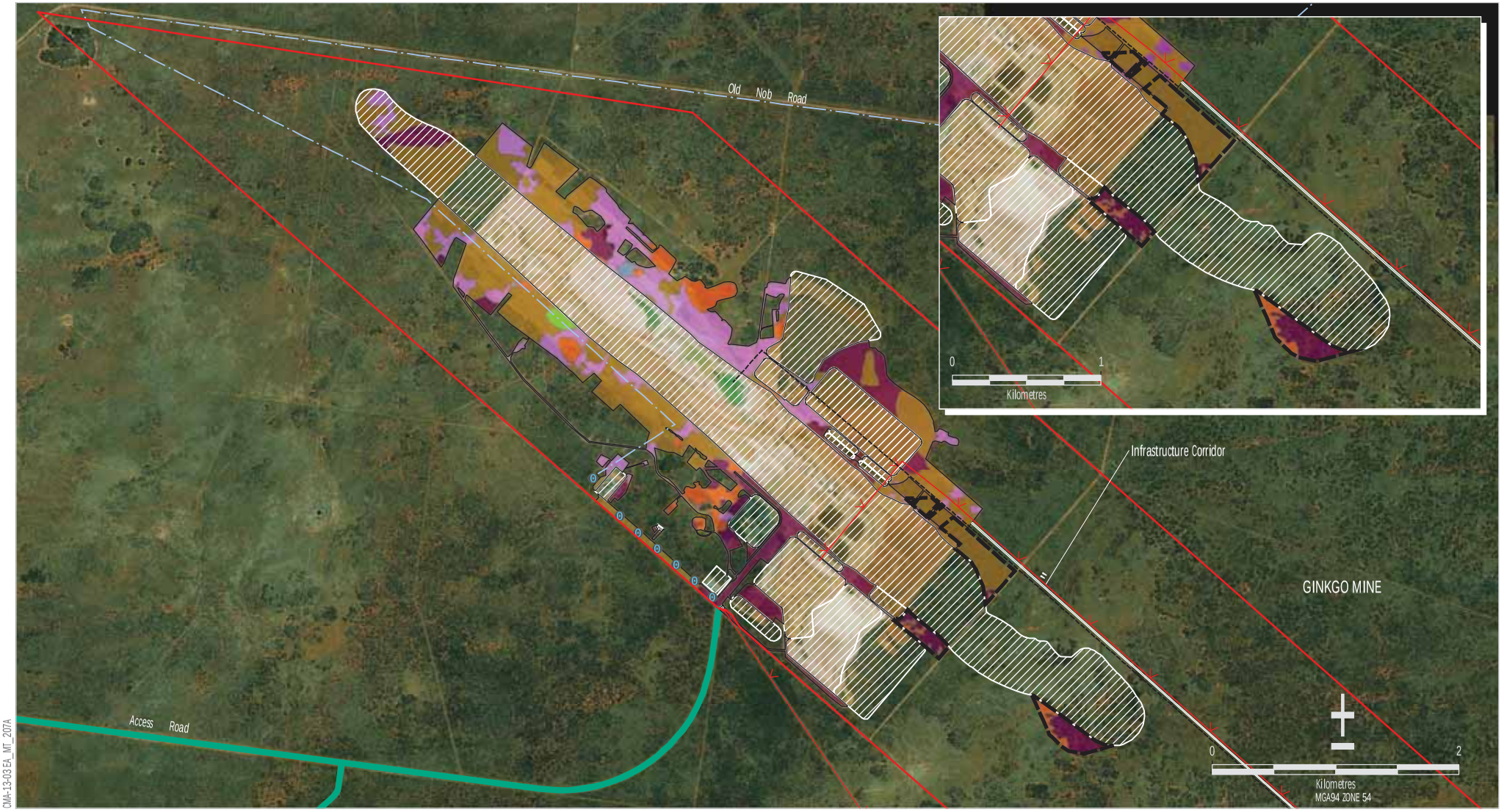
FloraSearch undertook a flora survey in the southern extension areas and surrounds in spring 2015 (14 and 15 October 2015) (Appendix A). The flora survey involved vegetation community mapping, quadrat sampling, spot sampling, transects and targeted surveys for threatened flora species listed under the NSW *Threatened Species Conservation Act*, *1995* (TSC Act) or Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act). The flora surveys were designed in consideration of the *NSW survey guidelines for threatened species* (Department of Environment and Conservation [DEC], 2004).

The condition of the vegetation in the southern extension areas was measured using the 'BioMetric' terrestrial biodiversity assessment methodology (Gibbons *et al.* 2005) (i.e. the data collection method used for biobanking). Condition mapping for the southern extension areas has been prepared by FloraSearch and is presented in Appendix A.

Biodiversity Monitoring Services conducted fauna surveys in the southern extension areas and surrounds between 29 October and 6 November 2015 (Appendix B). A range of fauna survey techniques were used including: Elliot traps, cage traps, spotlighting, hair funnels, remote cameras, bird surveys, call broadcasting, pitfall traps, reptile funnel traps, herpetological searches, harp trapping, bat call detection, inspection camera (hollows), sand plots and animal track recognition. Habitat complexity was also scored across survey sites. The fauna surveys were designed in consideration of the *NSW survey guidelines for threatened species* (DEC, 2004) and Commonwealth survey guidelines, targeting relevant species under the TSC Act and EPBC Act.

Vegetation Communities and Fauna Habitat

A total of 32 ha of native vegetation would be cleared for the southern extension areas in the modified approximate extent of surface development, comprising three vegetation communities and two broad fauna habitat types (Table 4 and Figures 4 and 5). The areas proposed to be cleared are immediately adjacent to the approved mine path (Figures 4 and 5).



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
- Ginkgo Mine General Arrangement (2010)
- Subject Area
- Modified Approximate Extent of Surface Development

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 *Eragrostic* Depression Grassland

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

Note: Vegetation Communities 1, 5 and 8 do not occur on the this figure.

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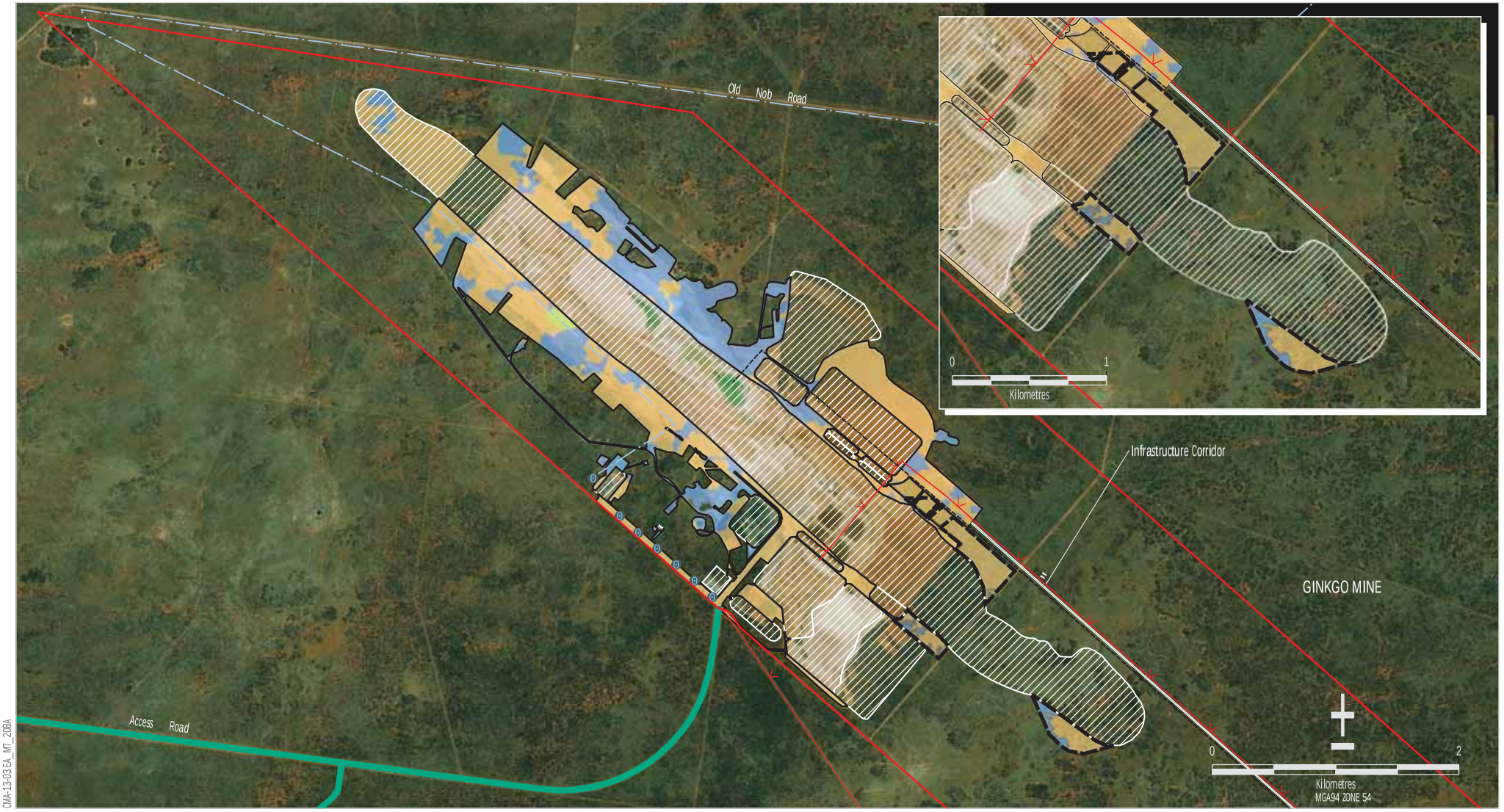
Vegetation Communities

Figure 4



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
- Ginkgo Mine General Arrangement (2010)
- Subject Area
- Modified Approximate Extent of Surface Development

Fauna Habitat Type

- 2 Black Oak - Woodland
- 3 Chenopod Mallee
- 4 Grassland/Low Shrubland

Source: Bemax Resources Limited (2010) and Cristal Mining (2013); Orthophoto: Cristal Mining (2012)
Note: Habitat type 1 does not occur on this figure.

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Habitat Types

Figure 5

Table 4
Vegetation Types Proposed to be Cleared in the Southern Extension Areas

Vegetation Community (Figure 4)	Broad Fauna Habitat (Figure 5)	Southern Extension Areas (ha)	BioMetric Vegetation Type (OEH, 2015)	% of the Biometric Vegetation Type Remaining in the LMDCMA (OEH, 2015)
2. Black Oak – Western Rosewood Woodland	Black Oak Woodland	12	LM108	80%
3. Black Oak – Pearl Bluebush Woodland		15	LM107	80%
7. *Austrostipa* – *Sida* Grassland/Low Shrubland*	Grassland/Low Shrubland	5	LM116	-
	Total	**32**		

* Secondary vegetation community.

One vegetation community, *Austrostipa* – *Sida* Grassland/Low Shrubland, is considered to be secondary vegetation community possibly resulting from past vegetation clearing (Appendix A).

Threatened Flora Species and Ecological Communities

Targeted searches of all threatened flora species and ecological communities listed under the TSC Act or EPBC Act and considered possible occurrences in the southern extension areas were completed (Appendix A). No threatened flora species or ecological communities have been identified in the southern extension areas (Appendix A).

Potential impacts on potentially occurring threatened flora species were assessed in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) (Appendix A). It was concluded that the Modification would be unlikely to significantly impact threatened flora species (Appendix A).

Threatened Fauna Species

Numerous targeted searches for potentially occurring threatened fauna species have been undertaken at the Ginkgo Mine since 2000 and a total of twelve threatened fauna species listed under the TSC Act have been recorded at the Ginkgo Mine (Table 5). Five of these threatened fauna species listed were recorded within or near the southern extension areas during the surveys undertaken by Biodiversity Monitoring Services in 2015 (Figure 6 and Table 5) (Appendix B).

No threatened fauna species listed under the EPBC Act or the NSW *Fisheries Management Act, 1994* have been recorded in the southern extension areas (Appendix B).

Potential impacts on threatened fauna species were assessed in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) (Appendix B). It was concluded that the Modification would be unlikely to significantly impact threatened fauna species known or predicted to occur (Appendix B).

Matters of National Environmental Significance

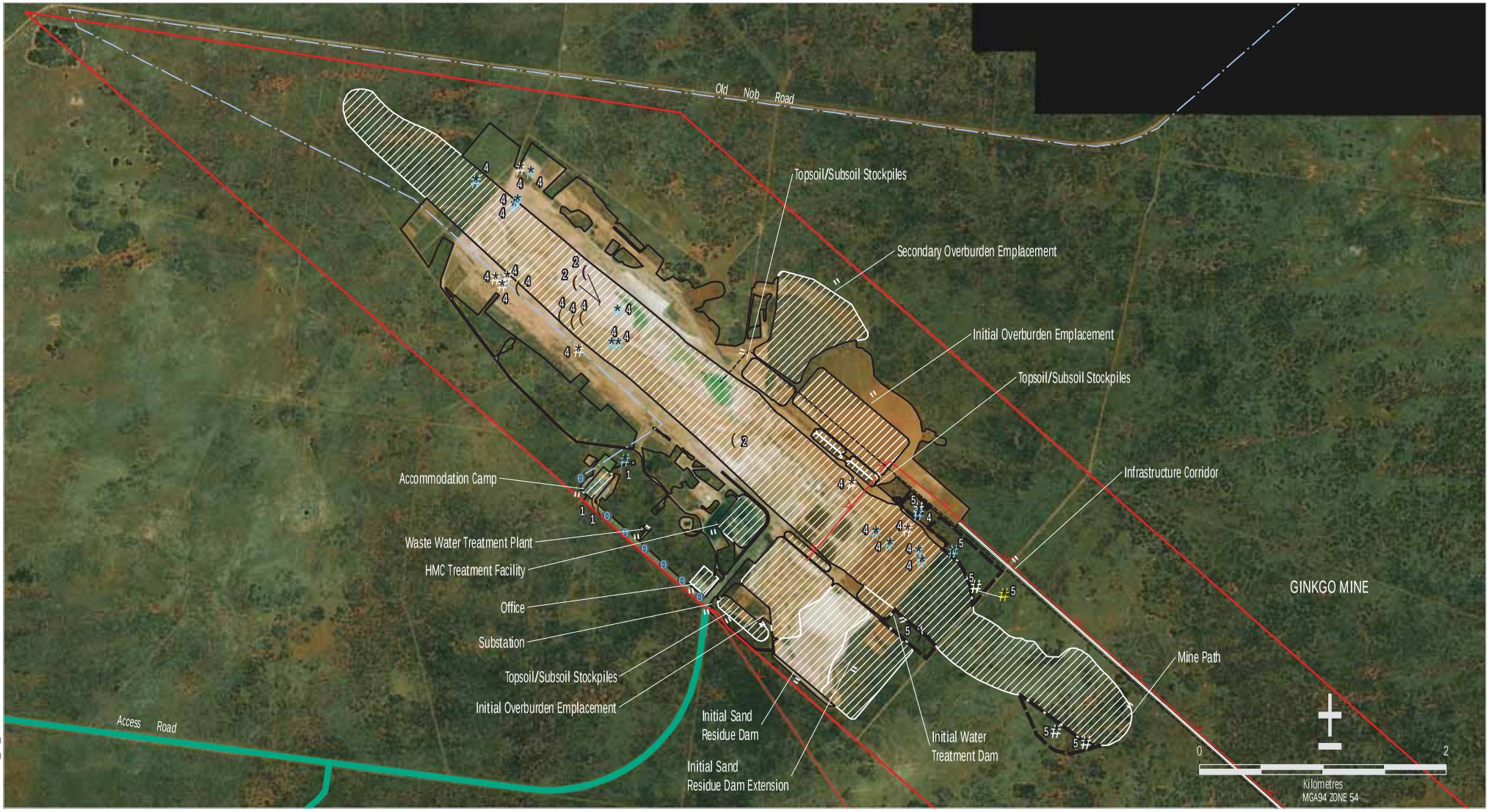
The Modification is unlikely to impact any Matters of National Environmental Significance under the EPBC Act as none are known to occur near the Ginkgo Mine (Appendix B).

Indirect Impacts

Indirect impacts on flora and fauna were assessed as part of the Environmental Impact Statement (Bemax Resources Limited [Bemax], 2001) including the increased potential for introduced flora and fauna species, dust, noise and groundwater changes. Potential indirect impacts associated with Ginkgo Mine are not likely to materially change as a result of the Modification (Appendices A and B).

Cumulative Impacts

Table 6 provides a summary of the native vegetation disturbed and associated offset areas for the relevant Ginkgo Mine environmental assessments.



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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
- Ginkgo Mine General Arrangement (2010)
- Subject Area
- Modified Approximate Extent of Surface Development

Threatened Fauna

- (Grey Falcon
- (Major Mitchell's Cockatoo
- (Hooded Robin (south eastern form)
-) Bolam's Mouse
- * Inland Forest Bat
- # Little Pied Bat
- # Yellow-bellied Sheathtail-Bat

Please note that Mount King Ecological Surveys (2001) recorded the Hooded Robin (south-eastern form) and White-fronted Chat; and Ogyris Ecological Research (2009-2012) also recorded the Hooded Robin (south-eastern form) however exact locations were not recorded.

Reference:

1 *Biodiversity Monitoring Services (2012)*
2 *Mount King Ecological Surveys (2001)*
4 *Ogyris Ecological Research (2009-2012)*
5 *Biodiversity Monitoring Services (2015)*

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

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GINKGO MINE

Threatened Species

Figure 6

Table 5
Threatened Fauna Recorded at the Ginkgo Mine

Scientific Name	Common Name	Conservation Status[1]	
		TSC Act	EPBC Act
Reptile			
Delma australis	Marble-faced Delma	E	-
Tiliqua occipitalis	Western Blue-tongued Lizard	V	-
Birds			
Falco hypoleucos	Grey Falcon	E	-
Hieraaetus morphnoides	Little Eagle	V	-
Cacatua leadbeateri	Major Mitchell's Cockatoo	V	-
Epthianura albifrons	White-fronted Chat	V	
*Melanodryas cucullata cucullata**	Hooded Robin (south-eastern form)	V	-
Daphoenositta chrysoptera	Varied Sittella	V	-
Mammals			
*Pseudomys bolami**	Bolam's Mouse	E	-
*Verpadelus baverstocki**	Inland Forest Bat	V	-
*Chalinolobus picatus**	Little Pied Bat	V	-
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail-bat	V	-

* Species recorded within or near the Modification area during the surveys undertaken by Biodiversity Monitoring Services in 2015 (Appendix B; Figure 6).

[1] Threatened fauna species status under the TSC Act and/or EPBC Act (current at December 2015).
V = Vulnerable; E = Endangered.

Table 6
Ginkgo Mine – Disturbance and Offset Summary

Source	Disturbance Area (ha)	Offset Area (ha) (Figure 2)
The EIS (Bemax, 2001)	490	None
May 2005 Modification (Bemax, 2005)	104	106
April 2006 Modification (Bemax, 2006)	15*	245
March 2007 Modification (Bemax, 2007)	85	170
Modified Request (Cristal Mining, 2013)	540	2,082
Modification 11 (Cristal Mining, 2015)	<1	0
Sub-total	**1,234**	**2,603**
Modification areas (Figure 4)	333	1,255
Modified Approximate Extent of Surface Development (Figure 4)	32	156
Total	**1,599**	**4,014**

* Condition 3.4.4c of Development Consent (DA 251-09-01) states: *The Applicant may release 230 ha of the Offset Area reflecting the May 2006 modification, if it can demonstrate the long term success of woodland (i.e native tree) rehabilitation on the northern initial overburden emplacement and those areas of the mine path subject to capping of less than 5 metres of non-slurried overburden, to the satisfaction of the Director-General, in consultation with NOW, DECCW and DPI.*

The existing/approved Ginkgo Mine surface development area is approximately 1,567 ha (comprising 1,234 ha from previous assessments and 333 ha in the subject area). The total existing and proposed Ginkgo Mine surface development area is approximately 1,599 ha. Also of relevance to cumulative impacts, the existing/approved Snapper Mine surface development area is approximately 1,630 ha.

Cristal Mining has established two existing offset areas for the Ginkgo Mine, totalling approximately 2,603 ha (Table 6) and two existing offset areas for the Snapper Mine, totalling approximately 5,470 ha. The existing and proposed offset areas held by Cristal Mining between the Great Darling Anabranch and Darling River are 9,484 ha in size[4] (more than double the size of Nearie Lake Nature Reserve which is 4,347 ha in size) (Figure 2).

3.3.3 Impact Avoidance, Mitigation and Biodiversity Offset Strategy

Impact Avoidance and Mitigation

The proposed southern extensions areas are located adjacent to the existing surface disturbance areas thereby minimising the extent of mine footprint (Appendix A).

The Black Box Woodland Habitat, located to the south of the southern extension areas, would be avoided (Appendix A).

The measures in the *Flora and Fauna Management Plan* would continue to be implemented for the Ginkgo Mine incorporating the Modification (Table 2). In addition, the *Flora and Fauna Management Plan* would be reviewed and, if necessary, revised for the Modification.

Rehabilitation and revegetation of disturbance areas is described in Section 2.3.

Proposed Biodiversity Offset Strategy

The proposed biodiversity offset strategy includes offset areas for the proposed southern extension areas (approximately 32 ha) and for existing surface development (approximately 333 ha) that has not been accounted for in previous Ginkgo Mine biodiversity offset area calculations (i.e. the subject area).

The existing biodiversity offset strategy (which was most recently augmented as a component of the Planning Assessment Commission's Modification 9 approval in March 2015) would be again augmented with additional offset areas as part of the Modification. The proposed biodiversity offset strategy is outlined in Table 7.

It is proposed that the existing Crayfish deposit offset located on the Mallara Western Lands Lease held by Cristal Mining is expanded with four additional offset areas (Figure 7). The proposed offset areas 1 to 3 (Figure 7) are to account for the subject area. The proposed offset area 4 (Figure 7) is to account for the southern extension areas.

Methodology for Selecting a Biodiversity Offset Area

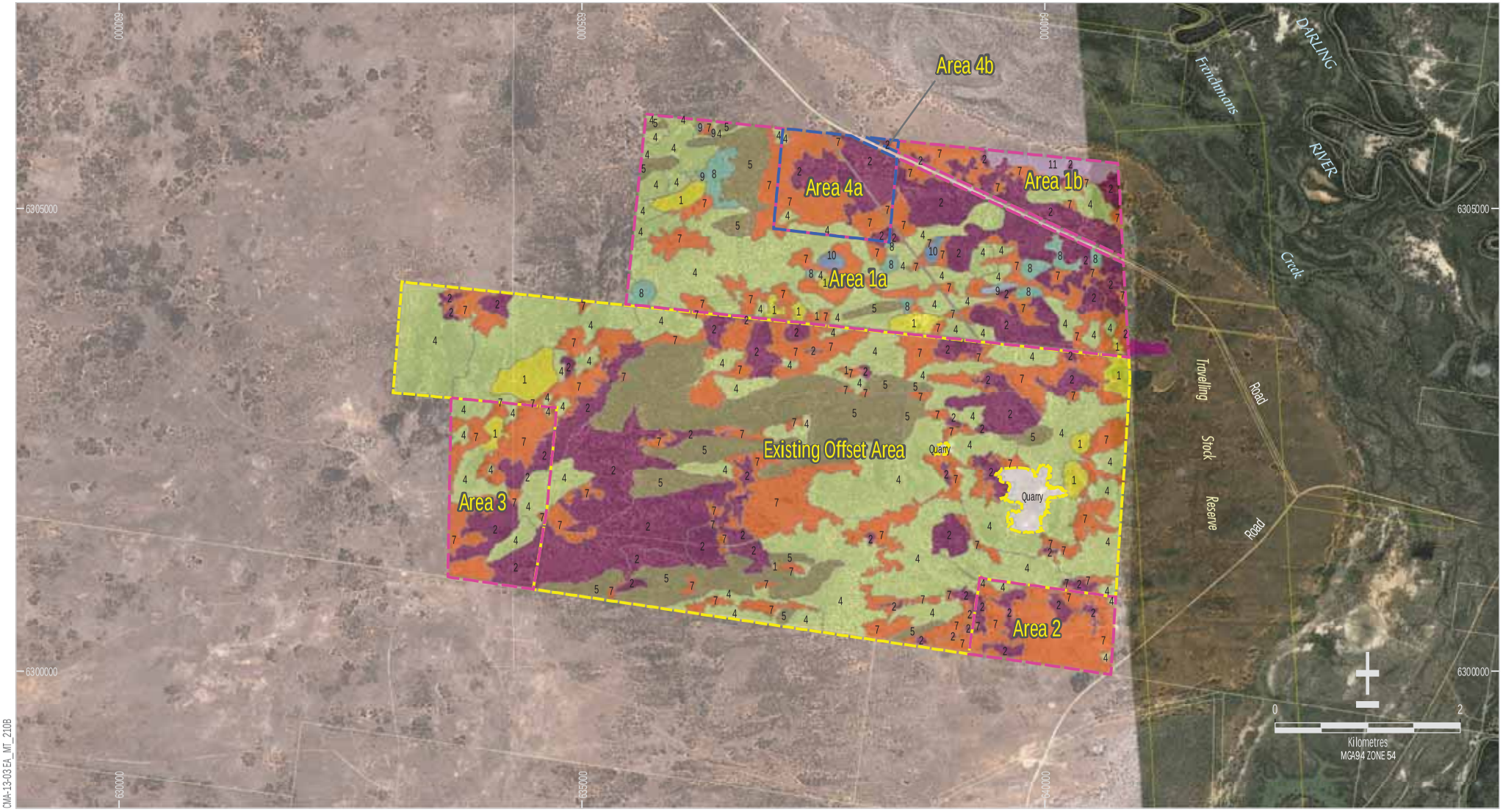
Flora and fauna surveys for the existing Crayfish deposit offset area were undertaken in 2012 (FloraSearch, 2012b; Biodiversity Monitoring Services, 2012b). These surveys included proposed offset areas 2 and 3.

Additional flora and fauna surveys were undertaken by FloraSearch (2014) (Appendix E) and Biodiversity Monitoring Services (2014) (Appendix F) for a larger area surrounding the existing Crayfish deposit offset area, covering proposed offset areas 1 and 4.

The area, location and proposed management regime for the proposed biodiversity offset area were selected on the basis of a range of factors, including the:

- relationship to existing Ginkgo Mine offset areas;
- vegetation composition of the southern extension and subject areas relative to the proposed offset areas; meeting the 'like for like' criterion;
- regional conservation priorities and vegetation most in need of conservation;
- size of the proposed offset areas relative to the southern extension and subject areas;
- ecosystem resilience and condition of the proposed offset areas; and
- initial feedback from OEH on a draft proposed offset areas.

[4] The existing offset areas for the Snapper Mine are 5,470 ha in size.



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 monoplocoides

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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GINKGO MINE

Vegetation within
the Proposed Offset Area

Figure 7

Table 7
Proposed Biodiversity Offset Strategy

Area	Minimum Size/Amount (ha)	Source	Figure
Southern Mallee Offset	521	Modification 4 Offset	Figure 2
Crayfish Deposit Offset	2,082	Modification 9 Offset	Figures 2 and 8
Proposed Offset Areas 1 to 3 (Subject Area)	1,255	This Modification	Figure 7
Proposed Offset Area 4 (Southern Extension Areas)	156	This Modification	Figure 7
Total	**4,014**		

Vegetation Communities and Threatened Ecological Communities

The combined quantity of vegetation communities in the southern extension and subject areas as well as the quantity of the proposed offset areas (offset areas 1 to 4) is presented in Table 8. In summary 365 ha of native vegetation clearance would be offset with the conservation of 1,411 ha of similar native vegetation (Table 8).

Black Oak – Pearl Bluebush Woodland is in the same vegetation class as Black Oak – Western Rosewood Woodland, of which there is 61 ha in the proposed offset areas (i.e. both are Semi-arid Sand Plain Woodlands). Of note, approximately 477 ha of Black Oak – Pearl Bluebush Woodland is present in the existing Southern Mallee offset area established for the Ginkgo Mine as is the Bluebush Shrubland (approximately 40 ha).

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 7).

Fauna Habitat

The combined quantity of fauna habitat types in the southern extension and subject areas (Figure 5) as well as the quantity of the proposed offset areas (offset areas 1 to 4) (Figure 8) is presented in Table 9. All of the broad fauna habitat types in the southern extension and subject areas are represented in the proposed offset areas in greater quantities.

Condition

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.

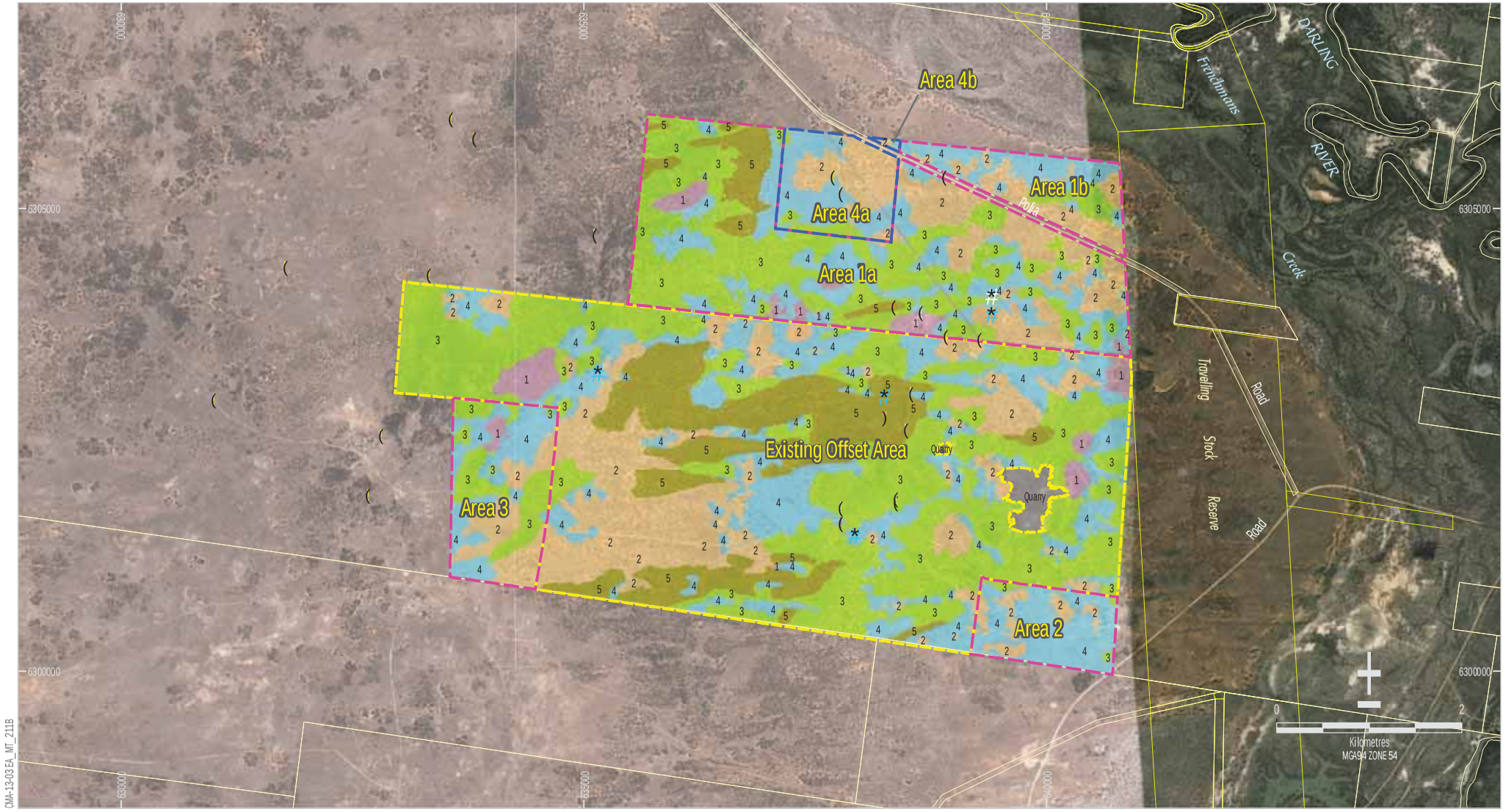
The condition of the vegetation (FloraSearch, 2014) (Appendix E) in the proposed offset areas was measured using the 'BioMetric' terrestrial biodiversity assessment methodology (Gibbons *et al.* 2005) (i.e. the data collection method used for biobanking). Condition mapping for the proposed offset areas has been prepared by FloraSearch and is presented in Appendix C.

Threatened Species

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 7, FloraSearch, 2014). Winged Peppercress is listed as Endangered under both the TSC Act and the EPBC Act.

All of the fauna habitat types that would/have be/been disturbed by the southern extension/subject areas are represented in the proposed offset areas (Table 8). All of the threatened fauna species that could potentially occur within the southern extension and subject areas, could also potentially occur within the proposed offset areas.

A total of seven threatened fauna species listed under the TSC Act have been recorded in the proposed offset areas and/or in the existing Crayfish deposit offset area. These are the Marble-faced Delma (*Delma australis*), Little Eagle (*Hieraaetus morpyhnoides*), Major Mitchell's Cockatoo (*Cacatua leadbeateri*), Hooded Robin (south-eastern form) (*Melanodryhas cucullata cucullata*), Varied Sittella (*Daphoenositta chrysoptera*), Little Pied Bat (*Chalinolobus picatus*) and Inland Forest Bat (*Verpadelus baverstocki*) (Figure 8).



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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)

Fauna Habitat Type

1 Black Box Woodland
2 Black Oak Woodland
3 Chenopod Mallee
4 Grassland/Low Shrubland
5 Dune Mallee

Other Map Unit

Quarry

Threatened Fauna

(Hooded Robin (south-eastern form)
(Major Mitchell's Cockatoo
(Varied Sittella
(Little Eagle
* Inland Forest Bat
# Little Pied Bat
) Marble-faced Delma

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GINKGO MINE

Habitat Types and Threatened Fauna Species within the Proposed Offset Area

Figure 8

Source: NSW L&PI (2012), Biodiversity Monitoring Services (2012, 2014) and Ortophoto: Google (2013)

Table 8
Vegetation Communities - Modification Areas and Offset Areas

Vegetation Community	Biometric Vegetation Type (OEH, 2015)	Ginkgo Mine Modification Areas (ha) (Figure 4)	Proposed Additional Biodiversity Offset Areas (1-4) (ha) (Figure 7)	% of the Biometric Vegetation Type Remaining in the Lower Murray Darling CMA (OEH, 2015)
Inland Floodplain Woodlands				
1. Black Box Woodland	LM104	0	37.5	80%
Semi-arid Sand Plain Woodlands				
2. Black Oak – Western Rosewood Woodland	LM108	77	349	80%
3. Black Oak – Pearl Bluebush Woodland	LM107	150	0	80%
Aeolian Chenopod Shrublands				
6. Pearl Bluebush Shrubland	LM138	106	0	90%
Sand Plain Mallee Woodlands				
4. Chenopod Mallee Woodland / Shrubland	LM116	3	424.5	70%
Dune Mallee Shrubland				
5. Dune Mallee Shrubland	LM130	0	61.5	95%
Derived Vegetation				
7. *Austrostipa – Sida* Grassland/Low Shrubland*	LM116	28	460	-
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)	**365**	**1,411**	

* Secondary vegetation community.

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

CMA = Catchment Management Authority.

Table 9
Fauna Habitat Types - Modification Areas and Offset Areas

Fauna Habitat Types	Ginkgo Mine Modification areas and Southern Extension Areas (ha) (Figure 5)	Proposed Additional Biodiversity Offset Areas (1-4) (ha) (Figure 8)
1. Black Box Woodland Habitat Type	0	37
2. Black Oak Woodland Habitat Type	227	349
3. Mallee Habitat Type	3	529
4. Grassland/Low Shrubland Habitat Type	135	496
	365	**1,411**

Ecological Gains

The proposed offset areas have the following biodiversity values (Appendices A to D):

- The proposed offset areas adjoin and enhance the large offset for the existing Crayfish deposit offset, thereby improving its long term viability.
- All of the broad fauna habitat types in the southern extension and subject areas are represented in the proposed offset areas in greater quantities.
- All threatened fauna species recorded within or immediately adjoining the southern extension and subject areas have known or potential habitat in the offset areas.
- All of the threatened fauna species that could have potentially occurred within the southern extension and subject areas, could also potentially occur within the proposed offset areas.
- The proposed offset areas have a greater diversity of vegetation communities than occur in the southern extension and subject areas.
- The proposed offset areas include threatened biodiversity; the Sandhill Pine Woodland EEC and the Winged Peppercress.
- The biodiversity values within the proposed offset areas are likely to improve in the medium to long-term as a result of proposed management actions (e.g. exclusion of grazing and management of feral goats).

Enduring Conservation of the Proposed Offset Areas

The proposed offset areas are located within the Mallara property which is perpetual Western Lands Lease 17, leased to 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 proposed offset areas within a timeframe to the satisfaction of the NSW Secretary of the DP&E.

Management of the Proposed Offset Areas

The *Offset Management Plan* would continue to be implemented for the Ginkgo Mine incorporating the Modification. In addition, the *Offset Management Plan* would be reviewed and, if necessary, revised for the Modification.

Biodiversity Offset Principles Reconciliation

The OEH has developed principles for the use of offsets for Projects other than those that are State significant (OEH, 2014). 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 10.

Table 10
Reconciliation of the Proposed Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2014)	How the Proposed Offset Areas Address 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 Crayfish deposit offset area (Figure 4), 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. The proposed offset areas contain a similar suite of fauna species and fauna habitats to those in the Subject and Modification areas.

Table 10 (Continued)
Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2014)	How the Proposed Offset Areas Address the OEH Offset Principles
5. *Offsets must be underpinned by sound ecological principles.(Cont.)*	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 threatened fauna species, 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 Offset Area 1 includes part of a large population of the Endangered (TSC Act and EPBC Act) Winged Peppercress (*Lepidium monoplocoides*). A net improvement in biodiversity is likely because: • The proposed offset areas (1-4) adjoin and enhance the existing Crayfish deposit offset area, improving its long term viability. • Management of the offset would include a series of measures likely to improve fauna habitat and reduce pressure on native fauna species, including removal of stock, ecological fire management and feral animal control. • The proposed offset areas contain a similar suite of habitats to those in the Subject and Modification areas. 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 southern extension areas. • The subject and southern extension areas 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.
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 Lands Lease associated with the proposed offset areas (1-4) would be changed to reflect its conservation purpose at the same time as the existing 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 7 and shown on Figures 4 and 7. • The types of vegetation communities and habitat to be conserved are described and mapped. • The fauna species known or with potential to occur, and their conservation status are described, mapped and quantified, where relevant. • 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. • The management actions and security for the proposed offset areas are discussed.

Table 10 (Continued)
Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2014)	How the Proposed Offset Areas Address the OEH Offset Principles
10. Offsets must be targeted.	The offset strategy addresses residual impacts associated with the Modification. The proposed offset areas contain a similar suite of fauna species and fauna habitats to those in the subject and southern extension areas. 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 areas are 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.

3.4 ABORIGINAL CULTURAL HERITAGE

3.4.1 Background

An Aboriginal Cultural Heritage Assessment (ACHA) was prepared for the Modification by Landskape Natural and Cultural Heritage Management (Landskape) (2015) and is presented in Appendix G.

The ACHA for the Modification has been undertaken in consideration of relevant requirements of various advisory documents and guidelines, including but not limited to (Appendix G):

- *Aboriginal cultural heritage consultation requirements for proponents 2010* (NSW Department of Environment, Climate Change and Water [DECCW], 2010a).
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW, 2010b).
- *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011).

Previous Archaeological Investigations

The area in the vicinity of the Ginkgo Mine has been the subject to the following Aboriginal cultural heritage surveys:

- *Ginkgo Mineral Sands Project Archaeological and Aboriginal Heritage Assessment* (Witter Archaeology, 2001a).
- *Archaeological and Aboriginal Heritage Survey: Ginkgo Mineral Sands Project Ancillary Infrastructure Modifications* (Landskape, 2003).
- *Ginkgo Mineral Sands Modification Project – Aboriginal Cultural Heritage Assessment Report* (Niche Environment and Heritage, 2012a).
- *Ginkgo Mineral Sands Mine Southern Extension Modification Aboriginal Cultural Heritage Assessment* (Landskape, 2015).

Witter Archaeology (2001a) conducted field surveys of ML 1504 (including the subject area) in 2001. A total of 36 Aboriginal cultural heritage sites were identified within ML 1504 (Figure 9), of which the majority were stone artefacts and or heat retainers from hearths.

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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)
- Electricity Transmission Line
- Water Bore
- Existing/Approved Approximate Extent of Surface Development (Processing Options 1 and 2)
- Modified Approximate Extent of Surface Development

Aboriginal Cultural Heritage

- Landskape (2003) Survey
- Witter Archaeology (2001) Survey
- Niche Environment and Heritage (2012) Survey

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

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Location of Known
Aboriginal Cultural Heritage Sites

Figure 9

Landskape (2003) conducted field surveys for the proposed ETL route for the Ginkgo Mine in 2003. Five registered Aboriginal cultural heritage sites were identified within approximately 2 km of the ETL corridor (Landskape, 2003) (Figure 9).

Field surveys of the Crayfish deposit MLA area were conducted by Niche Environment and Heritage (2012a) in 2012. Seven Aboriginal cultural heritage sites were identified during the field surveys (Figure 9) including artefact scatters, isolated finds and a culturally modified tree.

A detailed description of previous archaeological assessments and surveys undertaken in the vicinity of the Ginkgo Mine is provided in Appendix G.

Aboriginal Cultural Heritage Management Regime

Management of Aboriginal cultural heritage at the Ginkgo Mine (including the subject area) is conducted in accordance with section 87 Permit No. 1811 and section 90 Consent No. 1810 issued under the NSW *National Parks and Wildlife Act, 1974*.

Section 87 Permit No. 1811 and section 90 Consent No. 1810 together permit the destruction and collection of Aboriginal cultural heritage sites located in ML 1504 subject to amongst other things the management commitments outlined in the *Cultural Heritage Management Plan.* The *Cultural Heritage Management Plan* includes the following:

- consultation processes;
- management measures for known Aboriginal objects;
- management measures for previously unidentified Aboriginal objects;
- monitoring for Aboriginal objects; and
- cultural heritage dissemination measures.

Cristal Mining would consult with OEH regarding the need for a new Aboriginal Heritage Impact Permit (AHIP) or a variation to the existing Consent No. 1811 to allow for the Modification.

Aboriginal Cultural Heritage Sites Salvage Status

Landskape (2007) undertook salvage activities at the Ginkgo Mine (including the subject area) in April 2007. A total of 25 Aboriginal cultural heritage sites were salvaged (Table 11).

Table 11
Aboriginal Cultural Heritage Sites Salvaged at the Ginkgo Mine

Aboriginal Cultural Heritage Sites			
Gk-1	G1	G10	G17
Gk-2	G2	G11	G18
Gk-3	G5	G13	G20
Gk-4	G6	G14	G21
Gk-5	G7	G15	G22
Gk-6	G8	G16	G23
			G24

Source: Landskape (2007).

Landskape Natural and Cultural Heritage Management communicated the proposed salvage of Aboriginal heritage sites to the then NSW Department of Environment and Climate Change (now the OEH), prior to the salvage works being undertaken.

On the recommendation of the relevant Aboriginal community groups and individuals, Barkindji Elder Ray Lawson and Barkindji Elder Noel Johnson participated in the salvage works.

The salvage report (Landskape, 2007) incorporating a plain-English summary free of technical archaeological terms was provided to the relevant Aboriginal stakeholders. In addition, the salvage report (Landskape, 2007) was provided to the then Department of Environment and Climate Change (now the OEH) following the salvage works.

3.4.2 Environmental Review

Consultation

The ACHA included consultation with six Registered Aboriginal Parties, identified via a registration process consistent with the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW, 2010a) (Appendix G).

Consultation with the Aboriginal community regarding the existing Ginkgo Mine and the Modification has been extensive and involved various methods of communication including public notices, meetings, written and verbal correspondence, archaeological survey attendance and archaeological salvage.

A detailed description of the consultation undertaken for the Modification is provided in Appendix G.

Desktop Review

An Aboriginal Heritage Information Management System (AHIMS) search was undertaken in November 2015 (Appendix G) for the southern extension areas and surrounds. This search identified no Aboriginal sites located within the southern extension areas.

Archaeological Survey and Results

Additional field surveys of the southern extension areas were undertaken by Landskape (2015) on 10 November 2015 in consultation with the Registered Aboriginal Parties.

No Aboriginal cultural heritage sites were identified within the southern extension areas, despite the intensive nature of the survey.

There were no specific areas or places of cultural value identified by the Registered Aboriginal Parties during the archaeological survey undertaken for the Modification.

Potential Impacts

No Aboriginal cultural heritage sites were identified within the southern extension areas, and therefore the Modification would not have an impact on any known Aboriginal heritage sites, items or values (Appendix G).

The presence of unidentified items of Aboriginal cultural heritage within the southern extension areas is considered to be unlikely on the basis of shallow soils, past disturbance regimes and the lack of culturally sensitive landforms within the proposed disturbance area (Appendix G).

Management Measures

The *Snapper and Ginkgo Cultural Heritage Management Plan* would continue to be implemented for the Ginkgo Mine incorporating the Modification. In addition, the *Snapper and Ginkgo Cultural Heritage Management Plan* would be reviewed and, if necessary, revised for the Modification.

Cristal Mining would consult with OEH regarding the need for a new AHIP or a variation to the existing Consent No. 1811 to allow for the Modification.

3.5 HISTORIC HERITAGE

3.5.1 Background

A European Historical Heritage Assessment was prepared by Witter Archaeology (2001b) to assess the potential historic heritage impacts of the Ginkgo Mine (ML 1504). The survey conducted as part of the European Heritage Assessment identified two historic heritage sites (i.e. Bluebush Tank and Quamby Tank) (Witter, 2001b). Both of these historic heritage sites are located outside the existing/approved surface development area (including the subject area).

Niche Environment and Heritage (2012b) assessed the potential historic cultural heritage impacts of the Crayfish deposit MLA area of the Ginkgo Mine. The survey of the Crayfish deposit MLA area identified no historic cultural heritage items. There is a small possibility of low density, highly dispersed background scatter of objects relating to the pastoral use of the landscape. However, it is unlikely that any object would meet the criteria for local significance (Niche Environment and Heritage, 2012b).

3.5.2 Environmental Review

Potential Impacts

The Modification would not result in additional potential historic heritage impacts as no historic heritage sites are located within the southern extension areas.

Management Measures

No specific historic heritage management measures are proposed for the Modification.

3.6 GROUNDWATER RESOURCES

3.6.1 Background

Previous Assessments

A number of hydrogeological studies (including hydrogeological testwork) have been conducted which are applicable to the Ginkgo and Snapper Mines area including:

- Golder Associates Pty Ltd (2001) *Hydrogeological Assessment of the Ginkgo Mineral Sands Project*.

- Golder Associates Pty Ltd (2007) *Snapper Mineral Sands Project Hydrogeological Assessment*.
- GEO-ENG (2010) *Snapper and Ginkgo Mines – Hydrogeological Assessment*.
- GEO-ENG (2012) *Ginkgo Mine Modification Crayfish Deposit – Hydrogeological Assessment*.
- GEO-ENG (2013) *Ginkgo Mine Modification Modified Request Project Crayfish Deposit – Hydrogeological Assessment*.
- GEO-ENG (2014) *Snapper Mine Production Increase Modification – Hydrogeological Review*.

GEO-ENG (2013) evaluated the potential cumulative impacts of the Ginkgo and Snapper Mines on groundwater resources using hydrogeological conceptualisation and a supporting numerical groundwater model.

The numerical groundwater model was used to simulate the potential effects of the approved Ginkgo and Snapper Mines on Western Murray Porous Rock Groundwater Source, as defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011* under the *Water Management Act, 2000*, groundwater dependent ecosystems and existing groundwater users.

GEO-ENG (2013) concluded that:

> *The results from the groundwater modelling indicate negligible groundwater impacts at all potential receiving environments ….*

The conclusions of GEO-ENG (2013) were reviewed in the context of the Snapper Mine Production Increase Modification and it was concluded that (GEO-ENG, 2014):

> *The* [Snapper Mine Production Increase] *Modification is not expected to result in any significant change to the cumulative groundwater impacts associated with the Snapper and Ginkgo (including the proposed Crayfish deposit) Mines (Table 1).*

Regional and Local Hydrogeology

A number of large scale ridges and basins (likely fault bounded blocks) form the pre-Tertiary basement profile, over which the relatively flat lying Tertiary and Quaternary sediments of the Murray Basin have formed (GEO-ENG, 2014).

Specific groundwater information is provided by the Murray Basin Hydrogeological Map Series (Australian Geological Survey Organisation, 1993), which indicate the general geometry of various aquifers and aquitards, based on sparse distribution of drillholes (GEO-ENG, 2014).

The Ginkgo, Crayfish and Snapper ore bodies lie in the shallow, saline aquifer of the Loxton-Parilla Sands beneath the shallow Quaternary Woorinen and Shepparton Formation Layers (GEO-ENG, 2014).

Saline aquifers within the underlying Renmark Group have been mapped to include sand beds of the Upper, Middle and Lower Olney Formation and basal Warina Sand. At the Ginkgo Mine the Upper Olney is indicated to be a thin zone of fine sand directly beneath and connected to the Loxton-Parilla Sands.

The Middle Olney Formation is not well defined locally but is more significant to the north where it connects with both the Upper and Lower Olney Formations. The Lower Olney Formation and Warina Sand are located at about relative level (RL) -170 m to RL -260 m beneath the mine sites overlying pre-Tertiary bedrock. The Geera Clay Aquitard is approximately 130 m thick in the local area and separates the saline Upper and Lower Olney Formation units (GEO-ENG, 2014).

The groundwater flow in all aquifers is from recharge areas in the north and east to discharge in the south-west towards the Murray River and Lake Victoria. The groundwater gradient is very flat with a local gradient of about 1 vertical (V):10,000 horizontal (H). Groundwater pressures in each aquifer are similar, with a small downward gradient in the recharge areas (north) and a larger upward gradient in the discharge zone (south) (GEO-ENG, 2014).

Regional Groundwater-Related Features

Groundwater Dependent Ecosystems

There are currently no high priority groundwater dependent ecosystems identified in the Western Murray Porous Rock Groundwater Source defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* under the NSW *Water Management Act, 2000* (GEO-ENG, 2014).

In addition, GEO-ENG (2014) considered that it is unlikely that there is a groundwater dependent ecosystem at the Ginkgo Mine as the groundwater table is located approximately 30 m below the surface and there is no evidence of any perched water tables.

Notwithstanding, *The NSW State Groundwater Dependent Ecosystems Policy* (NSW Department of Land and Water Conservation, 2002) recognises the four Australian groundwater dependent ecosystem types (Hatton and Evans, 1998) that can be found in NSW, namely:

- terrestrial vegetation;
- baseflows in streams;
- aquifer and cave ecosystems; and
- wetlands.

There is no groundwater dependent vegetation known to occur at the Ginkgo Mine (GEO-ENG, 2012).

As there are no permanent surface water features (i.e. no groundwater window lakes fed by the deep underlying saline groundwater aquifer) at the Ginkgo and Snapper Mines, there are no groundwater dependent baseflows in streams or wetlands (GEO-ENG, 2014).

The Salt Lakes located approximately 18 km to the south-west of the Ginkgo Mine are considered to be a groundwater dependent ecosystem (Figure 10). The groundwater table is approximately 2 m from the surface at this location and the local ecosystem is affected by evapotranspiration of the saline water from the aquifer (GEO-ENG, 2014).

Other Groundwater-Related Features

Groundwater-related features in the region include the Darling River, Great Darling Anabranch and the Murray River (Figure 1).

Groundwater Quality

Groundwater monitoring results conducted by Cristal Mining and the Murray Basin Hydrogeological Map Series (Australian Geological Survey Organisation, 1993) indicate salinities in excess of 35,000 milligrams per litre (mg/L) for the shallow Pliocene Loxton-Parilla Sands aquifer and 14,000 mg/L to 35,000 mg/L for the deep Tertiary Lower Olney Formation/Warina Sand aquifer in the region of interest (GEO-ENG, 2014).

Groundwater Users

Groundwater use in the vicinity of the Ginkgo and Snapper Mines is limited to three locations (Chalky Well, Court Nareen Well and Greenvale Well) (Figure 10). The limited groundwater use in the region is expected given the poor groundwater quality (GEO-ENG, 2014).

Groundwater Management Regime

Groundwater management at the Ginkgo Mine is conducted in accordance with the *Borefield Impact Management Plan*. The *Borefield Impact Management Plan* includes the following:

- a detailed monitoring programme;
- trigger levels for commencement of preventative action;
- proposed remedial action (e.g. compensatory measures); and
- an independent dispute resolution process for proposed remedial actions (if required).

Licensing

The Ginkgo Mine is located within the Western Murray Porous Rock Water Source as defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011* under the *Water Management Act, 2000*.

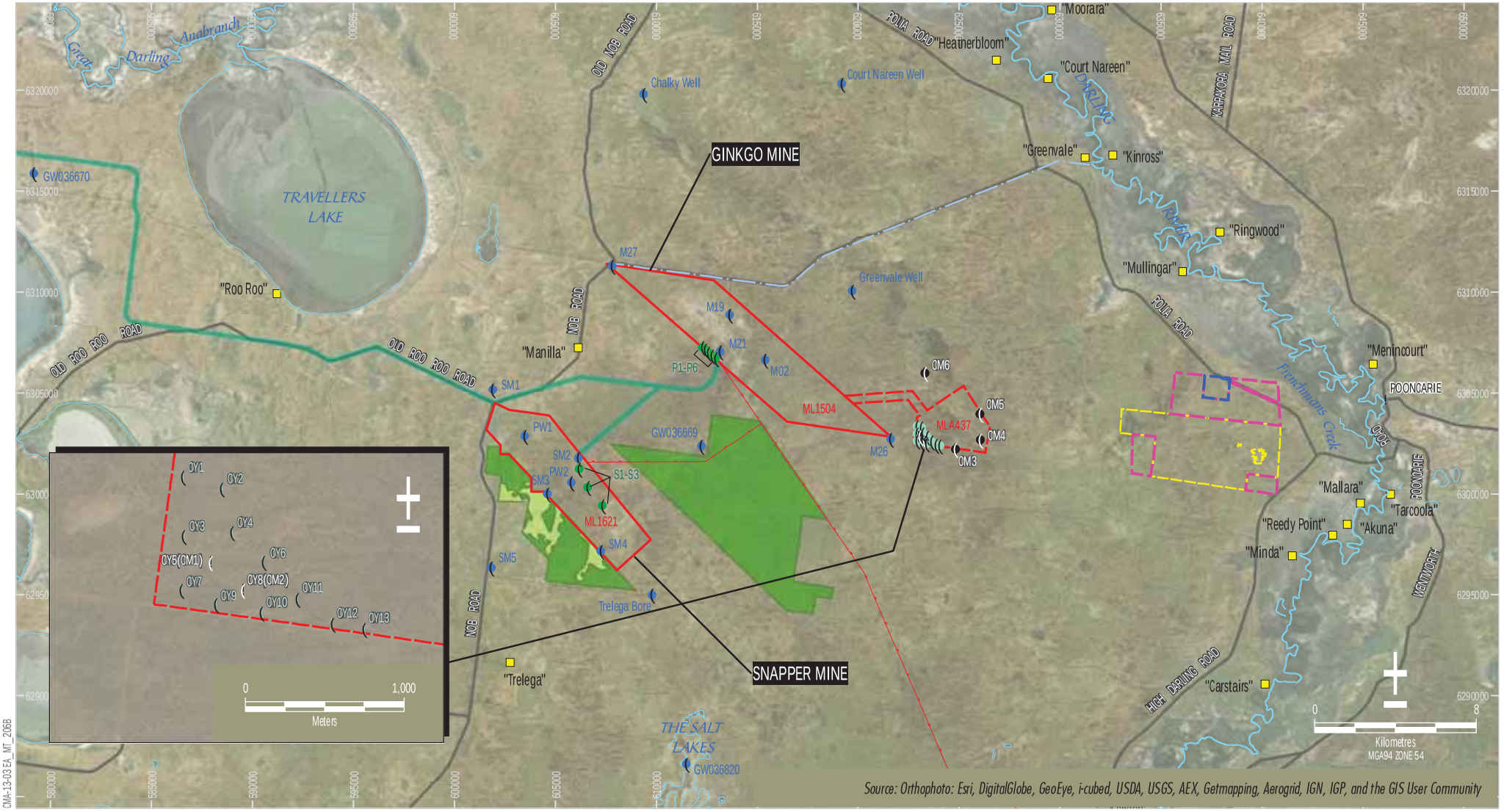
Cristal Mining currently holds a combined total 21,442 share components (units or ML) in the Western Murray Porous Rock Water Source for the Ginkgo and Snapper Mines.

3.6.2 Environmental Review

Potential Impacts

The potential groundwater impacts associated with the Modification include:

- Changes to predicted groundwater drawdown effects in the Lower Olney Formation and Loxton Parilla Sands aquifers due to the proposed minor extension to the Ginkgo deposit mine path.
- Changes to predicted impacts on groundwater users and groundwater-related features due to changes in the predicted groundwater drawdown effects.
- Changes to predicted groundwater quality impacts.



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 Constracted)
- 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)

Groundwater Monitoring Sites

- Existing Cristal Mining Groundwater Extraction Bore
- Approved Cristal Mining Groundwater Extraction Bore
- Existing Cristal Mining Groundwater Monitoring Bore
- Approved Cristal Mining Groundwater Monitoring Bore

CRISTAL

GINKGO MINE

Location of Groundwater Monitoring Sites

Figure 10

These potential impacts are discussed in more detail below.

Groundwater Drawdown Predictions

The minor extension to the Ginkgo deposit mine path (i.e. approximately 2 ha beyond the existing/approved surface development area) would result in changes to predicted groundwater drawdown effects in the Lower Olney Formation and Loxton Parilla Sands aquifers associated with the existing/approved Ginkgo Mine.

These changes to existing/approved predicted groundwater drawdown effects in the Lower Olney Formation and Loxton Parilla Sands aquifers would be negligible given the minor nature of the proposed mine path extension in the context of the existing approved Ginkgo and Crayfish deposit mine paths.

Groundwater Users

The Modification is not expected to have any measurable effect at the three local leaseholder bores (Chalky Well, Greenvale Well and Court Nareen Well [currently inoperable] [Figure 10]) given the negligible groundwater drawdown effects expected.

Regional Groundwater-Related Features

The Modification is not expected to have any measurable effect on regional groundwater-related features (e.g. Salt Lakes, Darling River, Great Darling Anabranch and Murray River [Figures 1 and 10]).

Groundwater Quality

The Modification is expected to result in negligible impacts on groundwater quality as no significant changes to the mining operations or water management are proposed.

Aquifer Interference Policy

An assessment of the potential groundwater impacts of the Modification against the minimal impact considerations in the NSW *Aquifer Interference Policy* (the AIP) (NSW Government, 2012a) concluded that the Modification is within 'Level 1' minimal impact considerations outlined in the AIP given:

- The *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* does not list any high priority groundwater dependent ecosystems in the vicinity of the Ginkgo Mine.
- The Modification would result in negligible cumulative drawdown at any privately owned water supply work.
- The Modification would not lower the beneficial use category of the groundwater source as it is expected to have negligible impact on groundwater quality.

Further discussion on the AIP is provided in Section 4.3.2.

Management Measures

Groundwater management at the Ginkgo Mine would continue to be conducted in accordance with the *Borefield Impact Management Plan*.
In addition, the *Borefield Impact Management Plan* would be reviewed and, if necessary, revised for the Modification.

Cristal Mining would continue to operate the site in accordance with the requirements of the existing Environment Protection Licence No. 12264.

Licensing

The Ginkgo Mine is located within the Western Murray Porous Rock Water Source as defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011* under the *Water Management Act, 2000*.

Cristal Mining would obtain and hold appropriate volumetric licences in accordance with the requirements of the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* for the Ginkgo and Snapper Mines.

Cristal Mining currently holds a combined total 21,442 share components (units or million litres) in the Western Murray Porous Rock Water Source for the Ginkgo and Snapper Mines.

The Modification would not change the Ginkgo Mine water supply or make-up water demand (Section 2.2) and therefore the existing volumetric licence allocations held by Cristal Mining are considered to be adequate.

3.7 SURFACE WATER RESOURCES

3.7.1 Background

Regional Hydrology

The Ginkgo Mine is located within the lower Darling River system, which extends from the Menindee Lakes to the junction of the Darling River and the Murray River at Wentworth (Figure 1). The Darling River and Great Darling Anabranch are significant regional surface water features which, at their closest points are located some 30 km south-east and 23 km north-west of the Ginkgo Mine, respectively.

Local Hydrology

There are no well-defined natural drainage channels within the Ginkgo Mine site (Cristal Mining, 2013).

The Ginkgo Mine site is located in an area of complex landforms with gentle slopes and numerous closed depressions which pond with surface runoff after significant rainfall. The climate of the area is semi-arid and surface runoff is highly ephemeral (Cristal Mining, 2013).

Surface Water Users

There are no known surface water users in the Ginkgo Mine area (Cristal Mining, 2013).

Surface Water Management Regime

Surface water management at the Ginkgo Mine is conducted in accordance with the *Murray Basin Mines Water, Erosion and Sediment Control Plan*.

The *Murray Basin Mines Water, Erosion and Sediment Control Plan* includes the following:

- a summary of erosion and sediment control structures;
- erosion and sediment control management measures;
- soil-stripping management measures;
- salinity management measures;
- monitoring and reporting requirements; and
- contingency measures.

3.7.2 Environmental Review

Potential Impacts

Potential surface water impacts of the Modification would be associated with the proposed increase in the existing/approved surface development area and would include:

- minor additional modification to the existing surface water flow regime; and
- reduction in surface water quality due to uncontrolled runoff from disturbed areas and/or release of contaminants.

Water flow direction may change and in places a localised reversal of direction may occur where areas of temporary surface ponding are excavated and exist adjacent to the surface development area (e.g. following rainfall events).

Potential impacts on surface water quality may occur due to uncontrolled runoff from disturbed areas and/or release of contaminants.

Surface water runoff from disturbed areas could potentially contain sediments, dissolved solids, oil, grease, metals and salts. Erosion and sediment controls and land contamination controls that would be applied for the Modification are described in Section 3.2.

The complex landform and semi-arid climate combine to provide conditions in which the risk of off-site surface water impacts is minimal.

Cristal Mining would operate the site in accordance with the requirements of the existing Environment Protection Licence No. 12264.

Management Measures

The *Murray Basin Mines Water, Erosion and Sediment Control Plan* would continue to be implemented for the Ginkgo Mine incorporating the Modification.

In addition, the *Murray Basin Mines Water, Erosion and Sediment Control Plan* would be reviewed and, if necessary, revised for the Modification.

4 STATUTORY CONTEXT

This section outlines the statutory requirements relevant to the assessment of the Modification. It also provides a consideration of the Modification against the objects of the EP&A Act.

4.1 APPLICABILITY OF SECTION 75W OF ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979

The Ginkgo Mine was approved under Part 4 of the EP&A Act in 2002 (Development Consent [DA 251-09-01]).

Clause 12 of Schedule 6A of the EP&A Act provides that section 75W of Part 3A of the EP&A Act continues to apply to modification of development consents referred to in clause 8J(8) of the *Environmental Planning and Assessment Regulation, 2000* (EP&A Regulation) following the repeal of Part 3A.

The Ginkgo Mine was approved under Part 4 of the EP&A Act in 2002 by development consent under Division 4 of Part 4 of the EP&A Act (relating to State significant development). Therefore the Development Consent (DA 251-09-01) is a development consent that falls within clause 8J(8)(c) of the EP&A Regulation. That is, section 75W of the EP&A Act continues to apply to modifications to the Wambo Development Consent (DA 251-09-01), notwithstanding its repeal[5].

Approval for the Modification will be sought as a modification to the Development Consent (DA 251-09-01) under section 75W of the EP&A Act. Section 75W of the EP&A Act relevantly provides:

> **75W Modification of Minister's approval**
>
> *(1) In this section:*
>
> ***Minister's approval** means an approval to carry out a project under this Part, and includes an approval of a concept plan.*
>
> ***Modification of approval** means changing the terms of a Minister's approval, including:*
>
> *(a) revoking or varying a condition of the approval or imposing an additional condition of the approval, and*
>
> *(b) changing the terms of any determination made by the Minister under Division 3 in connection with the approval.*
>
> *(2) The proponent may request the Minister to modify the Minister's approval for a project. The Minister's approval for a modification is not required if the project as modified will be consistent with the existing approval under this Part.*
>
> *(3) The request for the Minister's approval is to be lodged with the Director-General. The Director-General may notify the proponent of environmental assessment requirements with respect to the proposed modification that the proponent must comply with before the matter will be considered by the Minister.*
>
> *(4) The Minister may modify the approval (with or without conditions) or disapprove of the modification…*

4.2 GENERAL STATUTORY CONSIDERATIONS

4.2.1 Environmental Planning and Assessment Act, 1979

The EP&A Act and EP&A Regulation set the framework for planning and environmental assessment in NSW.

Section 5 of the EP&A Act describes the objects of the EP&A Act as follows:

> *(a) to encourage:*
>
> *(i) the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment,*
>
> *(ii) the promotion and co-ordination of the orderly and economic use and development of land,*
>
> *(iii) the protection, provision and co-ordination of communication and utility services,*
>
> *(iv) the provision of land for public purposes,*
>
> *(v) the provision and co-ordination of community services and facilities, and*
>
> *(vi) the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats, and*

[5] Part 3A of the EP&A Act (as in force immediately before its repeal) continues to apply for the Ginkgo Mine. The description and quotations of relevant references to clauses of Part 3A in this document are as if Part 3A of the EP&A Act is still in force.

(vii) ecologically sustainable development, and

(viii) the provision and maintenance of affordable housing, and

(b) to promote the sharing of the responsibility for environmental planning between the different levels of government in the State, and

(c) to provide increased opportunity for public involvement and participation in environmental planning and assessment.

The Modification is considered to be generally consistent with the objects of the EP&A Act, because it is a Modification which:

- allows activities to continue on Crown land at the Ginkgo Mine;
- would be conducted in accordance with relevant lease/licence/reserve conditions over Crown land within ML 1504;
- results in no significant impact on threatened species, populations and ecological communities or their habitats (Section 3.3);
- allows continued development of the State's mineral resources in a manner that minimises environmental impacts through the implementation of environmental management measures (Section 3);
- does not affect the ongoing provision of community services and facilities; and
- allows public involvement and participation through consultation activities (Section 1.3), which would be ongoing following the public exhibition of this EA document and DP&E assessment of the Modification in accordance with the requirements of the EP&A Act.

4.2.2 Other State Legislation

In addition to the EP&A Act, the following NSW Acts may be applicable to the Ginkgo Mine, incorporating the Modification:

- *Contaminated Land Management Act, 1997*;
- *Crown Lands Act, 1989*;
- *Dams Safety Act, 1978*;
- *Dangerous Goods (Road and Rail Transport) Act, 2008*;
- *Heritage Act, 1977*;
- *Mining Act, 1992*;
- *National Parks and Wildlife Act, 1974* (NPW Act);
- *Native Vegetation Act, 2003*;
- *Noxious Weeds Act, 1993*;
- *Protection of the Environment Operations Act, 1997* (PoEO Act);
- *Radiation Control Act, 1990*;
- *Roads Act, 1993*;
- TSC Act;
- *Water Act, 1912*;
- *Water Management Act, 2000*; and
- *Work Health and Safety Act, 2011*.

Relevant licences or approvals required under these Acts would continue to be obtained for the Ginkgo Mine as required.

Additional detail on the likely requirements under some of the key Acts is provided in the sub-sections below.

Mining Act, 1992

The southern extension areas are wholly within the boundary of ML 1504. Therefore, there is no need for the amendment or variation of existing authorities or the issue of new authorities under the *Mining Act, 1992*.

Under the *Mining Act, 1992*, environmental protection and rehabilitation are regulated by conditions of mining leases, including requirements for the submission of a *Mining Operations Plan* prior to the commencement of operations, and subsequent Annual Environmental Management Reports (or Annual Reviews).

The current *Mining Operations Plan* would require revision to reflect the Modification.

Protection of the Environment Operations Act, 1997

The PoEO Act is the primary NSW legislation that regulates pollution control and licensing. One key feature of the Act is the statutory requirement to apply for and obtain an Environmental Protection Licence (EPL) in circumstances where a scheduled activity or activities are being carried out (those activities being defined in Schedule 1 of the PoEO Act).

The existing Ginkgo Mine is currently licensed under EPL 12264 to conduct "mining for minerals", "metallurgical activities" and "crushing, grinding or separating" as defined in Schedule 1 of the PoEO Act. EPL 12264 would be varied as required following approval of the Modification.

Water Management Act, 2000 and Water Act, 1912

The *Water Management Act, 2000* and the *Water Act, 1912* contain provisions for the licensing, allocation, capture and use of water resources. Under the *Water Management Act, 2000*, water sharing plans are being introduced (and many have commenced) for water sources. Water sharing plans establish rules for sharing water between different users and between the various environmental sources (namely rivers or aquifers).

No additional water licences under the *Water Management Act, 2000* and *Water Act, 1912* are required for the Modification (Section 3.6).

National Parks and Wildlife Act, 1974

The NPW Act contains provisions for the protection and management of national parks, historic sites, nature reserves and Aboriginal heritage in NSW.

An ACHA for the Modification has been undertaken in consultation with the Registered Aboriginal Parties (Appendix G).

No Aboriginal cultural heritage sites were identified within the southern extension areas, and therefore the Modification would not have an impact on any known Aboriginal heritage sites, items or values (Appendix G).

Cristal Mining would consult with OEH regarding the need for a new AHIP or a variation to the existing Consent No. 1811 to allow for the Modification.

4.2.3 Environmental Planning Instruments

State environmental planning policies and local environmental plans that may be relevant to the Modification are discussed below.

State Environmental Planning Policy (Major Development) 2005

The Ginkgo Mine was approved under Part 4 of the EP&A Act in 2002 (Development Consent [DA 251-09-01]). The Modification activities are wholly contained within the Project Application area of the approved Ginkgo Mine.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

The *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries)* (Mining SEPP) regularises the various environmental planning instruments that previously controlled mining activities and aims to provide for the proper management of and development of mineral resources.

Clause 5(3) of the Mining SEPP gives it primacy where there is an inconsistency between the provisions of the Mining SEPP and the provisions of any other environmental planning instrument (except the *State Environmental Planning Policy [Major Development] 2005*, *State Environmental Planning Policy No. 14 [Coastal Wetlands]* and *State Environmental Planning Policy No. 26 [Littoral Rainforest]*).

Clause 2 – Aims of the Policy

Clause 2 sets out the aims of the Mining SEPP as follows:

> *(a) to provide for the proper management and development of mineral, petroleum and extractive material resources for the purpose of promoting the social and economic welfare of the State, and*
>
> *(b) to facilitate the orderly and economic use and development of land containing mineral, petroleum and extractive material resources, and*
>
> *(b1) to promote the development of significant mineral resources, and*
>
> *(c) to establish appropriate planning controls to encourage ecologically sustainable development through the environmental assessment, and sustainable management, of development of mineral, petroleum and extractive material resources, and*
>
> *(d) to establish a gateway assessment process for certain mining and petroleum (oil and gas) development:*
>
> *(i) to recognise the importance of agricultural resources, and*
>
> *(ii) to ensure protection of strategic agricultural land and water resources, and*
>
> *(iii) to ensure a balanced use of land by potentially competing industries, and*
>
> *(iv) to provide for the sustainable growth of mining, petroleum and agricultural industries.*

Clause 7 – Permissible Development

Clause 7(1) of the Mining SEPP states that development for any of the following purposes may be carried out only with development consent:

(b) mining carried out:

(i) on land where development for the purposes of agriculture or industry may be carried out (with or without development consent), or

(ii) on land that is, immediately before the commencement of this clause, the subject of a mining lease under the Mining Act 1992 or a mining licence under the Offshore Minerals Act 1999,

The southern extension areas are within ML 1504 (granted prior to commencement of the Mining SEPP) and on land where development for the purposes of agriculture is permissible. Therefore the Modification activities are permissible with development consent.

Part 3 of the Mining SEPP outlines the matters to be considered when determining development applications. Relevant clauses are discussed further below.

Clause 12 – Compatibility with Other Land Uses

Clause 12 of the Mining SEPP requires that, before determining an application for consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must:

(a) consider:

(i) the existing uses and approved uses of land in the vicinity of the development, and

(ii) whether or not the development is likely to have a significant impact on the uses that, in the opinion of the consent authority having regard to land use trends, are likely to be the preferred uses of land in the vicinity of the development, and

(iii) any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses, and

(b) evaluate and compare the respective public benefits of the development and the land uses referred to in paragraph (a) (i) and (ii), and

(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a) (iii).

Existing/approved land use in the vicinity of Ginkgo Mine is characterised by a combination of mineral sands mining operations and agricultural land uses.

The potential impacts of the Modification on land resources, biodiversity, Aboriginal and historic heritage, groundwater and surface water are assessed in Section 3. Potential noise, air quality, greenhouse gas emissions and road transport impacts are considered in Section 3.1.

Cristal Mining would implement a range of measures to avoid or minimise incompatibility of the Modification with existing and future land uses in the area. This would be achieved through the implementation of the existing Ginkgo Mine environmental management measures with relevant updates as described in Section 3.

Clause 14 – Natural Resource Management and Environmental Management

Clause 14(1) of the Mining SEPP requires that, before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the approval should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following:

(a) that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable,

(b) that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable,

(c) that greenhouse gas emissions are minimised to the greatest extent practicable.

In addition, clause 14(2) requires that, without limiting clause 14(1), in determining a development application for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider an assessment of the greenhouse gas emissions (including downstream emissions) of the development, and must do so having regard to any applicable state or national policies, programmes or guidelines concerning greenhouse gas emissions.

The potential impacts of the Modification on groundwater and surface water resources are discussed in Sections 3.6 and 3.7, including measures to minimise potential impacts.

The potential biodiversity impacts as a result of the Modification are described in Section 3.3.

Consideration of the Modification greenhouse gas emissions is provided in Section 3.1.

Clause 15 – Resource Recovery

Clause 15 of the Mining SEPP requires that:

> *(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider the efficiency or otherwise of the development in terms of resource recovery.*
>
> *(2) Before granting consent for the development, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at optimising the efficiency of resource recovery and the reuse or recycling of material.*
>
> *(3) The consent authority may refuse to grant consent to development if it is not satisfied that the development will be carried out in such a way as to optimise the efficiency of recovery of minerals, petroleum or extractive materials and to minimise the creation of waste in association with the extraction, recovery or processing of minerals, petroleum or extractive materials.*

It is in Cristal Mining's financial interest to maximise the efficiency of ore recovery and minimise the generation of process wastes which requires disposal.

Clause 16 – Transport

Clause 16(1) of the Mining SEPP requires that, before granting consent for development for the purposes of mining or extractive industry that involves the transport of materials, the consent authority must consider whether or not the consent should be issued subject to conditions that do any one or more of the following:

> *(a) require that some or all of the transport of materials in connection with the development is not to be by public road,*
>
> *(b) limit or preclude truck movements, in connection with the development, that occur on roads in residential areas or on roads near to schools,*
>
> *(c) require the preparation and implementation, in relation to the development, of a code of conduct relating to the transport of materials on public roads.*

The Modification would not change mineral concentrate/HMC transport (Section 2.5).

The potential impacts of the Modification on the road transport network are considered in Section 3.1.

Clause 17 – Rehabilitation

Clause 17 of the Mining SEPP requires that before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the approval should be issued subject to conditions aimed at ensuring the rehabilitation of land that will be affected by the development. In particular, the consent authority must consider whether conditions of the consent should:

> *(a) require the preparation of a plan that identifies the proposed end use and landform of the land once rehabilitated, or*
>
> *(b) require waste generated by the development or the rehabilitation to be dealt with appropriately, or*
>
> *(c) require any soil contaminated as a result of the development to be remediated in accordance with relevant guidelines (including guidelines under section 145C of the Act and the Contaminated Land Management Act 1997), or*
>
> *(d) require steps to be taken to ensure that the state of the land, while being rehabilitated and at the completion of the rehabilitation, does not jeopardize public safety.*

The rehabilitation of the modified Ginkgo Mine would generally be conducted in accordance with the existing/approved rehabilitation strategy.

Section 2.3 provides a description of proposed changes to the existing/approved rehabilitation strategy.

State Environmental Planning Policy No. 33 (*Hazardous and Offensive Development*)

Clause 13 of the *State Environmental Planning Policy No. 33 (Hazardous and Offensive Development)* (SEPP 33) requires the consent authority, in considering a Development Application for a potentially hazardous or a potentially offensive industry, to take into account:

> *(c) in the case of development for the purpose of a potentially hazardous industry—a preliminary hazard analysis prepared by or on behalf of the applicant, and*

(d) any feasible alternatives to the carrying out of the development and the reasons for choosing the development the subject of the application (including any feasible alternatives for the location of the development and the reasons for choosing the location the subject of the application),

...

The risks and hazards and relevant mitigation measures associated with the Modification are considered in Section 3.1.

Notwithstanding, relevant environmental management plans would be reviewed and, if necessary, revised by Cristal Mining to include the Modification and manage any associated environmental risk (subject to any modified Development Consent conditions).

State Environmental Planning Policy No. 55 (*Remediation of Land*)

State Environmental Planning Policy No. 55 (*Remediation of Land*) (SEPP 55) aims to provide a State-wide planning approach to the remediation of contaminated land. Under SEPP 55, planning authorities are required to consider the potential for contamination to adversely affect the suitability of the site for its proposed use.

A consent authority must consider the following under clause 7(1):

(a) it has considered whether the land is contaminated, and

(b) if the land is contaminated, it is satisfied that the land is suitable in its contaminated state (or will be suitable, after remediation) for the purpose for which the development is proposed to be carried out, and

(c) if the land requires remediation to be made suitable for the purpose for which the development is proposed to be carried out, it is satisfied that the land will be remediated before the land is used for that purpose.

Further, under clause 7(2), before determining an application for consent to carry out development that would involve a change of use of land, the consent authority must consider a report specifying the findings of a preliminary investigation of the land concerned, carried out in accordance with the contaminated land planning guidelines.

Because the southern extension area are within the Project Application Area in the Development Consent (DA 251-09-01), no change of use is proposed and no preliminary land contamination investigation is required.

Wentworth Local Environmental Plan 2011

The Ginkgo Mine is located wholly within the Wentworth Shire Council local government area (Figure 1). The following identifies the provisions in the *Wentworth Local Environmental Plan 2011* (Wentworth LEP) which may have relevance to the Modification.

Part 2.3, clause 2 of the Wentworth LEP provides:

The consent authority must have regard to the objectives for development in a zone when determining a development application in respect of land within the zone.

The Ginkgo Mine is located within Zone RU1 (Primary Production) within the Wentworth local government area. The objectives of this zone include:

- *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*
- *To encourage diversity in primary industry enterprises and systems appropriate for the area.*
- *To minimise the fragmentation and alienation of resource lands.*
- *To minimise conflict between land uses within this zone and land uses within adjoining zones.*
- *To ensure the protection of both mixed dryland and irrigation agricultural land uses that together form the distinctive rural character of Wentworth.*
- *To ensure land is available for intensive plant agricultural activities.*
- *To encourage diversity and promote employment opportunities related to primary industry enterprises, including those that require smaller holdings or are more intensive in nature.*

Under the Wentworth LEP, open cut mining is listed as permissible activity with consent on lands zoned RU1 (Primary Production).

4.2.4 Commonwealth Legislation

The objective of the EPBC Act is to provide for the protection of those aspects of the environment that are of national environmental significance.

Proposals that are likely to have a significant impact on a matter of environmental significance are defined as a controlled action under the EPBC Act. Proposals that are, or may be, a controlled action are required to be referred to the Department of the Environment (DotE) to determine whether or not the action is a controlled action.

The Modification is unlikely to impact any Matters of National Environmental Significance under the EPBC Act as none are known to occur near the Ginkgo Mine (Appendices A to D).

It is considered that there is no need to refer the Modification to the Commonwealth Minister for the Environment.

4.3 NSW GOVERNMENT POLICY

4.3.1 Strategic Regional Land Use Plan

The NSW Mining and Petroleum Gateway Panel was established by the NSW Government in October 2013 as part of the Strategic Regional Land Use Policy.

The Strategic Regional Land Use Policy and the 'Gateway Process' only applies to new State Significant Development applications or modifications for mining projects which are located outside of existing mining lease areas (NSW Government, 2012b). As the Modification does not require any change to ML 1504, the 'Gateway Process' does not apply.

An assessment of potential impacts on land resources is presented in Section 3.2.

An assessment against the provisions of the Aquifer Interference Policy is provided in Section 4.3.2.

4.3.2 Aquifer Interference Policy

The AIP has been developed by the NSW Government as a component of the NSW Government's Strategic Regional Land Use Policy.

The AIP applies State-wide and details water licence and impact assessment requirements.

The AIP has been developed to ensure equitable water sharing between various water users and proper licensing of water taken by aquifer interference activities such that the take is accounted for in the water budget and water sharing arrangements. The AIP also aims to enhance existing regulation, contributing to a comprehensive framework to protect the rights of all water users and the environment in NSW.

The NSW *Water Management Act, 2000* defines an aquifer interference activity as that which involves any of the following:

- *the penetration of an aquifer;*
- *the interference with water in an aquifer;*
- *the obstruction of the flow of water in an aquifer;*
- *the taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations; and*
- *the disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations.*

The Modification does not propose any changes to the existing water supply or demand at the Ginkgo Mine (Section 2.2).

An assessment of potential groundwater impacts is provided in Section 3.6 and has been prepared in consideration of the AIP and the key conclusions are summarised below.

Water Source

The AIP requires all water taken by aquifer interference activities to be accounted for within the extraction limits set by the relevant Water Sharing Plan. The Water Sharing Plan relevant to the Snapper Mine is the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011*. Therefore, licensing under the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011* is required to account for the Modification.

Baseline Groundwater Conditions

Baseline groundwater conditions are presented in Section 3.6.1.

Modelling of Potential Impacts

The hydrogeological impacts of the Ginkgo and Snapper Mines have been modelled (GEO-ENG, 2013).

The potential impacts of the Modification have been assessed by making comparisons between the mining operations assessed by GEO-ENG (2013 and 2014) and the modified mining operations.

Licensing Requirements

As described above, the Ginkgo Mine is located within the Western Murray Porous Rock Water Source as defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011* under the *Water Management Act, 2000*.

Cristal Mining would obtain and hold appropriate volumetric licences in accordance with the requirements of the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* for the Modification. Cristal Mining currently holds a combined total 21,442 share components (units or million litres) in the Western Murray Porous Rock Water Source.

The existing volumetric licence allocations held by Cristal Mining are considered to be adequate (Section 3.6.2).

Post-closure annual licensing requirements are expected to be less than the licensing requirements during operation. Given Cristal Mining currently holds adequate licenses to account for the potential take of water associated with the Modification it is expected Cristal Mining would have adequate licences to account for the potential post-closure take of water.

Minimal Impact Considerations

The AIP establishes minimal impact considerations for highly productive and less productive groundwater.

DPI-Water mapping indicates that there is no highly productive groundwater in the vicinity of the Ginkgo Mine. It follows that porous rock aquifers in the vicinity of the Ginkgo Mine are less productive.

An assessment of the potential groundwater impacts of the Modification against the minimal impact considerations in the AIP concluded that the Modification is within 'Level 1' minimal impact considerations outlined in the AIP (Section 3.6).

Relevant Mitigation and Contingency Measures

Other Groundwater Users

The predicted changes to groundwater drawdown effects associated with the Modification may potentially modify the approved impacts on groundwater users. These potential impacts on groundwater users have been assessed as negligible and would meet the 'Level 1' minimal impact considerations outlined in the AIP (Section 3.6.2).

Notwithstanding the above, Cristal Mining implements the *Borefield Impact Management Plan*. The *Borefield Impact Management Plan* includes the following:

- a detailed groundwater monitoring program;
- trigger levels for commencement of preventative action;
- proposed remedial action (e.g. compensatory measures); and
- an independent dispute resolution process for proposed remedial actions (if required).

Monitoring and Reporting of Water Make

Cristal Mining monitors groundwater extraction as required under the conditions of its water licences.

5 REFERENCES

Australian Geological Survey Organisation (1998). *Lower Darling Regional Steady State Groundwater Flow Model. AGSO Record 1998/19.*

Australian Geological Survey Organisation, Brown, C.M., Stephenson, A.E. and Wooley, D. (1993). *Murray Basin Hydrogeological Map Series. Sheet SI 55-44, Jerilderie, New South Wales and Victoria*, 1st ed, The Organisation, Canberra.

Bemax Resources Limited (2001). *Ginkgo Mineral Sands Project Environmental Impact Statement*.

Bemax Resources Limited (2005). *Ginkgo Mineral Sands Project Modification Application – May 2005*.

Bemax Resources Limited (2006). *Ginkgo Mineral Sands Project Modification Application – April 2006*.

Bemax Resources Limited (2007). *Ginkgo Mineral Sands Project Modification Application – March 2007*.

Bemax Resources Limited (2011). *Snapper Mineral Sands Mine and Ginkgo Mineral Sands Mine Offset Management Plan*. Bemax Resources Limited.

Bemax Resources Limited (2012*). Annual Environmental Management Report Snapper Mineral Sands Mine 2011.*

Benson, J.S., Allen, C.B., Togher, C., and Lemmon, J. (2006). New South Wales Vegetation Classification and Assessment: Part 1. Plant Communities of the New South Wales Western Plains. *Cunninghamia* 9(3): 383-450.

Biodiversity Monitoring Services (2012a). *Ginkgo Mineral Sands Mine – Crayfish Modification Fauna Assessment*. Report prepared for Bemax Resources Limited.

Biodiversity Monitoring Services (2012b). *Ginkgo Mineral Sands Mine – Crayfish Modification Biodiversity Offset Fauna Assessment*. Report prepared for Bemax Resources NL.

Biodiversity Monitoring Services (2014). *Mallara Fauna Survey.* Report prepared for Cristal Mining Pty Ltd.

Biodiversity Monitoring Services (2015a). *Ginkgo Mineral Sands Mine Southern Extension Modification Southern Extension Areas Fauna Assessment.*

Biodiversity Monitoring Services (2015b). *Ginkgo Mineral Sands Mine Southern Extension Modification Offset Increase Fauna Report.*

Bower, C.C and Porteners, M.F. (2001). *Flora Assessment*, Volume 2, Appendix G of Ginkgo Mineral Sands Project Environmental Impact Statement. Bemax Resources NL.

Cristal Mining (2013). *Ginkgo Mineral Sands Mine November 2012 Modification Modified Request*.

Cristal Mining (2015). *Ginkgo Mineral Sands Mine Waste Management Modification Environmental Assessment.*

Department of Environment and Conservation (2004). *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities*.

Department of Environment and Conservation and Department of Primary Industries (2005). *Draft Guidelines for Threatened Species Assessment*.

Department of Environment, Climate Change and Water (2010a). *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010.*

Department of Environment, Climate Change and Water (2010b). *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW*.

Department of Land and Water Conservation (2002). *The NSW State Groundwater Dependent Ecosystems Policy.*

Eamus, D., Hatton, T., Cook, P., Colvin, C. (2006). *Ecohydrology*. CSIRO, Collingwood, VIC.

Emery, K.A. (1985). *Rural Land Capability Mapping. Soil Conservation Service of NSW, Sydney.*

FloraSearch (2007). *Trelega North Flora Survey and Assessment.* Report prepared for Bemax Resources NL.

FloraSearch (2012a). *Ginkgo Mineral Sands Project – Crayfish Modification Flora Assessment.* Report to Cristal Mining Pty. Ltd.

FloraSearch (2012b). *Crayfish Modification – Offset Flora Survey*. Report prepared for Bemax Resources NL.

FloraSearch (2014). *Mallara Flora Survey*. Report to Cristal Mining Pty. Ltd.

FloraSearch (2015a). *Ginkgo Mineral Sands Mine Southern Extension Modification, Southern Extension Areas Flora Assessment*.

FloraSearch (2015b). *Ginkgo Mineral Sands Mine, Southern Extension Modification Offset Increase Flora Assessment*. Report to Cristal Mining Pty. Ltd.

FloraSearch and Resource Strategies (2007). *Flora Assessment.* Appendix E in Snapper Mineral Sands Project Environmental Assessment. Bemax Resources Limited.

GEO-ENG (2010). *Snapper and Ginkgo Mines – Hydrogeological Assessment*.

GEO-ENG (2012). *Ginkgo Mine Modification Crayfish Deposit – Hydrogeological Assessment*.

GEO-ENG (2013). *Ginkgo Mine Modification Modified Request Project Crayfish Deposit – Hydrogeological Assessment*.

GEO-ENG (2014). *Snapper Mine Production Increase Modification - Hydrogeological Review*.

GHD (2014). *Snapper and Ginkgo Cultural Heritage Management Plan.* November 2014.

Gibbons, P., Ayers, D., Seddon, J., Doyle, S. and Briggs, S. (2005). *Biometric Version 1.8. A terrestrial biodiversity assessment tool for the NSW Property Vegetation Plan Developer*. Operational Manual. New South Wales Department of Environment and Conservation.

Golder Associates Pty Ltd (2001). *Hydrogeological Assessment of the Ginkgo Mineral Sands Project*. May 2001, Report No. 01612006.

Golder Associates Pty Ltd (2007). *Snapper Mineral Sands Project Hydrogeologcial Assessment*.

Hatton, T. And Evans, R. (1998). Dependence of Ecosystems on Groundwater and Its Significance to Australia. LWRDC Occasional Paper No. 12/98.

Landskape Natural and Cultural Heritage Management (2003). *Archaeological and Aboriginal Heritage Survey: Ginkgo Mineral Sands Project Ancillary Infrastructure Modifications*. Report prepared for Bemax Resources Limited.

Landskape Natural and Cultural Heritage Management (2007). *Snapper Mineral Sands Project Cultural Heritage Assessment*.

Landskape Natural and Cultural Heritage Management (2015). *Ginkgo Mineral Sands Mine Southern Extension Modification Aboriginal Cultural Heritage Assessment.* Report to Cristal Mining Australia Limited. November 2015.

Lower Western Zone Bush Fire Management Committee (2010). *Lower Western Zone Bush Fire Management Committee Bush Fire Risk Management Plan.*

Mount King Ecological Surveys (2001). *Ginkgo Mineral Sands Project Fauna Assessment* Appendix H of the *Ginkgo Mineral Sands Project Environmental Impact Statement.*

New South Wales Government (2012a). *NSW Aquifer Interference Policy NSW Government policy for the licensing and assessment of aquifer interference activities*. Released September 2012.

New South Wales Government (2012b). *Strategic Regional Land Use Policy*. Released September 2012.

Niche Environment and Heritage Pty Ltd (2012a). *Ginkgo Mineral Sands Modification Project – Aboriginal Cultural Heritage Assessment Report.* Report prepared for Cristal Mining Australia Limited. November 2012.

Niche Environment and Heritage Pty Ltd (2012b). *Ginkgo Mineral Sands Modification Project – Non-Aboriginal Heritage Due Diligence Assessment.*

Office of Environment and Heritage (2011). *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW.*

Office of Environment and Heritage (2014). *OEH Principles for the Use of Biodiversity Offsets In NSW.* Website: http://www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.htm.

Office of Environment and Heritage (2015). *VIS Classification 2.1*. Website: http://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx?ReturnUrl=%2fNSWVCA20PRapp%2fdefault.aspx

Ogyris Ecological Research (2005). *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.* Report to Bemax Resources Ltd.

Ogyris Ecological Research (2006a). *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.* Report to Bemax Resources Ltd.

Ogyris Ecological Research (2006b). *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.* Report to Bemax Resources Ltd.

Ogyris Ecological Research (2007a). *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources Ltd Murray-Darling Basin Sand Mine Sites. 4) Ginkgo Sand Mine, February 2007.* Report to Bemax Resources Ltd.

Ogyris Ecological Research (2007b). *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources Ltd Murray-Darling Basin Sand Mine Sites. 5) Ginkgo Sand Mine Stage 2 Extension, May 2007.* Report to Bemax Resources Ltd.

Ogyris Ecological Research (2009a). *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources Ltd Murray-Darling Basin Sand Mine Sites. 6) Ginkgo Sand Mine Stage 3 Extension and northern boundary fenceline. February 2009.* Report to Bemax Resources NL.

Ogyris Ecological Research (2009b). *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources Ltd Murray-Darling Basin Sand Mine Sites. 8) Ginkgo Sand Mine Stage 4 Northern Extension and Expansion of Overburden Stockpile OB2. May 2009.* Report to Bemax Resources NL.

Ogyris Ecological Research (2010). *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources Ltd Murray-Darling Basin Sand Mine Sites. 9) Ginkgo Sand Mine Stage 4 Northern Extension. Winter 2009.* Report to Bemax Resources NL.

Ogyris Ecological Research (2011). *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 13) Ginkgo Mine. August 2011*. Report to Bemax Resources NL.

Ogyris Ecological Research (2012a). *Vegetation Pre-clearance Flora and Fauna Surveys of Land at Bemax Resources NL Murray-Darling Basin Sand Mine Sites. 14) Ginkgo Mine. January 2012*. Report to Bemax Resources NL.

Ogyris Ecological Research (2012b). *Vegetation Pre-clearance Fauna Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin Sand Mine Sites. Ginkgo Mine - Winter 2012*. Report to Cristal Mining Pty Ltd.

Ogyris Ecological Research (2012c). *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.* Report to Cristal Mining Pty Ltd.

Ogyris Ecological Research (2012d). *Ginkgo Modification: Soils and Rehabilitation Capability Assessment.*

Ogyris Ecological Research (2013). *Vegetation Pre-clearance Fauna Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin mineral sand mine sites. Ginkgo Mine. February 2013.* Report to Cristal Mining Pty Ltd.

Ogyris Ecological Research (2014a). *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.* Report to Cristal Mining Pty Ltd.

Ogyris Ecological Research (2014b). *Vegetation Pre-clearance Fauna Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin mineral sand mine sites. Ginkgo Mine – Autumn – Winter 2014.* Report to Cristal Mining Pty Ltd.

Ogyris Ecological Research (2015a). *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.* Report to Cristal Mining Pty Ltd.

Ogyris Ecological Research (2015b). *Vegetation Pre-clearance Fauna Report of Land at Cristal Mining Australia Ltd Murray-Darling Basin mineral sand mine sites. Ginkgo Mine. July 2015.* Report to Cristal Mining Pty Ltd.

Resource Strategies Pty Ltd (2001). *Ginkgo Mineral Sands Project Preliminary Hazard Analysis.*

Riddler, A.M.H. (1996). *Agricultural Suitability Maps – Uses and Limitations. Agfact AC.9. 3rd Edn. NSW Agriculture, NSW.*

Western Research Institute (2007). *Trelaga North Fauna Survey and Assessment.* Report to Bemax Resources NL.

Western Research Institute and Resource Strategies (2007). *Snapper Mineral Sands Project Environmental Assessment Appendix D Fauna Assessment*.

Witter Archaeology (2001a). *Ginkgo Mineral Sands Project: Archaeological and Aboriginal Heritage Assessment.* Report prepared for Bemax Resources Limited. August 2001.

Witter Archaeology (2001b). *Ginkgo Mineral Sands Project European Historical Heritage Assessment*. Report prepared for Bemax Resources Limited. August 2001.

Wilkinson Murray (2012). *Ginkgo Mineral Sands Mine Crayfish Modification Noise Impact Statement.*