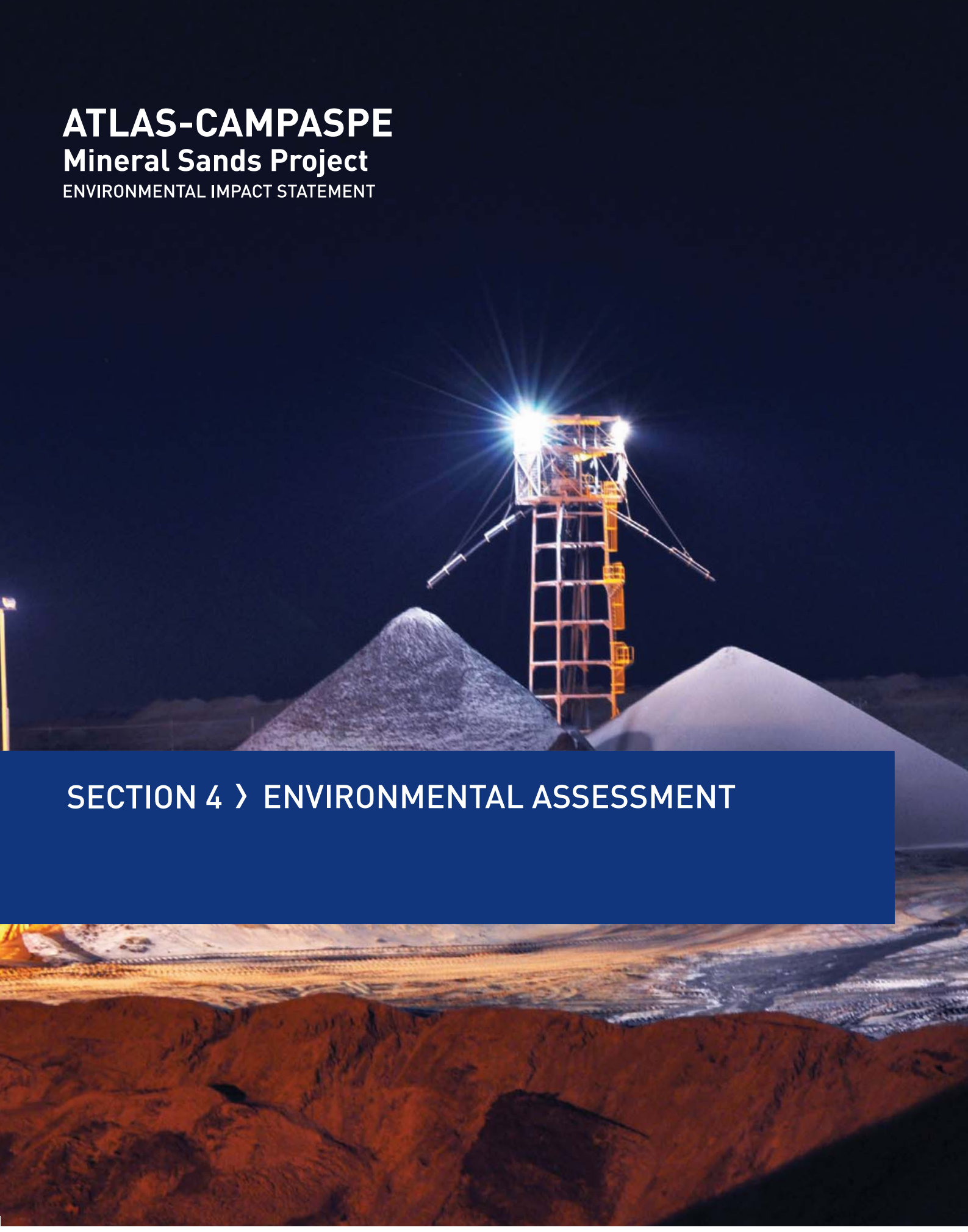
ATLAS-CAMPASPE
Mineral Sands Project
ENVIRONMENTAL IMPACT STATEMENT



SECTION 4 〉 ENVIRONMENTAL ASSESSMENT

CRISTAL Resource Strategies

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4 ENVIRONMENTAL ASSESSMENT

The following sub-sections present the environmental assessment for the Project, including:

- a description of the existing environment, using sufficient baseline data;
- an assessment of the potential impacts associated with all stages of development of the Project, including potential cumulative impacts;
- a description of the measures that would be implemented to avoid, minimise and/or offset the potential impacts of the Project; and
- a description of the mitigation, management and monitoring measures, including contingency measures that would be implemented by Cristal Mining.

The assessment of the potential impacts of the Project was conducted in accordance with the DGRs (Section 1.2 and Attachment 1), and in consideration of the outcomes of consultation with key stakeholders, including the community (Section 3) and the results of the Environmental Risk Assessment (ERA) (Section 4.1 and Appendix O).

A consolidated summary of Cristal Mining's management, mitigation, monitoring and reporting commitments for the Project has been developed as a result of the environmental assessment and is provided in Section 7.

4.1 ENVIRONMENTAL RISK ASSESSMENT

As a component of the environmental assessment of the Project to meet the requirements of the DGRs issued on 19 March 2012, an ERA was undertaken by Cristal Mining to identify key potential environmental issues for further assessment in the EIS. An ERA workshop was held in July 2012 and involved a risk assessment team consisting of representatives from:

- Cristal Mining;
- Australian Museum Business Services; and
- Resource Strategies.

The key potential environmental issues identified during the ERA workshop are summarised in Table 4-1 and addressed in Sections 4.2 to 4.17, and the relevant appendices to this EIS.

Table 4-1
Key Potential Environmental Issues

Subject Area	Issue Identified	EIS Appendix/Section
Flora	Impacts to threatened flora species and communities due to vegetation clearance.	Appendix A and Section 4.6.2
	Impact to flora as a result of vegetation clearance.	Appendix A and Section 4.6.2
Fauna	Impacts to threatened known/unknown fauna species due to loss of habitat associated with vegetation clearance.	Appendix B and Section 4.7.2
Road Transport	Impacts of mineral concentrate transport traffic on the safety and performance of the road network.	Appendix D and Section 4.13.2
Mineral Concentrate/Waste Materials	Sand residue dams storage failure.	Section 2.9.1
Groundwater	Changes to groundwater gradients and consequential impacts on surface water features.	Appendix F and Section 4.4
Surface Water	Changes to surface water flow regimes at the Atlas-Campaspe Mine and surrounding areas and as a consequence potential impacts on the Black Box Woodland and wetland.	Appendix G and Section 4.5
Agricultural Resources	Permanent loss of agricultural lands (final void or rehabilitation failure).	Appendix H and Section 4.3
Rehabilitation	Failure of rehabilitation at the Atlas-Campaspe Mine.	Section 5
	Failure to provide appropriate habitat structure and linkages for native species.	Section 5

Source: Appendix O.

The risks associated with the key potential environmental issues shown in Table 4-1 were ranked in accordance with the frameworks detailed in Australian Standard/New Zealand Standard International Organization for Standardization (AS/NZS ISO) 31000:2009 *Risk Management – Principles and Guidelines*, *MDG 1010 Minerals Industry Safety and Health Risk Management Guideline* (NSW Department of Industry and Investment, 2011) and Handbook (HB) 203:2006 *Environmental Risk Management – Principles and Process*. All of the potential issues were ranked within the "Medium– As Low as Reasonably Practicable" or "Low" range by the risk assessment team. The ERA is provided in full as Appendix O.

4.2 CLIMATE

4.2.1 Existing Environment

Meteorology

Long-term meteorological data records for the region are available from a range of Commonwealth Bureau of Meteorology (BoM) meteorological stations (Figure 4-1).

An on-site automatic weather station (AWS) has also been installed at Boree Plains for the Atlas-Campaspe Mine (Figure 4-1). It would record a number of meteorological parameters including rainfall, temperature, barometric pressure, humidity, dew point, solar radiation and wind speed/direction.

A summary of meteorological statistics for stations in the vicinity of the Project relevant to the environmental studies in this EIS are provided in Table 4-2.

Temperature

The closest BoM meteorological stations to the Project recording temperature data are located in Pooncarie, Balranald and Ivanhoe (BoM, 2012) (Figure 4-1).

Long-term, monthly-average daily maximum and minimum temperatures from the Pooncarie Mail Agency, Balranald (RSL) and Ivanhoe Post Office meteorological stations show that temperatures are warmest from November to March and coolest in the winter months of June, July and August (Table 4-2).

Monthly-average daily maximum temperatures are highest in January (38.5, 38.1 and 39.5 degrees Celsius [ºC] at the Pooncarie Mail Agency, Balranald [RSL] and Ivanhoe Post Office meteorological stations, respectively) and monthly-average daily minimum temperatures are lowest in either June or July (14.8, 12.4 and 13.7ºC for the Pooncarie Mail Agency, Balranald [RSL] and Ivanhoe Post Office meteorological stations, respectively) (Table 4-2).

Rainfall and Drought

The long-term average annual rainfall at meteorological stations proximal to (i.e. less than approximately 50 km) the Atlas-Campaspe Mine site (Figure 4-1) varies from approximately 268 mm at the Pooncarie (Top Hut) meteorological station to approximately 323 mm at the Oxley (Walmer Downs) meteorological station (Table 4-2).

The long-term average annual rainfall at meteorological stations at Ivanhoe (Figure 4-1) varies from approximately 284 mm at the Ivanhoe (Kilfera) meteorological station to approximately 306 mm at the Ivanhoe Post Office meteorological station (Table 4-2).

Average monthly rainfall is relatively uniform throughout the year and no seasonal variation is obvious (Table 4-2).

Based on an analysis by Evans & Peck (2012) of the Hatfield (Clare) meteorological station rainfall data (which has 133 years of complete records), the data shows that long-term droughts are a feature of the climate of the area. In particular (Appendix G):

- an extended drought occurred between about 1880 and 1900;
- a further extended drought occurred between about 1930 to 1950;
- since 1950, rainfall has generally been above the long-term average with the exception of droughts in the late 1960s and from 2000 to the end of 2009; and
- rainfall has been significantly above average since 2010 with 650 mm of rainfall in that year and 440 mm in 2011, which was evident by water ponding in low-lying areas surrounding the Atlas-Campaspe Mine site during the surveys and assessments undertaken during the preparation of this EIS.

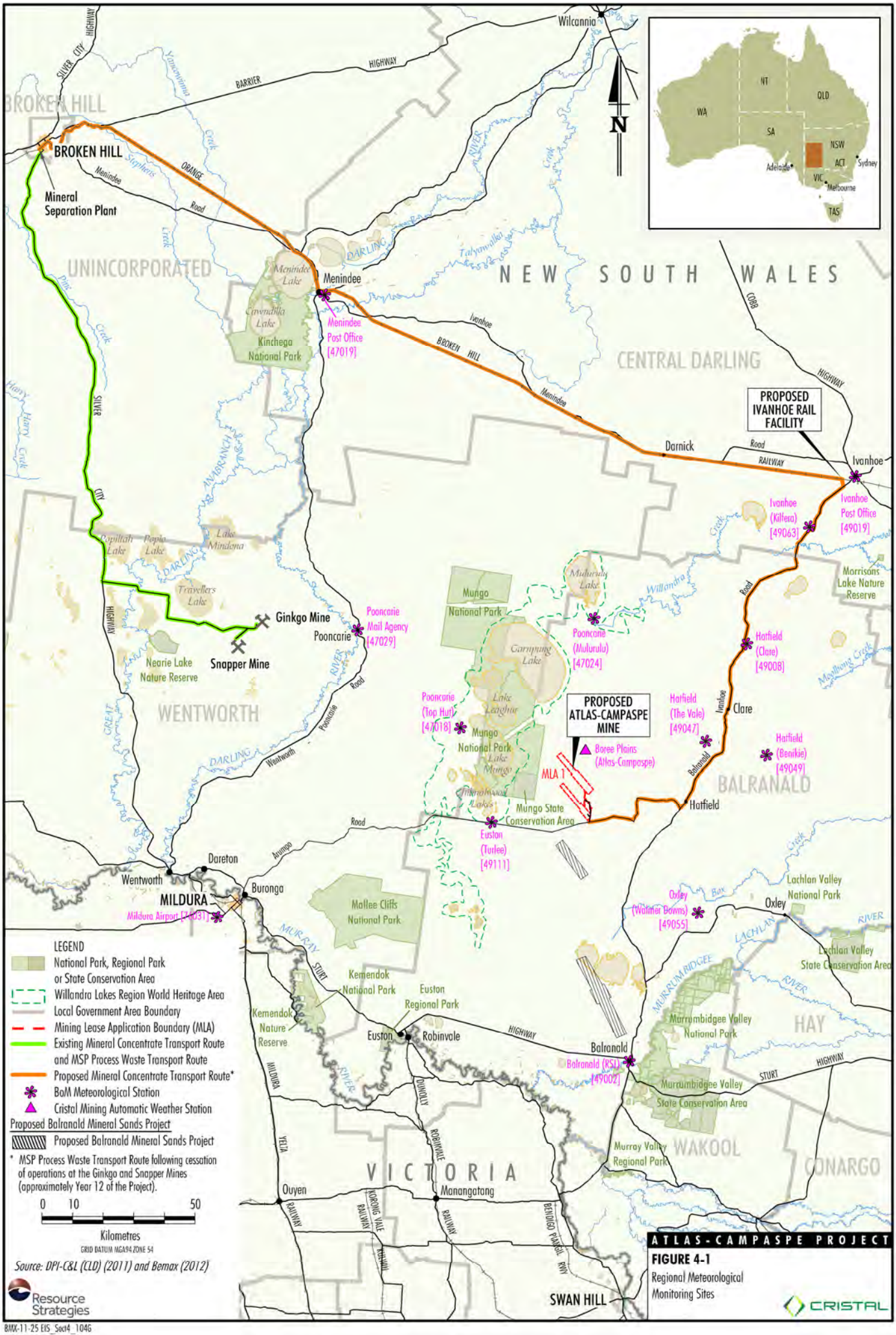

BROKEN HILL
Mineral Separation Plant
Menindee
Menindee Post Office [47019]
Kinchega National Park
Menindee Lake
Cawndilla Lake
UNINCORPORATED
NEW SOUTH WALES
CENTRAL DARLING
PROPOSED IVANHOE RAIL FACILITY
Darnick
Ivanhoe
Ivanhoe (Kilfera) [49063]
Ivanhoe Post Office [49019]
Morrisons Lake Nature Reserve
Ginkgo Mine
Snapper Mine
Pooncarie
Pooncarie Mail Agency [47029]
Nearie Lake Nature Reserve
WENTWORTH
Mungo National Park
Mulurulu Lake
Pooncarie (Mulurulu) [47024]
Hatfield (Clare) [49008]
Pooncarie (Top Hut) [47018]
Lake Leaghur
Lake Mungo
PROPOSED ATLAS-CAMPASPE MINE
Boree Plains (Atlas-Campaspe)
MLA 1
Hatfield (The Vale) [49047]
Clare
Hatfield (Benikie) [49049]
BALRANALD
Hatfield
Mungo State Conservation Area
Euston (Turlee) [49111]
Dareton
Wentworth
MILDURA
Mildura Airport [76031]
Buronga
Mallee Cliffs National Park
Oxley (Wallmer Downs) [49055]
Oxley
Lachlan Valley National Park
Lachlan Valley State Conservation Area
Kemendok National Park
Kemendok Nature Reserve
Euston Regional Park
Euston
Robinvale
Balranald
Balranald (RSL) [49002]
Murrumbidgee Valley National Park
Murrumbidgee Valley State Conservation Area
HAY
WAKOOL
CONARGO
Murray Valley Regional Park
VICTORIA
Ouyen
Manangatang
SWAN HILL
LEGEND
National Park, Regional Park or State Conservation Area
Willandra Lakes Region World Heritage Area
Local Government Area Boundary
Mining Lease Application Boundary (MLA)
Existing Mineral Concentrate Transport Route and MSP Process Waste Transport Route
Proposed Mineral Concentrate Transport Route*
BoM Meteorological Station
Cristal Mining Automatic Weather Station
Proposed Balranald Mineral Sands Project
Proposed Balranald Mineral Sands Project
* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines (approximately Year 12 of the Project).
0 10 50
Kilometres
GRID DATUM MGA94 ZONE 54
Source: DPI-C&L (CLD) (2011) and Bemax (2012)
Resource Strategies
ATLAS-CAMPASPE PROJECT
FIGURE 4-1
Regional Meteorological Monitoring Sites
CRISTAL
BMX-11-25 EIS_Sect4_1046

Table 4-2
Meteorological Summary – Long-Term Average Temperature, Rainfall and Evaporation

Period of Record	Average Daily Temperature (°C)[1] [Minimum-Maximum]			Average Monthly Rainfall (mm)[1]									Average Monthly Evaporation (mm)[1,2]	
	Pooncarie Mail Agency [47029]	Balranald (RSL) [49002]	Ivanhoe Post Office [49019]	Hatfield (Clare) [49008]	Euston (Turlee) [49111]	Hatfield (The Vale) [49047]	Hatfield (Benikie) [49049]	Pooncarie (Mulurulu) [47024]	Pooncarie (Top Hut) [47018]	Oxley (Walmer Downs) [49055]	Ivanhoe (Kilfera) [49063]	Ivanhoe Post Office [49019]	Menindee Post Office [47019]	Mildura Airport [76031]
	1882-2012	1879-2012	1884-2012	1873-2012	1960-2012	1924-2012	1876-2012	1882 – 2012	1920-2012	1922-2012	1872-2012	1884-2012	1968-2012	1965-2012
January	33.4-38.5	29.5-38.1	29.5-39.5	25.6	33.1	28.0	23.6	24.0	22.9	28.2	20.7	30.0	332.6	328.6
February	31.8-37.0	28.6-37.1	30.1-38.4	25.9	22.7	24.7	25.0	22.7	27.0	29.4	29.0	28.4	268.3	274.0
March	27.6-33.4	25.3-33.8	26.3-37.6	27.4	21.2	24.1	22.1	23.2	20.1	24.9	24.5	29.8	225.1	229.4
April	22.9-30.0	16.3-28.6	22.1-31.2	21.5	20.1	20.4	18.9	19.1	16.7	23.0	19.4	19.1	143.1	141.0
May	18.8-23.4	16.4-23.3	17.1-23.6	29.0	24.9	25.5	27.9	29.0	22.7	29.1	27.7	27.1	85.3	83.7
June	14.8-18.5	13.2-20.0	14.8-19	26.1	20.2	24.0	25.6	25.7	19.7	26.6	27.6	26.6	57.7	57.0
July	16.0-19.6	12.4-21.0	13.7-19.5	22.9	25.1	21.6	21.6	21.8	23.5	26.1	20.1	22.9	64.7	62.0
August	16.8-21.4	14.7-25.4	15.8-23.4	24.0	25.8	23.7	24.0	23.8	22.5	26.1	22.7	23.5	99.5	93.0
September	20.5-24.7	16.9-24.9	18.5-25.8	22.9	24.8	21.2	22.7	23.4	19.7	22.8	22.4	22.2	147.0	138.0
October	23.3-28.9	19.8-30.0	21.9-30.2	26.6	28.1	28.2	27.2	26.7	29.1	31.9	25.6	28.6	212.2	201.5
November	27.2-33.9	23.4-32.8	25.2-35.1	23.7	25.9	25.0	23.2	23.2	19.3	26.1	25.3	24.0	260.4	255.0
December	30.9-35.4	24.5-34.9	29.5-37.1	22.0	22.9	22.5	21.8	23.7	20.8	26.4	20.6	26.1	319.9	310.0
Average Annual	**25.1-26.9**	**22.1-26.6**	**24.8-28.1**	**299** ***[297.6]***	**300** ***[294.8]***	**286** ***[288.9]***	**281** ***[283.6]***	**282** ***[286.3]***	**268** ***[264.0]***	**323** ***[320.6]***	**284** ***[285.6]***	**306** ***[308.3]***	**2,208** ***[2,215.8]***	**2,190** ***[2,173.2]***

[1] Source: BoM (2012).

[2] As measured by Class A Evaporation Pan.

[ ] Sum of average monthly records.

The analysis by Evans & Peck (2012) is also supported by the fact that the nearest BoM meteorological station to the Atlas-Campaspe Mine site (Euston [Turlee] – Figure 4-1) recorded its highest daily total of 110 mm on 14 January 2011 in 52 years of record (BoM, 2012).

Review of rainfall intensity-frequency-duration (IFD) data for the region derived from the BoM Computerised Design IFD Rainfall System (CDIRS) website also shows that moderate intensity rainfall can be expected at the Project site (Appendix G).

Evaporation and Evapotranspiration

Long-term evaporation records are available from the Menindee Post Office and Mildura Airport meteorological stations (Figure 4-1), which have recorded an average annual evaporation of approximately 2,208 and 2,190 mm, respectively (Table 4-2).

The highest monthly-average evaporation is in January (332.6 and 328.6 mm at Menindee Post Office and Mildura Airport, respectively) (Table 4-2). The lowest monthly evaporation is in June (57.7 and 57.0 mm for Menindee Post Office and Mildura Airport, respectively) (Table 4-2).

Based on the available datasets, measured monthly-average evaporation exceeds the measured monthly-average rainfall in all months (Table 4-2).

Based on an analysis by Evans & Peck (2012) of the Menindee Post Office meteorological station daily pan evaporation data recorded since 1955, and use of monthly potential evapotranspiration derived from the electronic spatial data on the BoM dataset *Climatic Atlas of Australia – Evapotranspiration,* the following conclusions were made (Appendix G):

- Net open water evaporation in excess of 1.5 m per year can be expected. Accordingly, any runoff collected in the shallow depressions that characterise the landscape can be expected to evaporate rapidly.
- Potential evapotranspiration from vegetation exceeds the average rainfall in each month. Under these conditions, vegetation is under continual water stress and actual evapotranspiration is governed by the ability of vegetation to access moisture deep in the soil profile.

Wind Direction and Wind Speed

Morning (9 am) and afternoon (3 pm) annual wind roses for the Balranald (RSL) and Ivanhoe Post Office meteorological stations are presented on Figure 4-2.

The annual wind roses indicate southerly winds generally occur during the morning, trending to west south-westerly winds in the afternoon in the region. Wind speeds are typically less than 10 kilometres per hour (Figure 4-2).

As part of the Air Quality and Greenhouse Gas Assessment (Appendix K of the EIS), annual and seasonal wind roses for the Atlas-Campaspe Mine and the Ivanhoe Rail Facility were developed using a combination of the meteorological models, including The Air Pollution Model (TAPM) and CALMET. This synthesised dataset was prepared for use in air quality modelling, the results of which are presented in Section 4.10.2.

4.2.2 Monitoring

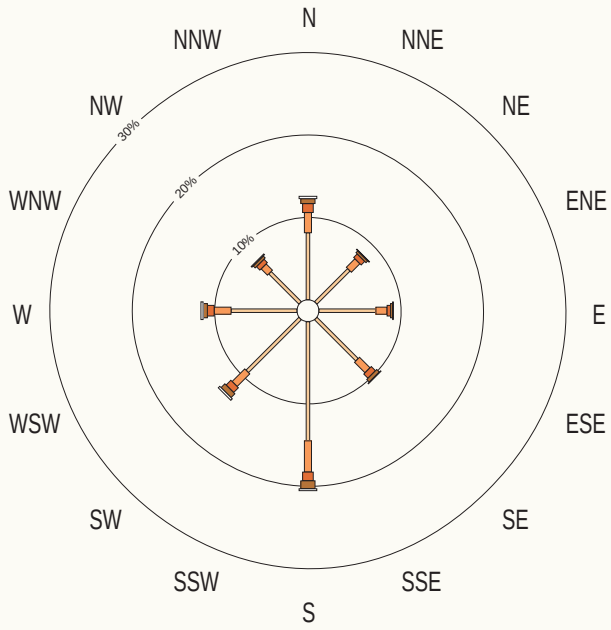
The Boree Plains AWS located at the Atlas-Campaspe Mine site would operate for the Project.

The data recorded would be used: to assist in the interpretation of the groundwater, surface water, air quality and noise monitoring data (Sections 4.4, 4.5, 4.10 and 4.12 respectively); for site water balance reviews (Section 4.5); and in assessing the performance of erosion and sediment controls and rehabilitation (Section 5).

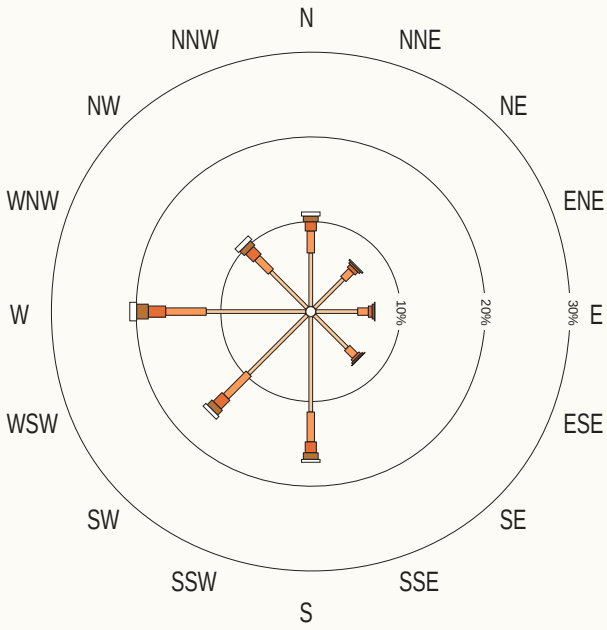
4.3 LAND RESOURCES AND AGRICULTURAL PRODUCTION

A description of the existing environment relating to land resources and agricultural production is provided in Section 4.3.1. Section 4.3.2 describes the potential impacts of the Project on land resources and agricultural production, and Section 4.3.3 describes applicable management, mitigation and monitoring measures.

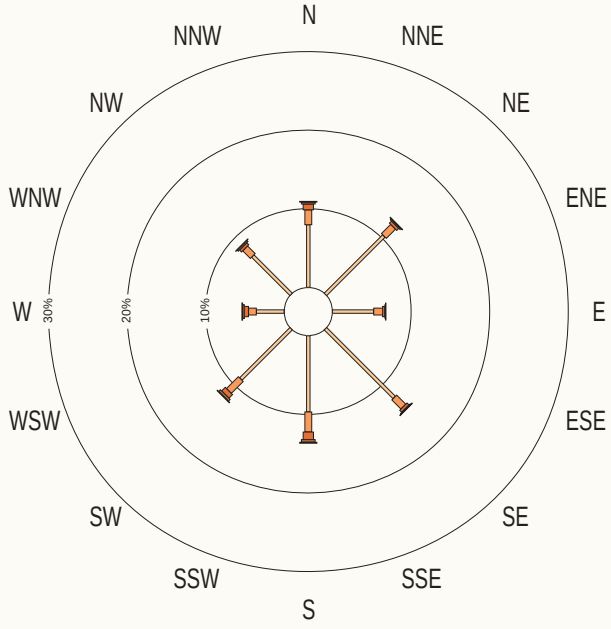
An Agricultural Impact Statement for the Project was undertaken by Cristal Mining and is presented in Appendix H. The Agricultural Impact Statement has been prepared in consideration the NSW Government's *Guideline for Agricultural Impact Statements* (NSW Government, 2012).



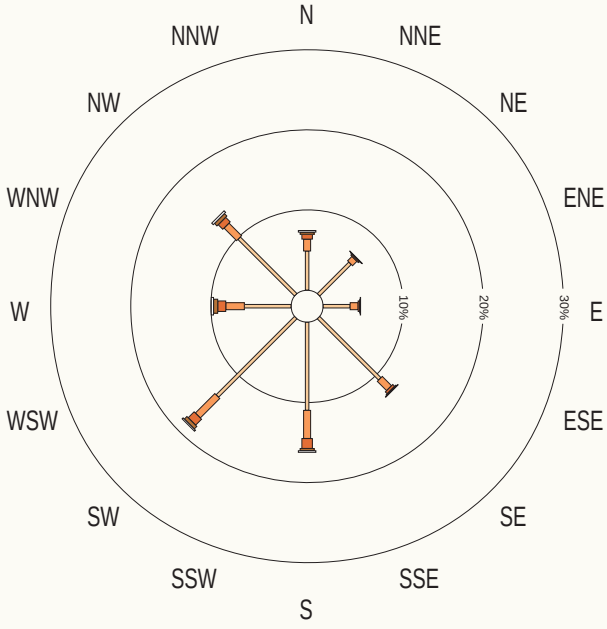
Balranald 9am
Calms = 7%



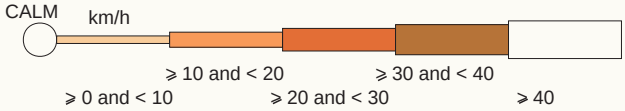
Balranald 3pm
Calms = 3%



Ivanhoe 9am
Calms = 15%



Ivanhoe 3pm
Calms = 10%



Source: BOM (2012)

ATLAS - CAMPASPE PROJECT

FIGURE 4-2
Annual Wind Roses -
Balranald and Ivanhoe

Resource Strategies

CRISTAL

4.3.1 Existing Environment

Geology

Regional Geology

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-Darling basin have formed, and within which the Atlas-Campaspe Mine is located (Appendix F). The main structural feature of the area is the Ivanhoe Block, which is defined by the south-west to north-east trending Iona and Neckarboo basement ridges (Figure 4-3). In the west of the Ivanhoe Block, the Willandra Trough exists as a basement low between the ridges and continues to the north-east as the Willandra Creek Depression and is generally associated with the Willandra Lakes Region World Heritage Area. The Atlas-Campaspe Mine is located in the east of the Ivanhoe Block (Figure 4-3).

Local Geology

A description of the local stratigraphy of the Atlas-Campaspe Mine and surrounds, including the mineral deposits, is provided in Section 2.2. Further description of the lithology is provided in the Hydrogeological and Water Supply Assessment (Appendix F).

Landforms and Topography

The Atlas-Campaspe Mine is located within the Benanee basin which is very flat and characterised by a number of ill-defined creeks, streams and ephemeral lakes (NOW, 2012).

Manfred Mountain (171 m Australian Height Datum [AHD]) (located to the north of the Atlas-Campaspe Mine) and the Murray River (45 m AHD) (located to the south of the Atlas-Campaspe Mine) are the topographic high and low points in the region respectively. The dry lake depressions associated with the Willandra Lakes Region World Heritage Area (located to the west of the Atlas-Campaspe Mine) are located at approximately 50 to 70 m AHD.

The topography of the region is dominated by the Iona Ridge (along which the Atlas-Campaspe Mine is located) and the Neckarboo Ridge (located to the west of the Willandra Lakes Region World Heritage Area) which are on average 40 m higher than the adjacent land surface. The landform in the vicinity of the Atlas-Campaspe Mine is highly complex with numerous closed minor depressions ranging from approximately 60 to 120 m AHD (Figure 4-3).

The mineral concentrate transport route traverses an area containing numerous clay pan depressions and dry lakes (located to the east of the Atlas-Campaspe Mine) that form part of the complex landform system that extends northward from an ill-defined drainage system located east and south of the Atlas-Campaspe Mine, known as the Arumpo Creek drainage system. A description of the local hydrology is provided in Section 4.5.1. Elevations range from approximately 100 m AHD in the west and approximately 70 m AHD in the east.

The landform at the Ivanhoe Rail Facility is flat at approximately 100 m AHD.

Land Use

The Project area is located on the tribal lands of the Barkandji (Paakantji), Mutthi Mutthi and Ngiyampaa Aboriginal people (Appendix E).

European settlement of the area surrounding the Atlas-Campaspe Mine commenced in the mid-nineteenth century and the township of Ivanhoe was established in the 1870's (Appendix E).

Contemporary land use in the vicinity of the Atlas-Campaspe Mine is dominated by agriculture activities conducted on Western Lands Lease. Low intensity grazing (primarily sheep [*Ovis aries*]) is the dominant agricultural activity although limited cropping has been conducted (Appendix H).

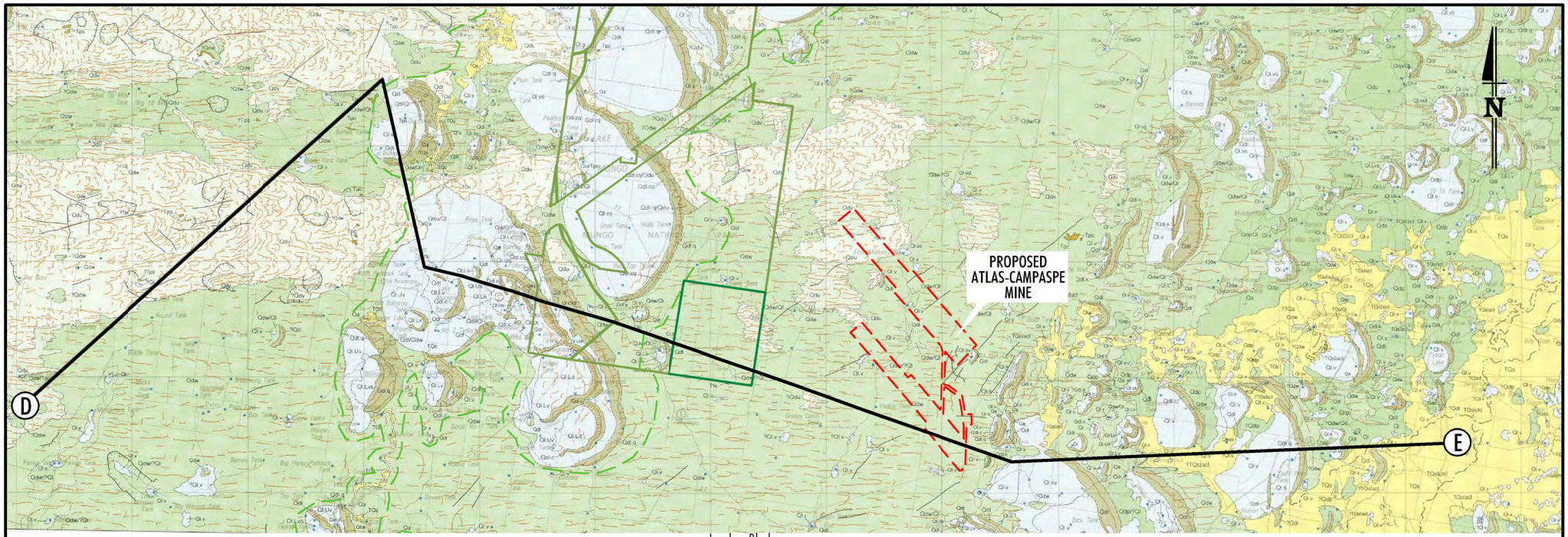
Only six private dwellings are located with 20 km of the Atlas-Campaspe Mine (Figure 1-2a).

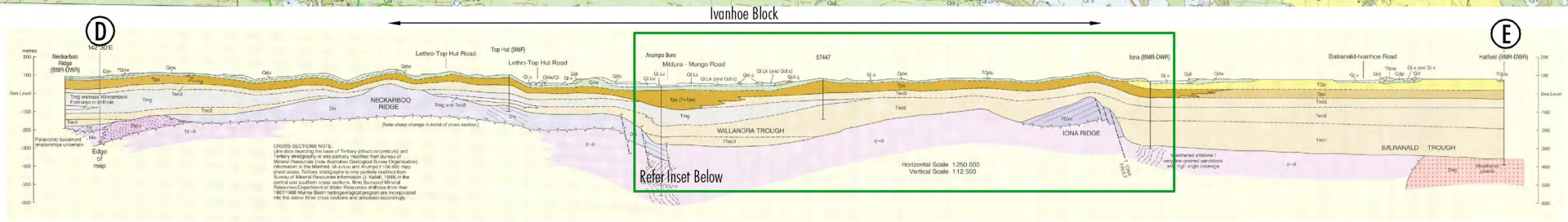
A number of reserved areas are located in the general vicinity of the Atlas-Campaspe Mine including the Willandra Lakes Region World Heritage Area, Mungo National Park, Mungo State Conservation Area, a number of private conservation areas established as Southern Mallee Landuse Agreements and a Timber Reserve to the south-east (Figure 2-3).

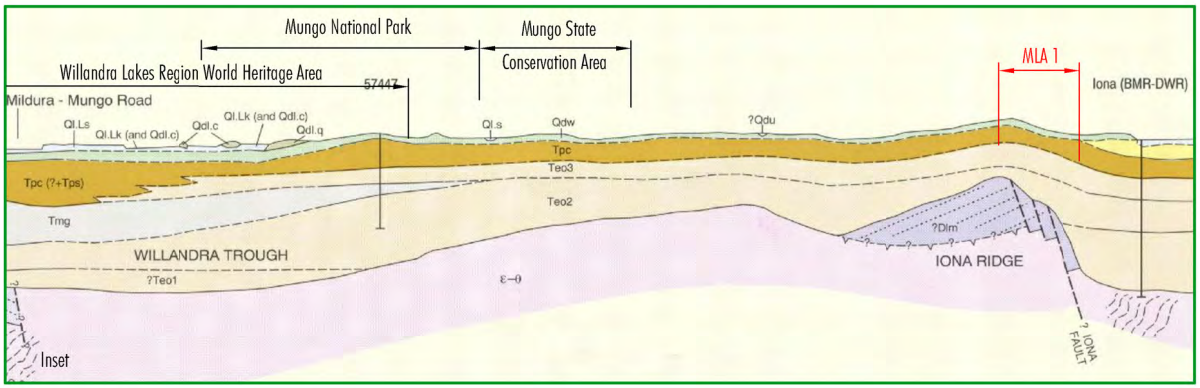
Contemporary land use in the vicinity of the Ivanhoe Rail Facility is dominated by agricultural activities (low intensity grazing) and the Orange – Broken Hill railway. The township of Ivanhoe is located approximately 4.5 km to the north-east of the Ivanhoe Rail Facility (Figure 2-9).

Soils

A Soils, Rehabilitation Capability and Agricultural Resources Assessment was undertaken for the Project by Ogyris Ecological Research (2012a) and is included as an attachment to Appendix H.







KEY

Qdl	Undifferentiated Lunette
Qdw	Woorinen Formation
Qdu	Lowan Sand
Ql	Lacustrine and Related Systems
TQs	Shepparton Formation
Tps/Tpc	Loxton/Parilla Sand
Teo	Olney Formation of Renmark Group
Dlm	Manfred Sandstone
ε-Θ	Saint Arnaud Group Equivalent

LEGEND

- National Park /State Conservation Area
- Willandra Lakes Region World Heritage Area
- Mining Lease Application Boundary (MLA)

0 10
Kilometres
GRID DATUM: MGA94 ZONE 54

Source: Department of Mineral Resources, Pooncarie 1:250000 (1996)

ATLAS-CAMPASPE PROJECT

FIGURE 4-3

Regional Geology

Resource Strategies

CRISTAL

The soil types mapped in the Atlas-Campaspe Mine area comprise Calcic, Hypercalcic, Supracalcic and Lithocalcic Calcarosols and Thin Red, Medium Red, Thick Red and Very Thick Red Chromosols. At the Ivanhoe Rail Facility, only Calcic Calcarosols were mapped (Appendix H).

Soil landscape units containing groupings of the above soil types identified during the soil survey are listed below:

- **Lower Dune Slopes and Sandplains** – medium depth (40 centimetres [cm]), sandy clay loam or light sandy clay loam topsoil, with some clay content in the subsoil: dominated by Hypercalcic, Supracalcic and Lithocalcic Calcarosols.
- **Dune Crests and Upper Dune Slopes** – deep (110 cm), sandy loam topsoil, with sandy subsoil layers: dominated by Hypercalcic Calcarosols.
- **Clayey Plains** – shallow (10 to 30 cm) topsoil, with clayey subsoil: dominated by Calcic Calcarosols and Supracalcic Calcarosols.
- **Run-on Depressions** – medium depth (45 cm) topsoil, with light to light medium clay subsoil: dominated by Calcic Calcarosols and Red Chromosols.
- **Cropping Areas** – cropping land with shallow (30 cm) topsoil, with medium clay subsoil: dominated by Calcic Calcarosols.

The soil types and associated soil landscapes of the Project area and surrounds have been mapped and are presented in Appendix H.

Soil Condition

A number of constraints for agricultural production were identified at the Atlas-Campaspe Mine, including (Appendix H):

- very low carbon levels;
- very low nitrogen levels;
- very low phosphorous levels;
- low fertility; and
- prone to wind erosion.

A carbonate layer occurs in the subsoil at the Atlas-Campaspe Mine (particularly in the Clayey Plains and Run-on Depressions landscape units). This subsoil carbonate layer can contain high boron levels (greater than 15 milligrams per kilogram which can be potentially toxic to plants (Appendix H).

Land and Soil Capability

The Land and Soil Capability classification system uses the biophysical features of the land and soil to assess the potential of land to support a range of sustainable land uses and land management practices (OEH, 2012a). Land is allocated to one of eight classes.

Land and Soil Capability mapping for the Atlas-Campaspe Mine and Ivanhoe Rail Facility has been completed by Ogyris Ecological Research (2012a) and is documented in Appendix H. The Atlas-Campaspe Mine and Ivanhoe Rail Facility were mapped by Ogyris Ecological Research (2012a) to be Class 6.

Class 6 Land and Soil Capability is defined as (OEH, 2012a):

> *Land Capable for a Limited Set of Land Uses*
>
> *Class 6 – Low Capability Land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.*

The Atlas-Campaspe Mine and Ivanhoe Rail Facility areas were mapped as Class 6 due to a number of soil constraints to agricultural production (described above in *Soil Condition*). The low long-term average annual rainfall (Section 4.2.1) and the lack of irrigation water sources also limits potential agricultural production (particularly cropping) in the Atlas-Campaspe Mine area (Appendix H).

Agricultural Activities and Productivity

Agricultural activities known to have been conducted in the Atlas-Campaspe Mine area include sheep grazing for meat and wool production, cattle grazing for meat production and rain-fed cropping (grains) (Appendix H). Opportunistic harvesting of feral goats is known to be undertaken in the Ivanhoe Rail Facility area.

The proposed biodiversity offset area includes approximately 16,540 ha of agricultural land primarily used for grazing.

Land Contamination

A Land Contamination Assessment has been prepared for the Project in accordance with *State Environment Planning Policy No 55 – Remediation of Land* (SEPP 55) by Cristal Mining (2012c) (Appendix M).

No potentially contaminating activities or contaminated areas were identified in the Atlas-Campaspe Mine, mineral concentrate transport route roadworks footprint and Ivanhoe Rail Facility (Appendix M).

The Land Contamination Assessment concluded that no further investigation was required and that the Atlas-Campaspe Mine, mineral concentrate transport route footprint and Ivanhoe Rail Facility areas are suitable for the Project use (Appendix M).

Bushfire Regime

The Project is located in the Lower Western Zone Bush Fire Management Committee Bush Fire Risk Management Plan area (Atlas-Campaspe Mine) and the Central Darling Bush Fire Management Committee Bush Fire Risk Management Plan area (Ivanhoe Rail Facility).

The main sources of bushfire ignition in these fire management committee zones include (Lower Western Zone Bush Fire Management Committee, 2010 and Central Darling Bush Fire Management Committee, 2011):

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

In the Project area, the bushfire season generally runs from October to March (Lower Western Zone Bush Fire Management Committee, 2010 and Central Darling Bush Fire Management Committee, 2011).

4.3.2 Potential Impacts

The Project would alter the landforms and topography at the Atlas-Campaspe Mine. Some topographic changes would be temporary (e.g. temporary bunds/drains) and some would be permanent (e.g. final mine landforms).

As described in Section 2.7.3, overburden would generally be used to reinstate the natural ground surface (i.e. backfill) behind the advancing ore extraction areas. Overburden would however be mounded above the natural ground surface in certain sections of the mine paths (Figures 2-5 and 2-7).

The rehabilitated Atlas mine path would include an overburden emplacement at the south-eastern end of the mine path approximately 10 m in height. The remaining extent of the rehabilitated mine path would be approximately level with the natural ground surface except for the final void (approximately 10 to 15 m deep) at the north-western end of the mine path.

The rehabilitated Campaspe mine path would include two overburden emplacements (approximately 10 m in height) at the south-eastern end of the mine path which would be separated by an area level with the natural ground surface. The remainder of the rehabilitated mine path would be approximately level with the natural ground surface with the exception for the final void (approximately 15 to 20 m deep) at the north-western end of the mine path.

There would also be periods during mining when there is insufficient capacity to place all overburden behind the ore extraction areas (e.g. the initial stages of mining at the Atlas and Campaspe deposits [i.e. Years 2 and 6]). The overburden would be placed in overburden emplacements adjacent to the mine path (Figures 2-4 and 2-6) during these periods. The overburden emplacements would be constructed to a maximum height of approximately 20 m above the natural ground surface.

At the cessation of mining, a final void would remain at the north-western extent of both the Atlas and Campaspe mine paths (Section 5.3.2). The final voids would be partially backfilled with overburden material pushed down from the void batters and replaced overburden. The depths of the final voids would remain above the groundwater table (i.e. a permanent water body would not be formed in the void).

A range of lesser topographic changes would be associated with the construction of the Ivanhoe Rail Facility, roadworks along the mineral concentrate transport route, internal roads, hardstands, water management, and erosion and sediment control features over the Project life.

Soils

Potential impacts of the Project on soils would relate primarily to:

- disturbance of *in-situ* soil resources within disturbance areas;
- alteration of soil structure beneath infrastructure items, hardstand areas and roads;

- possible soil contamination resulting from spillage of fuels, lubricants, other chemicals and saline water;
- increased erosion and sediment movement due to exposure of soils during construction (e.g. road realignments); and
- alteration of physical and chemical soil properties (e.g. structure, fertility, permeability and microbial activity) due to soil stripping and stockpiling operations.

A review of the physical and chemical properties of the soils assessed by Ogyris Ecological Research (2012a) from the Atlas-Campaspe Mine and Ivanhoe Rail Facility has established that there are soil resources present that would be suitable as a rehabilitation medium on the Project landforms post-mining (Appendix H).

Land Contamination

Potential land contamination risks were identified as part of the Preliminary Hazard Analysis (PHA) (Section 4.15) and were associated with the transport, storage and use of hydrocarbons, chemicals, saline water use and MSP process waste (Appendix N).

MSP Process Waste

After the cessation of the Ginkgo and Snapper Mines (approximately Year 12 of the Project), MSP process waste would be transported via the mineral concentrate transport route to the Atlas-Campaspe Mine for subsequent unloading, stockpiling and placement behind the advancing ore extraction areas (Section 2.8.3).

The MSP process waste transported in sealed containers to the Atlas-Campaspe Mine would likely be classified as "hazardous" in accordance with the *Waste Classification Guidelines Part 3: Waste Containing Radioactive Material* (DECC, 2008b) and a "radioactive substance" under the NSW *Radiation Control Act, 1990* (Appendix L).

Consistent with operations at the existing Ginkgo and Snapper Mines, the MSP process waste would be removed from the designated stockpile at the Atlas-Campaspe Mine and placed in a designated hopper (MORT), mixed with waste water from the salt washing facility, then transported to the primary gravity concentration unit via a slurry pipe, where it would be combined in the reject bin with sand residues and coarse rejects prior to placement behind the advancing ore extraction areas (Section 2.8.3).

This blended process waste (i.e. combined sand residues, coarse rejects and MSP process waste) would likely be classified as "restricted solid waste" in accordance with the *Waste Classification Guidelines Part 3: Waste Containing Radioactive Material* (DECC, 2008b) (Appendix L).

Additional information on the characterisation of the MSP process waste and blended process waste is provided in Section 2.8.3 and Appendix L.

Potential land contamination impacts associated with MSP process waste could occur as a result of loss of containment during the handling, stockpiling and transporting MSP process waste (e.g. road traffic accident). In the event of a loss of containment, there would be limited radiological consequences, as the coarse heavy nature of the radioactive material and its insolubility in water, would limit the potential for dispersal and therefore the extent of contamination (Appendix L).

Consistent with operations at the existing Ginkgo and Snapper Mines, the blended process waste (i.e. combined sand residues, coarse rejects and MSP process waste) would be deposited in process waste emplacement cells in the mine path and covered such that the radiation level at the surface of the rehabilitated process waste emplacement cells would be equivalent to the natural background radiation level (Section 4.3.3).

Radiation Advice & Solutions (2012) concluded that with the implementation of the proposed management measures (Section 4.3.3) it is considered that there would be no significant radiological impact on the environment (Appendix L).

Saline Water

The loss of containment of saline water or saline materials (e.g. sand residues) at the Atlas-Campaspe Mine could potentially contaminate surface soils.

In addition, the use of saline water at the Atlas-Campaspe Mine for dust suppression and as part of ongoing road maintenance works (i.e. road conditioning and safety purposes) following completion of the roadworks on areas and unsealed sections of the mineral concentrate transport route (road maintenance works only) could potentially increase the salinity of the surface soils in these areas.

Consistent with the management practices carried out at the Ginkgo and Snapper Mines, residual salts from the road surfaces collected in the drains would be periodically removed and deposited at the Atlas-Campaspe Mine behind the advancing ore extraction area.

These saline water dust suppression management and road maintenance practices are consistent with those applied at the operations at the Ginkgo and Snapper Mines, where Cristal Mining has observed no significant impacts on surface soils where saline water has been used.

Land Use – Agricultural Activities and Productivity

The Project (including the proposed biodiversity offset area) would result in the long-term disturbance or alteration of existing agricultural lands.

Rehabilitation of the Project would aim to restore self-sustaining ecosystems including native species characteristic of vegetation communities cleared by Project 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 (Appendix H). 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.

In the event that the final land use of the Project area is nature conservation, the Project (including the proposed biodiversity offset area) would result in the sterilisation of approximately 21,018 ha of agricultural land in the long-term. These sterilised agricultural lands are not considered to be highly productive or of strategic importance (Appendix H).

Consideration of the economic value of lost agricultural production on these lands is provided in Appendices H and I. The Project has very little potential to materially affect regional agricultural production or demand for agricultural infrastructure, supplies and services at a local or regional level (Appendix H).

In addition, no significant cumulative impacts on regional agricultural production and associated support industries are anticipated to arise from the co-incident development of the Project and the proposed Balranald Mineral Sands Project (Appendix H).

Lands controlled by Cristal Mining that adjoin the Project area would continue to be used for agricultural uses (e.g. via agistment of stock, leasing or agreements with existing landholders).

The potential impacts of the Project on the local amenity of adjoining privately-owned land, or water resources available for agricultural use, are considered where relevant in the groundwater, surface water, air quality and noise studies (Appendices F, G, J and K and Sections 4.4, 4.5, 4.10 and 4.12).

Bushfire Hazard

Any uncontrolled fires originating from activities associated with the Project may present potentially serious impacts to nearby rural properties and conservation areas.

Similarly, fires originating in nearby rural areas could pose a significant risk to Project infrastructure, progressive rehabilitation and Cristal Mining staff, contractors and equipment.

The degree of potential impacts of a bushfire would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel.

The Project could increase the potential for fire generation. However, given the range of preventative measures proposed (Section 4.6.3) and no bushfire incidents have occurred at the existing Ginkgo Mine and Snapper Mine, the overall risk of increased bushfire frequency due to the Project is likely to be low.

4.3.3 Mitigation Measures, Management and Monitoring

Soils and Erosion Potential

General soil resource management practices would include the stripping and stockpiling of soil resources for use in rehabilitation. The following management strategies would be implemented for the stripping of soils within Project disturbance areas:

- conducting pre-clearance soil surveys including delineating areas requiring soil stripping following vegetation clearing;
- quantification and characterisation of topsoil and subsoil materials prior to commencement of stripping (particularly the presence and depth of the carbonate layer);

- stripping in accordance with nominated depths and scheduling, as well as procedures for avoiding contamination of soils with material from the carbonate layer to minimise potential risks to the success of revegetation works; and
- preference for the direct placement of rehabilitation growth media in a manner which maintains the long-term viability of the soil.

Topsoil and subsoil materials suitable for future rehabilitation use and not placed directly on rehabilitated areas would be stored according to each stripping stage and would include (Appendix H):

- topsoil stockpiles; and
- subsoil stockpiles.

Stripped topsoil and subsoil materials including a high clay content (e.g. associated with local depressions) would be stored separately for selective placement in low-lying portions of the re-profiled landform within the mine path to reinstate the water holding capacity of, and run-on to adjacent depressions (Section 5.3.2 and Figures 2-7 and 2-8).

Soil stockpiles would be managed to maintain soil viability by using the following key management practices (Appendix H):

- soil stockpiles would be limited to a maximum height of 5 m;
- soil stockpiles would be constructed with a "rough" surface condition by cross ripping to minimise erosion, encourage drainage and promote revegetation;
- stockpiles would be sown with a stabilising cover crop and may include the fast growing native species Bladder Saltbush (*Atriplex vesicaria*), as well as species which can provide a natural nutrient benefit, such as native herbaceous legumes including Red-flowered Lotus (*Lotus cruentus*) and Small-leaf Swainson-pea (*Swainsona micropyhlla*); and
- where additions such as lime, gypsum or fertiliser are needed to improve the condition of stripped soil, they would be applied to the soil stockpiles as a component of soil stockpiling activities.

Soil resource management measures that would be used during the Project life would be described in the Rehabilitation Management Plan (Section 5.6).

Land Contamination

A number of hazard control and mitigation measures would be described in management plans for the Project, including, but not necessarily limited to, the following:

- MOP.
- Environmental Management Strategy.
- Water Management Plan.
- Biodiversity Management Plan.
- Heritage Management Plan.
- Radiation Management Plan.
- Radioactive Waste Management Plan.
- Mineral Concentrate and MSP Process Waste Transport Management Plan.
- Rehabilitation Management Plan.
- Mine Closure Plan.
- Construction Environmental Management Plan – Ivanhoe Rail Facility.
- Operational Environmental Management Plan – Ivanhoe Rail Facility.

General measures to reduce the potential for contamination of land would include the following:

- contractors transporting dangerous goods loads would be appropriately licensed in accordance with the provisions of the ADG Code (National Transport Commission, 2007);
- on-site consumable storage areas would be designed with appropriate bunding and would be operated, where applicable, in compliance with the requirements of AS 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids*; and
- fuel storage areas would be regularly inspected and maintained.

In addition, during construction and exploration activities, fuels, oils and other hydrocarbons would be managed to minimise the risk of spills which could cause soil contamination.

MSP Process Waste

MSP process waste would be managed at the Project in accordance with the *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA, 2005) and the *Code of Practice for the Safe Transport of Radioactive Material, 2008* (ARPANSA, 2008). Section 2.8.3 provides a description of the proposed management measures for MSP process waste.

Blended process waste (i.e. combined sand residues, coarse rejects and MSP process waste) would be deposited in process waste emplacement cells in the mine path and covered such that the radiation level at the surface of the rehabilitated process waste emplacement cells would be equivalent to the natural background radiation level (Section 2.8.3).

To establish the background radiation levels at the Project, environmental gamma radiation monitoring would be conducted at the following locations prior to the commencement of operations:

- At 200 m intervals along the mine path at the Atlas and Campaspe Mine.
- Mineral concentrate and MSP process waste stockpile areas adjacent the HMC treatment facility at the Atlas-Campaspe Mine.
- Mineral concentrate stockpile and MSP process waste container storage areas at the Ivanhoe Rail Facility.

Environmental gamma radiation monitoring would be conducted at these same locations after rehabilitation to determine if radiation levels equivalent to the natural background radiation level are being achieved (Section 5.7).

A Radiation Management Plan would be prepared for the Project in accordance with the *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA, 2005). The Radiation Management Plan would include:

- identification of potential sources of potential dose delivery pathways and potential doses;
- a description of operations and control measures;
- details of appropriate equipment, staff, facilities and operational procedures;
- induction and training courses;
- details of radiation monitoring (including baseline information);
- record keeping, reporting and periodic review procedures;
- a plan for dealing with incidents, accidents and emergencies involving exposure to radiation; and
- demonstration of access to professional expertise in radiation protection.

A Radioactive Waste Management Plan would also be prepared for the Project in accordance with the *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA, 2005).

The Radioactive Waste Management Plan would include:

- a description of waste generating processes;
- characterisation of the MSP process waste and blended process waste;
- a description of the proposed MSP process waste and blended process waste management measures;
- predicted environmental concentrations of radionuclides and radiation doses;
- a radiation monitoring programme;
- contingency plans for dealing with accidents;
- a reporting schedule;
- a site decommissioning plan; and
- reporting and periodic review procedures.

In addition, a Mineral Concentrate and MSP Process Waste Transport Management Plan (Section 4.13.3) would be prepared for the Project.

Saline Water

Measures to limit the potential risk of contamination of soil resources from the loss of containment of saline sand residues or saline water would include:

- locating the sand residue pipeline and water supply pipeline within a bunded corridor to contain any potential pipeline ruptures/spills;
- regular inspections of the sand residue pipeline, water supply pipeline, borefield and water management structures for signs of wear or damage; and
- maintaining suitable freeboard in the initial sand residue dams.

The risk of failure of the clay lining/capping of the initial sand residue dams would be minimised by:

- survey control during construction; and
- permeability testing during construction and use.

Areas where saline water is applied as a dust suppressant would be tested prior to rehabilitation to determine the suitability of the surface materials as a revegetation medium. If necessary (i.e. where material is unsuitable as a revegetation medium), the affected surface materials would be disposed with sand residues.

Where saline water is applied to the unsealed sections of the mineral concentrate transport route, residual salts from the road surfaces collected in the drains would be periodically removed and deposited at the Atlas-Campaspe Mine behind the advancing ore extraction area (Section 5.3.5), consistent with the management practices carried out at the Ginkgo and Snapper Mines.

Land Use – Agricultural Activities and Productivity

Agricultural land resource management during the life of the Project would include the following key components:

- minimisation of disturbance to agricultural lands, where practicable;
- continued use of adjoining lands controlled by Cristal Mining for agricultural uses;
- management of soil resources at the Atlas-Campaspe Mine so that they can be used for rehabilitation;
- potential inclusion of agricultural lands in the Project rehabilitation strategy; and
- reimbursement to leaseholders for stock losses.

Minimisation of Disturbance to Agricultural Lands

The area of agricultural land disturbed by the Project at any one time would be minimised so that beneficial agricultural uses can continue to be undertaken on available grazing lands during the life of the Project.

Continued Use of Existing Agricultural Areas

Adjoining lands controlled by Cristal Mining would continue to be used for agricultural uses, where practicable.

Cristal Mining would manage Boree Plains Station and the relevant parts of Wampo Station, Iona Station and Carrawatha Station in accordance with the requirements of the Western Lands Lease (e.g. control of noxious weeds and management of grazing). The management of the land would be described in the Biodiversity Management Plan (Section 4.6.3) and would be consistent with the *Guidelines for Developments Adjoining Department of Environment and Climate Change Land* (DECC, 2008d).

The implementation of the Biodiversity Management Plan would serve to minimise the potential direct impacts of the Project on agricultural production within the Project area and lands controlled by Cristal Mining, and potential indirect impacts (e.g. weeds and pests) on surrounding agricultural lands.

Management of Soil Resources

Soil resource management measures that would be used during the life of the Project are described above and in Appendix H.

Re-establishment of Agricultural Lands

Rehabilitation of the Project would aim to restore self-sustaining ecosystems including native species characteristic of vegetation communities cleared by Project development that could be used either for light intensity grazing or for nature conservation purposes (Section 5.3.1).

Reimbursement to Leaseholders for Stock Losses

Cristal Mining would consult with relevant leaseholders and negotiate appropriate reimbursement at the current market values for stock losses attributable to Project traffic or other Project activities.

Bushfire Hazard

Cristal Mining would consult with the Lower Western Zone Bush Fire Management Committee and Central Darling Bush Fire Management Committee, and provide assistance to and co-ordinate with these organisations as required.

The Biodiversity Management Plan would incorporate a bushfire management section to identify bushfire management issues, assess bushfire risk, establish bushfire management measures and outline standard procedures in the event of a bushfire.

Further bushfire preventative measures are outlined in Section 4.6.3.

4.4 GROUNDWATER

A Hydrogeological and Water Supply Assessment for the Project was undertaken by GEO-ENG (2013) and is presented in Appendix F. The Hydrogeological and Water Supply Assessment was peer reviewed by Heritage Computing (Dr Noel Merrick) and the final review letter is presented in Attachment 3.

A description of existing groundwater resources in the Project area and surrounds is provided in Section 4.4.1. The potential impacts of the Project on groundwater resources including cumulative impacts are outlined in Section 4.4.2. Section 4.4.3 outlines mitigation measures, management and monitoring in relation to groundwater resources, while Section 4.4.4 outlines licensing considerations.

4.4.1 Existing Environment

Baseline Hydrogeological Data

Baseline hydrogeological and geological data was reviewed and compiled from a number of sources as part of the Hydrogeological and Water Supply Assessment including:

- Murray Basin Hydrogeological Map Series (Bureau of Mineral Resources, Geology and Geophysics [BMR] and Australian Geological Survey Organisation [AGSO], 1991-1994);
- Lachlan Fan/Ivanhoe Block Steady State Groundwater Model (Kellet, 1997);
- Lower Lachlan Groundwater Model (Mampitiya, 2010);
- NOW PINNEENA Groundwater Works Database records (NOW, 2010);
- Victorian Water Resources Data Warehouse (Department of Sustainability and Environment, 2012);
- Cristal Mining's exploration drilling database;
- existing water management records (including groundwater licensing) from the Ginkgo and Snapper Mines;
- previous hydrogeological assessments and water level and quality data from monitoring programmes at the Ginkgo and Snapper Mines;
- other hydrogeological investigation testwork undertaken by Cristal Mining (e.g. bore installation, pumping tests at the Atlas deposit and drilling of shallow geological logs); and
- other regional topographic mapping data.

The Hydrogeological and Water Supply Assessment has also considered the requirements of the applicable Water Sharing Plans under the NSW *Water Management Act, 2000*.

The results of a bore census undertaken by Cristal Mining in July 2011, and outcomes of consultation with landholders during the preparation of the EIS were also used to augment baseline datasets.

Review of the available baseline hydrogeological data has enabled an understanding of existing groundwater systems, and a broader understanding of the scale and nature of the effects of existing Cristal Mining operations in the Murray-Darling basin at the Ginkgo and Snapper Mines on the local and regional groundwater systems.

Existing Hydrogeological Regime

Groundwater Systems, Depth to Groundwater Table and Western Murray Porous Rock Groundwater Source

The review of available baseline hydrogeological data identified underlying saline groundwater aquifers at moderate to significant depths.

The groundwater table in the region (ranging from approximately 10 to 30 m below ground level) is associated with the underlying saline groundwater systems and generally sits within the shallow Shepparton Formation or underlying Loxton-Parilla Sands. The average depth to water for the shallow monitoring bores at the Atlas-Campaspe Mine and surrounds is approximately 20 m, with the shallowest recorded result of 11.2 m. At a local scale, between the two deposits at the Atlas-Campaspe Mine site is a topographic low at 75 m AHD. Water levels in the Atlas test bore indicate that the local water table is at 45 m AHD, approximately 30 m below this topographic low (Appendix F).

There are no permanent surface water features at the proposed Atlas-Campaspe Mine (i.e. no groundwater window lakes fed by the deep underlying saline groundwater aquifer) (Appendix F).

The Loxton-Parilla Sands overlies the Renmark Group which is subdivided into the Upper, Middle and Lower Olney Formations and Warina Sand. At the Atlas-Campaspe Mine site there is no significant aquifer zone in the Renmark Group, due to the elevated height of basement rock and prevalence of low permeability materials. However, to the west (Willandra and Wentworth Troughs) and east (Balranald Trough) significant aquifer zones have been encountered in the Renmark Group, especially in the deepest layers of the Lower Olney Formation and Warina Sand (Appendix F).

Despite the multiple aquifer systems in the region, the Western Murray Porous Rock Groundwater Source defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* includes groundwater contained in all shallow unconsolidated geological layers (Shepparton Formation to Renmark Group) of the Murray-Darling basin apart from the shallow alluvial deposits around the major rivers.

The Atlas and Campaspe deposits both occur within the Loxton-Parilla Sands host unit (deposited during the Late Miocene to Late Pliocene period [i.e. of Tertiary age]) and are located predominantly above the existing regional groundwater table (Section 2.2). As described in Section 2.4.3, a groundwater borefield would be installed for water supply purposes during the life of the Project. Localised dewatering systems (including bores, spearfields and trenches) would also be used to dewater the orebody where it lies below the groundwater table, as described in Section 2.9.4.

All groundwater extracted for the Project is therefore considered part of the Western Murray Porous Rock Groundwater Source (i.e. one groundwater source) (Appendix F).

Groundwater Flow Direction and Recharge (*Infiltration*)

The region is characterised by low-gradient groundwater flow from east to west (Appendix F).

Evapotranspiration in the Project area and surrounds varies as a function of the vegetation cover and surficial geology. The vegetation of the Ivanhoe Block is indicated to be an extremely efficient interceptor of rainfall. Infiltration is expected to increase along the depression of the Willandra Lakes Region World Heritage Area and across the more intense agricultural areas along the Murray, Murrumbidgee and Lachlan Rivers (Appendix F).

The thin Quaternary surficial sediments are quite variable in terms of infiltration potential including both clayey and sandy layers. The Shepparton Formation tends to be clayey, reducing the potential for infiltration, while the Loxton-Parilla Sands are more permeable (Appendix F).

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 *Water Management Act, 2000* within which the Atlas-Campaspe Mine site is located (Appendix F).

Notwithstanding, the NSW State Groundwater Dependent Ecosystems Policy (NSW Department of Land and Water Conservation [DLWC], 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.

The Flora Assessment (Appendix A and Section 4.6) concluded there is no groundwater dependent terrestrial vegetation known to occur at the Atlas-Campaspe Mine site.

As there are no permanent surface water features at the proposed Atlas-Campaspe Mine (i.e. no groundwater window lakes fed by the deep underlying saline groundwater aquifer), there are no groundwater dependent baseflows in streams or wetlands.

As described in Section 4.7.1, the aquifer systems could provide habitat for stygofauna.

Groundwater Quality

Groundwater salinity mapping of the region (Murray-Darling Basin Authority, 2008) indicates generally saline conditions (Appendix F).

Water sampling from the test bore at the Atlas-Campaspe Mine site indicates a salinity of approximately 32,000 mg/L and is dominated by sodium (Na) and chloride (Cl) (Appendix F).

It is recognised that groundwater associated with localised concentrated infiltration (due to higher permeability surface soils and local topographic concentration) can form freshwater lenses of water at the groundwater table surface, due to the density contrast. No specific evidence of such freshwater lenses has however been identified at the Atlas-Campaspe Mine site or surrounds, but have been found at other locations in the region (Appendix F).

Groundwater Use

A review of the NOW PINNEENA Groundwater Works Database indicates seven bores drilled within approximately 20 km of the Atlas-Campaspe Mine site. Three (GW036790, GW036674 and GW036875) are multi-level government installations, and are monitored on a quarterly basis by NOW (Figure 4-4). Site reconnaissance by Cristal Mining in July 2011 identified only one potentially active privately-owned bore location (Boree Plains [GW063606] to the north of the Campaspe deposit) out of the remaining four private registered bores, with the three others being destroyed or buried (Appendix F). The Boree Plains bore (GW063606) had a broken pump in the bore at the time of the site visit and could not be investigated (Appendix F).

Two large diameter shallow wells were also found at Carrawatha near the NOW bore installation (GW036674), however, did not appear to intercept the regional groundwater table (Appendix F).

The lack of active bore usage is understandable given the poor quality of the groundwater in the region (Appendix F).

4.4.2 Potential Impacts

The Hydrogeological and Water Supply Assessment (Appendix F) has evaluated the potential impacts of the Project on groundwater resources using hydrogeological conceptualisation and is supported by a numerical groundwater model.

The numerical groundwater model covers an area of approximately 20,000 km^2 (178 km east-west and 216 km north-south) and includes a large portion of the Benanee basin in NSW. The model extent incorporates the proposed Balranald Mineral Sands Project in the south (Figure 4-1), and has been considered as part of the cumulative impact assessment in the EIS.

The numerical groundwater model was used to simulate the potential effects of the Project (including groundwater supply borefield and localised dewatering) on groundwater systems and groundwater users. It was also used to estimate the potential magnitude of groundwater inflows/dewatering requirements for the mining operations over the life of the Project.

A summary of the potential impacts on the Western Murray Porous Rock Groundwater Source (the deep underlying saline groundwater aquifer), temporary surface ponding, local surface water resources, groundwater dependent ecosystems and existing groundwater users is presented below.

Western Murray Porous Rock Groundwater Source

Underlying Saline Groundwater Aquifer

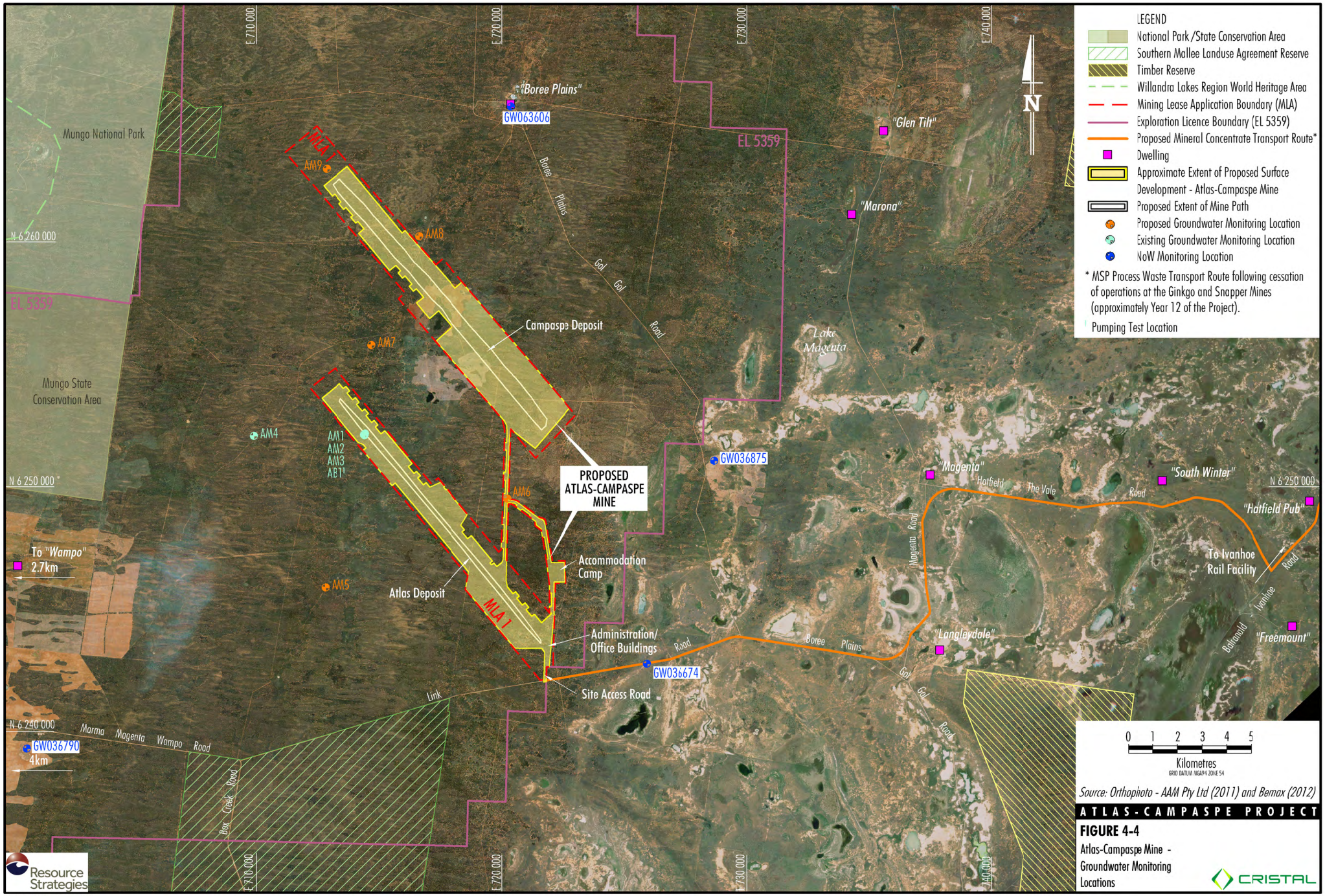
Extraction of groundwater for water supply purposes from the groundwater supply borefield and dewatering systems (where the orebody lies below the groundwater table) would form localised groundwater drawdown. The maximum depth of orebody below the groundwater table is approximately 7 m for the deepest section of the Campaspe deposit, and down to approximately 15 m at the Atlas deposit (Appendix F).

There would also be a change in hydraulic properties over the mine footprint where overburden and process waste is used to backfill the mine voids behind the advancing ore extraction areas. As overburden and process waste may have a different permeability than any in-situ material there would be associated changes in localised infiltration rates (Appendix F).

Numerical modelling conducted as part of the Hydrogeological and Water Supply Assessment (Appendix F) predicts a reduction in groundwater head in the underlying saline groundwater aquifer surrounding the groundwater supply borefield and where dewatering of the orebody is required for mining.

The model predicts maximum drawdown extents from the groundwater supply borefield and dewatering of the Atlas and Campaspe deposits as follows (Figures 4-5 and 4-6):

- Atlas deposit at the end of mining [Year 5] – 1 m drawdown at approximately 2 km from the water supply borefield; and
- Campaspe deposit at the end of mining [Year 20] – 1 m drawdown at approximately 2.9 km from the water supply borefield/dewatering of the Campaspe deposit.



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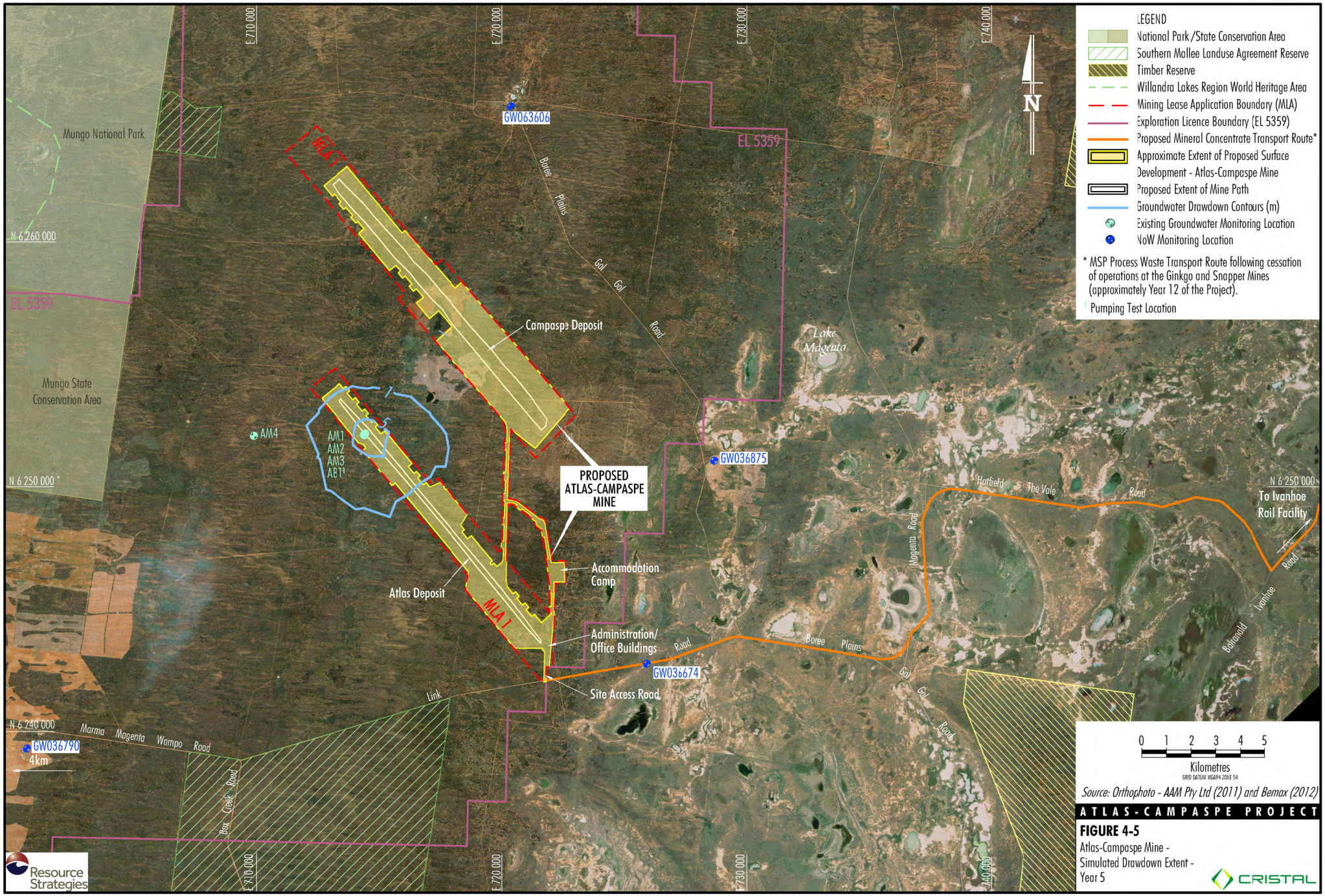

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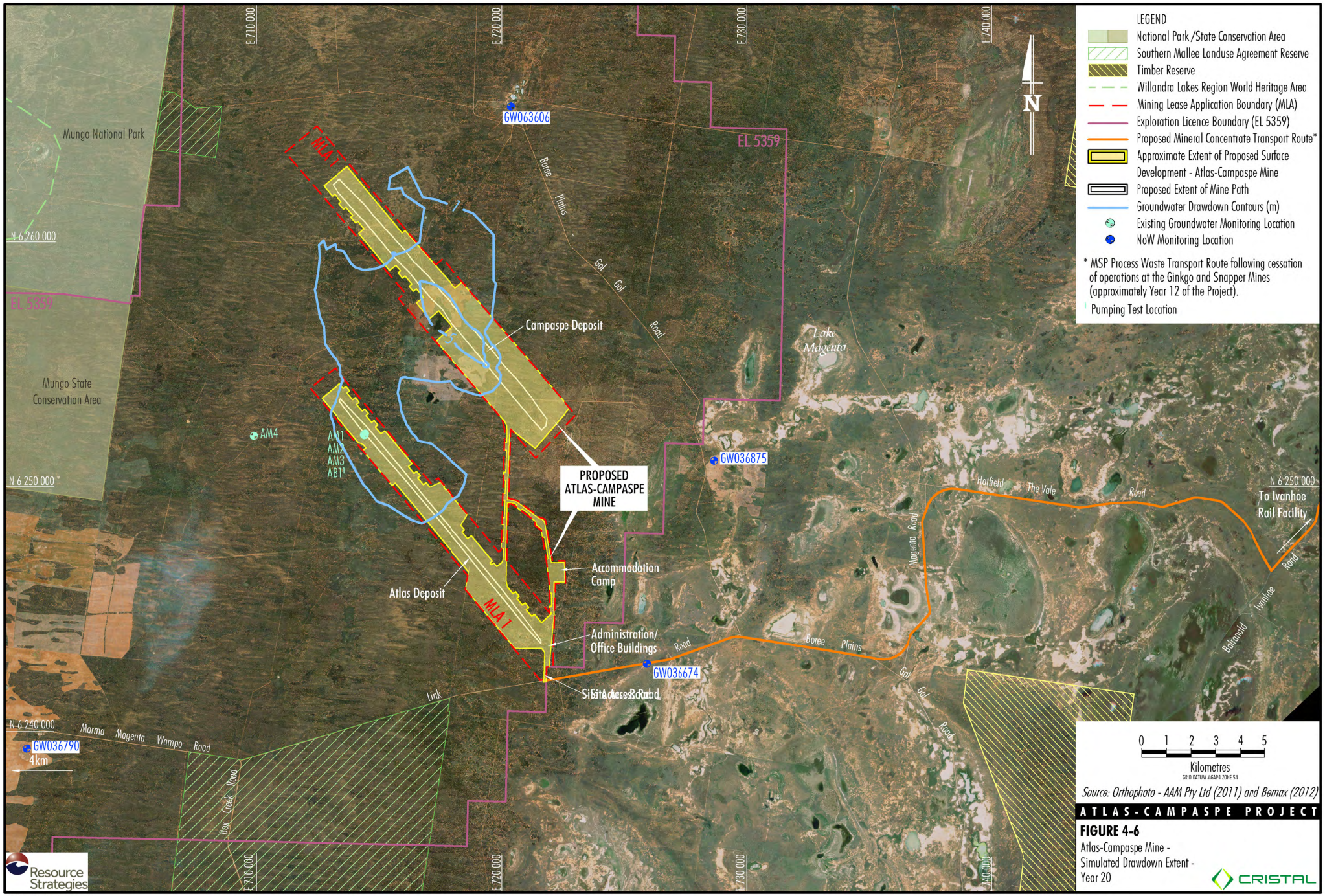

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Staged groundwater drawdown contours during the life of the Project are presented in Appendix F.

The groundwater modelling results show that drawdown (of the deep underlying saline groundwater aquifer) as a result of the Project does not extend to the Willandra Lakes Region World Heritage Area or the Mungo National Park (Appendix F).

Based on the results presented in the Hydrogeological and Water Supply Assessment (Appendix F), up to approximately 180 L/s (averaging approximately 120 L/s over the life of the Project) would be extracted from the groundwater supply borefield. The numerical model also indicates dewatering requirements of up to 300 L/s (from pit-side bores and in-pit dewatering) at the Atlas deposit in Year 4 and up to 160 L/s at the Campaspe deposit in Year 12 (Appendix F).

The water balance results also indicate that approximately 140 L/s (on average) of process water would be returned (i.e. recharge via infiltration) to the deep underlying saline groundwater aquifer (e.g. with in-path sand residues) over the life of the Project. Based on the planned maximum mine plan progression, it is anticipated that water disposal of up to approximately 54 L/s would be required during mining of the Atlas deposit (Year 4) of the Project (Appendix F).

As discussed in Section 2.7.2, based on the geochemical testwork undertaken by Cristal Mining (2012b), overburden materials would typically be non-saline to moderately-saline and the acid-generating potential of overburden materials was considered to be very low (Appendix G).

The small increase in potential infiltration would add fresher water to the deep underlying saline groundwater aquifer. Given the existing higher salinities of the deep groundwater aquifer and relatively minor volumes of recharge via infiltration, no appreciable change in groundwater salinity is expected as a consequence of mining.

The Hydrogeological and Water Supply Assessment concludes that there is expected to be negligible change in groundwater quality as a result of the Project (Appendix F).

The Hydrogeological and Water Supply Assessment also describes that capillary rise in sand is typically less than 1 m (Venkatramaiah, 2006) (Appendix F).

The minimum depth to the groundwater table from the floor of the Atlas and Campaspe final voids would be approximately 5.3 m and 11.8 m, respectively (Appendix F). The depth of material proposed from the floor of the voids to the water table is significantly more than 1m. This would therefore prevent direct evaporation from the groundwater aquifer (Appendix F).

Groundwater Dependent Ecosystems

As described in Section 4.4.1, there are currently no high priority groundwater dependent ecosystems identified in the Western Murray Porous Rock Groundwater Source.

As concluded in Section 4.7.1, lowering of the groundwater table could impact stygofauna if they were to occur in the groundwater system. The Project would result in localised groundwater drawdown in the deep underlying saline groundwater aquifer, however, this system is extensive in the Project area and surrounds and is likely to provide continuous habitat for stygofauna if present (i.e. stygofauna species that potentially occur within the Project area are also likely to occur in the surrounds).

There is no evidence of any groundwater dependent ecosystems that would be affected by the Atlas-Campaspe Mine (Appendix F).

Groundwater Users

The only registered bore local to the Atlas-Campaspe Mine site is at Boree Plains (GW063606), approximately 7 km to the north-east (Figure 4-4). The water quality in this bore could not be sampled during the bore census, but is expected to be poor, and the bore is not currently used. Notwithstanding, the model predicted drawdown at this bore due to the Project is negligible (Appendix F).

Cumulative Impacts

The Hydrogeological and Water Supply Assessment (Appendix F) included consideration of the cumulative impacts of the Project and the proposed Balranald Mineral Sands Project.

Cumulative groundwater drawdown contours showing the magnitude and water table changes caused by coincident mining of the Nepean deposit at the proposed Balranald Mineral Sands Project and mining at the Atlas-Campaspe Mine are presented in Appendix F.

Whilst conservative for assessment purposes, the cumulative groundwater modelling results also show that drawdown (of the deep underlying saline groundwater aquifer) does not extend to the Willandra Lakes Region World Heritage Area or the Mungo National Park (Appendix F).

4.4.3 Mitigation Measures, Management and Monitoring

Groundwater Monitoring

A Groundwater Monitoring Programme would be developed for the Project. The Groundwater Monitoring Programme would be progressively implemented to detect changes in groundwater levels and quality as a result of groundwater extraction for water supply, dewatering during mining operations, deposition of process wastes behind the advancing ore extraction areas and disposal of excess waters if required.

The results would also be used to improve knowledge of aquifer definition and interactions to assist with the groundwater supply borefield detailed design and installation.

In addition to the existing monitoring bores installed for the pumping test (AM1 to AM4) at the Atlas deposit, up to five additional monitoring bores would be installed at the Atlas-Campaspe Mine including (Figure 4-4):

- **AM5** – to monitor the groundwater table south-west of the Atlas deposit where groundwater drawdown extents are anticipated due to the groundwater supply borefield.
- **AM6 and AM7** – to monitor the groundwater table between the Atlas and Campaspe deposits where combined groundwater drawdown extents are anticipated.
- **AM8 and AM9** – to monitor the groundwater table response at the Campaspe deposit as mining advances to the north-west.

Existing site AM4 (Figure 4-4) would be retained for the life of the Project to monitor the groundwater table west of the groundwater supply borefield (i.e. outside of the Willandra Lakes Region World Heritage Area and Mungo National Park) where groundwater drawdown extents are anticipated.

The final location and timing of piezometer installations would include consideration of site characteristics, their location relevant to the mine plan progression and groundwater supply borefield, access and site inspection.

Flow meters would be installed on all bores to monitor pumping rates from the groundwater supply borefield. Water levels would be recorded on a quarterly basis.

Samples for water quality analysis (e.g. pH, EC, cations, anions and metals) would also be taken at such time. Water quality samples would however only be required from one of the groundwater supply borefield bores. Groundwater quality samples would also be taken during drilling of any new/future piezometer bores.

Monitoring would also be undertaken at the existing Boree Plains bore (GW063606) to the north of the Campaspe deposit (Figure 4-4) to confirm and validate that model predicted groundwater table drawdown extents do not extend to the privately-owned bore.

Available groundwater monitoring data from the existing NOW bore monitoring network to the east, south-east and west (GW036790, GW036674 and GW036875) would be used to supplement the groundwater monitoring network for the Project (Figure 4-4).

Groundwater Users – Management of Complaints

In the event that a complaint is received during the life of the Project in relation to groundwater drawdown of a privately-owned bore or well, the results of the Groundwater Monitoring Programme would be reviewed by Cristal Mining as part of a preliminary evaluation to determine if further investigation notification, mitigation (bore-reconditioning), compensation (e.g. alternative water supply) or other contingency measures are required.

Numerical Model and Water Balance Review

The numerical model developed and used for the Hydrogeological and Water Supply Assessment (Appendix F) would be used as a management tool for the periodic review and calibration of predicted groundwater drawdown during the life of the Project.

The results of the Groundwater Monitoring Programme would inform progressive refinement of the numerical model as the mining operations are developed.

Revised outputs from the numerical model would be reported periodically over the life of the Project and used to inform the site water balance review (Section 4.5.3).

Groundwater Management Plan

A Groundwater Management Plan would be prepared and included as a component of the Water Management Plan for the Atlas-Campaspe Mine (Section 7.3.1).

It would include a summary of the Groundwater Monitoring Programme and procedures/reporting that would be implemented over the life of the Project (e.g. responses to complaints, progressive numerical model refinement and periodic reporting to inform the site water balance review).

The Groundwater Management Plan would also describe contingent mitigation, compensation, and/or offset options that would be enacted if, in the unlikely event, users of groundwater resources in the region are adversely affected by the Project. For example, if drawdown of a privately-owned bore or well was materially greater than that predicted in the EIS and results in loss of supply to the local groundwater user, Cristal Mining's responses may include:

- bore reconditioning; or
- provision of an alternative water supply (and appropriate licence).

4.4.4 Licensing

A summary of groundwater licensing requirements for the Project is provided below, with further details provided in Attachment 5 (Water Licensing Addendum) including consideration of the Project against the water management principles and access licence dealing principles under the *Water Management Act, 2000*, and a discussion of the access licences required for each water source associated with the Project.

Atlas-Campaspe Mine

The Atlas-Campaspe Mine is located within the 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*.

Relevant to the Project, the Western Murray Porous Rock Groundwater Source includes groundwater contained in all shallow unconsolidated geological layers (Shepparton Formation to Renmark Group Units) of the basin apart from the shallow alluvial deposits around the major rivers.

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,* prior to:

- extraction of groundwater for water supply purposes from the deep underlying groundwater aquifer associated with the Western Murray Porous Rock Groundwater Source; and/or
- mining in areas of temporary surface ponding (if saturated) (Section 4.5) or deep underlying saline groundwater aquifer associated with the Western Murray Porous Rock Groundwater Source.

Based on the results of the numerical modelling undertaken by GEO-ENG in the Hydrogeological and Water Supply Assessment (Appendix F), the predicted annual groundwater volumes required to be licensed over the life of the Project and post-mining are summarised in Table 4-3.

Table 4-3
Estimated Project Groundwater Licensing Requirements

Project Year	Predicted Average Annual Volumes Requiring Licensing [Western Murray Porous Rock Groundwater Source*] (ML/annum)
1 (Construction)	<500 (or as required)
2 to 5 (Atlas)	3,256 (ranging from 536 to 5,582)
6 to 8 (Campaspe)	2,449 (ranging from 599 to 4,699)
8 to 13 (Campaspe)	6,156 (ranging from 5,771 to 6,528)
14 to 20 (Campaspe)	5,316 (ranging from 4,289 to 6,244)
Post-mining	Nil

Source: Appendix F.

* As defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* under the *Water Management Act, 2000.*

For comparison purposes, the long-term annual extraction limit stipulated in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* for the Western Murray Porous Rock Groundwater Source, in addition to basic landholder rights, is 530,486 ML/annum. It was estimated at the time of commencement of the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* on 16 January 2012 that only approximately 21,780 unit shares had been authorised to take water from the Western Murray Porous Rock Groundwater Source (i.e. an under allocation of aquifer access licences).

Cristal Mining currently holds a combined total of 21,442 share components (units or megalitres [ML]) in the Western Murray Porous Rock Groundwater Source for the Ginkgo and Snapper Mines, authorised by the following water access licences (WALs):

- WAL 27918 (60AL582836) – 14,000 shares;
- WAL 27915 (60AL582832) – 7,402 shares; and
- WAL 27912 (60AL582834) – 40 shares.

Based on the planned mine progression at the Atlas-Campaspe Mine described in Section 2.3.1, and continued operations at the Ginkgo and Snapper Mines until cessation of operations in approximately Year 12 of the Project, the existing volumetric licence allocations held by Cristal Mining are considered to be adequate (Appendix F). As the Ginkgo and Snapper Mines and Atlas-Campaspe Mine are located within the same groundwater source (i.e. Western Murray Porous Rock Groundwater Source) the appropriate licence allocations would be traded in accordance with the rules of the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011.*

As described in Section 4.4.2, it is anticipated that water disposal (via water disposal dams within the mine path) would likely only be required during mining of the Atlas deposit (Year 4) of the Project. If required during the life of the Project, Cristal Mining would seek appropriate licences to allow for re-injection to the underlying saline groundwater aquifer.

Further to the above, as the groundwater is saline, there is no significant demand for water from this source in the region (Appendix F).

Ivanhoe Rail Facility

As no groundwater is proposed to be extracted at the Ivanhoe Rail Facility (i.e. from the Lower Lachlan unconsolidated alluvial sediments), the *Water Sharing Plan for the Lower Lachlan Groundwater Source, 2003* would not apply to the Project.

4.5 SURFACE WATER

A Surface Water Assessment for the Project was undertaken by Evans & Peck (2012) and is presented in Appendix G.

A description of existing local and regional surface water resources, including baseline data is provided in Section 4.5.1. The potential impacts of the Project on surface water resources including cumulative impacts is outlined in Section 4.5.2. Section 4.5.3 outlines mitigation measures, management and monitoring relating to surface water resources, while Section 4.5.4 outlines licensing considerations.

4.5.1 Existing Environment

The discussion below provides a summary description of the baseline surface water data and regional and local hydrology.

Baseline Surface Water Data

Evans & Peck (2012) reviewed available data from Commonwealth and State government agencies, and proposed mining operations and Projects in the region, including:

- rainfall and evaporation records from the BoM weather stations (Figure 4-1);
- Lidar data from the proposed Atlas-Campaspe Mine site and surrounds; and
- other regional topographic mapping data.

The Surface Water Assessment (Appendix G) has also considered the requirements of the relevant water sharing plans.

Regional Hydrology

The Atlas-Campaspe Mine is located within the Benanee basin of the lower Murray River system in NSW. The Benanee basin borders the upstream effluent creeks of the Lachlan River basin, Darling and Murrumbidgee River basins and the downstream Murray River basin. The Benanee basin is made up of a number of ill-defined creeks, streams and ephemeral lakes that contribute negligible inflows to the Murray River (NOW, 2012).

The Ivanhoe Rail Facility is located within the Willandra Creek catchment in the Lachlan River basin. Willandra Creek is an effluent creek of the lower Lachlan River which terminates in a series of lignum swamps and intermittent lakes in the Benanee basin south-west of Ivanhoe (Green *et al*., 2011). Flows into Willandra Creek are primarily controlled by Willandra Weir on the Lachlan River, and like most unregulated streams in western NSW experience long periods of no flow interspersed with rare flows of varying magnitude.

Local Hydrology

The Atlas-Campaspe Mine site is located approximately mid-way between two ill-defined drainage systems (Appendix G):

- **Willandra Creek and Willandra Lakes system** (to the north and west of the Atlas-Campaspe Mine site) – this system contains numerous dry lakes (Mulurulu, Garnpung, Leaghur, Mungo and Chibnalwood) which drain from north-east to south-west; and
- **Arumpo Creek and Prungle Lakes system** (to the east and south of the Atlas-Campaspe Mine site) – this system also drains from north-east to south-west.

The regional surface drainage in the vicinity of the Atlas-Campaspe Mine site occurs by overland flow from north-east towards the south-west. The Atlas-Campaspe Mine site contains no defined watercourses other than a few minor drainage lines that drain from the south-eastern end of the Campaspe deposit towards a relic lake depression (Appendix G).

Temporary Surface Ponding

Temporary ponding of rainfall occurs in localised topographic depressions where rainfall runoff is concentrated and the surficial soils have lower permeability (i.e. contains clays). These locations are isolated and do not contribute to any significant surface water system. Drainage from these locations is limited due to the low permeability surficial soils and the majority of the water eventually dissipates by evaporation. Given the limited rainfall and drought experienced in the area historically (Section 4.2.1), the frequency of surface ponding is low (Appendix F).

Surface Water Quality

Given the temporary nature of surface water ponding, no water quality baseline data has been collected from any of the ephemeral or constructed permanent waterbodies in the vicinity of the Atlas-Campaspe Mine site.

Surface Water Users

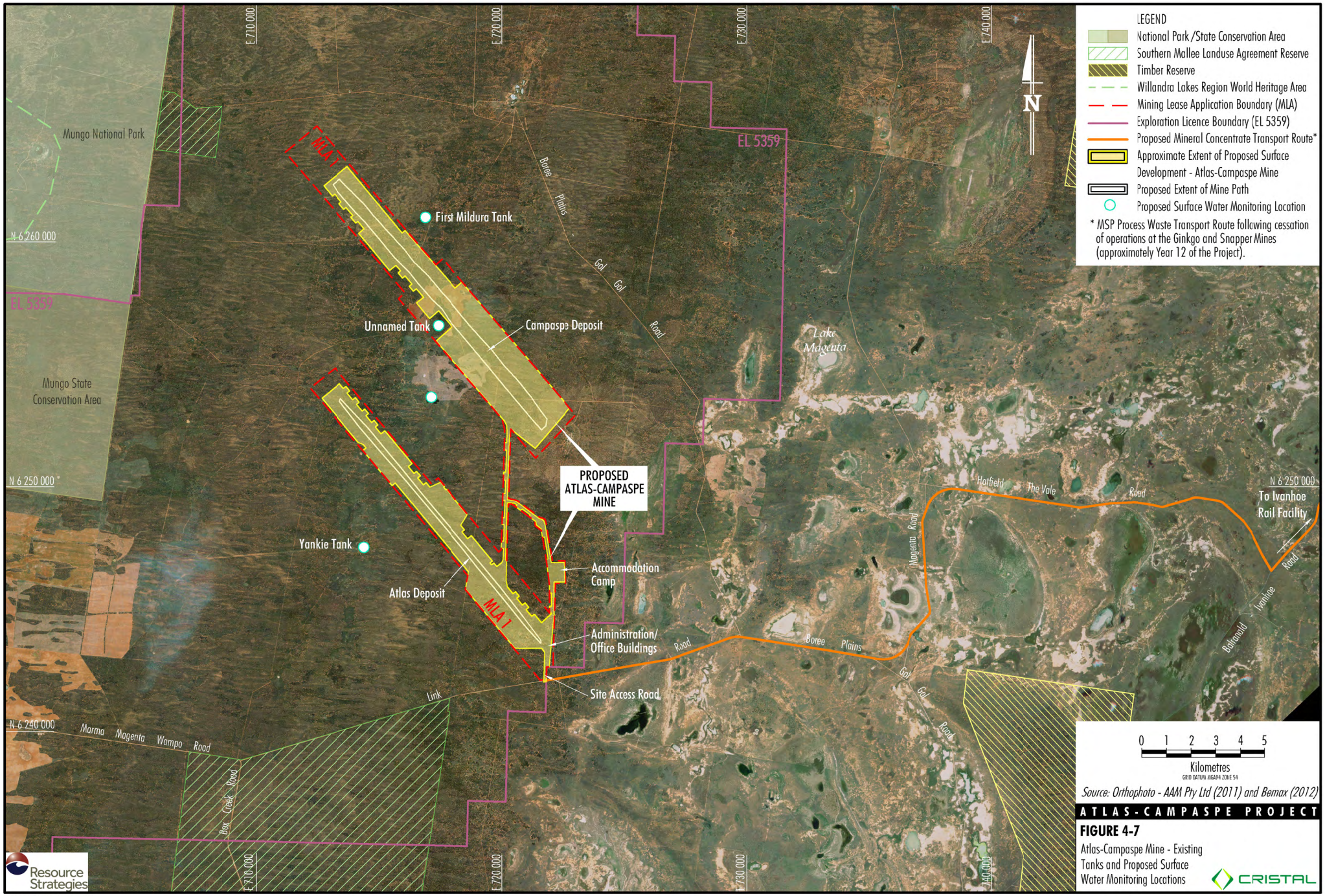
The absence of defined drainage lines has led landholders to construct extensive catch drain systems in the region to direct overland flow into excavated tanks to provide water for domestic stock. In the vicinity of the Atlas-Campaspe Mine site, the topographic maps show the existence of a number of such tanks, including (Figure 4-7):

- **'First Mildura Tank'** (located approximately 850 m north of the Campaspe footprint). The catchment draining to this tank is located to the north and west and would not be affected by the Project.
- **An unnamed tank system** (located approximately 500 m south of the Campaspe footprint). The catchment for the unnamed tank is located predominantly to the south and west. The Atlas mine path would encroach into a small portion of the northern section of the sub-catchment and has the potential to have a minor effect on runoff to the tank.
- '**Yankie Tank'** (located approximately 3 km south-west of the Atlas footprint). Both the Atlas and Campaspe mine paths would cross this depression but there are intervening ridges that would impede runoff from the mine paths reaching this tank.

4.5.2 Potential Impacts

The proposed Atlas-Campaspe 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 (average annual rainfall less than 300 mm) and surface runoff is highly ephemeral. The complex landform and semi-arid climate combine to provide conditions in which the risk of off-site surface water impacts is minimal (Appendix G).

Notwithstanding, the potential impacts on temporary surface ponding, surface water users, surface water flow regimes, surface water quality, Willandra Lakes Region World Heritage Area and post-mining surface water impacts are discussed below.



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Temporary Surface Ponding

As mining progresses, the ore extraction areas within the mine path would act as a localised depression. This would cause a change in water flow direction and in places a localised reversal of direction where areas of temporary surface ponding are excavated and exist adjacent to the mine path (e.g. following rainfall events) (Appendix F).

There would also be a change in hydraulic properties over the mine footprint where overburden and process waste is used to backfill the mine voids behind the advancing ore extraction areas. As overburden and process waste may have a different permeability than the excavated material (including associated clay-based run-on depressions and gilgai), there would be associated change in localised infiltration rates (Appendix F).

The proposed mining of the Atlas and Campaspe deposits is expected to have a limited and localised effect on areas where temporary surface ponding occurs (i.e. through excavation) (Appendix F). As described in Section 5.3.2, clay materials would be selectively placed in low-lying portions of the re-profiled landform within the mine path to reinstate the water holding capacity of, and run-on to adjacent depressions and gilgai. Therefore, such limited and localised effects would also be temporary in nature (Appendix F).

The construction of off-path sand residues dams, in-pit sand residues cell walls, sand residues placement, in-path replacement of overburden and end-of-path mine voids would also change the geological profile and therefore alter the local rate of groundwater recharge to the deep underlying saline groundwater aquifer (Appendix F).

The existing unsaturated profile includes significant clay layers which limit the potential for rainfall infiltration reaching the groundwater table. The deposition of process wastes would include clay fines and the sand residues cell walls would be mostly constructed from clayey materials, thus the hydraulic conductivity of portions of the replaced material would also be low (Appendix F).

The final voids would be a potential location for increased infiltration, but would also increase the potential for evaporation. Given the limited size of the final voids, the net effect is expected to be negligible. Considering the effect of the deposition of process wastes and the final voids, it is expected that the overall change is expected to be a small increase to rainfall recharge (Appendix F).

Based on the above, there are not expected to be any measurable changes in the quality of temporary surface ponding areas as a consequence of the Project (Appendix F).

Surface Water Users

As described in Section 4.5.1, the Atlas mine path would encroach into a small portion of a sub-catchment which has the potential to have a minor effect on runoff to an unnamed tank system (Figure 4-7).

Local Surface Water Resources

There are no existing permanent surface water features that would be affected by the mining at the Atlas-Campaspe Mine (Appendix F).

Surface Water Flow Regimes

Because of the complex landform characteristics, there are no “rivers” as defined in the NSW *Water Act, 1912, Water Management Act, 2000* or the *Water Sharing Plan for the Lower Murray-Darling Unregulated and Alluvial Water Sources, 2011*. Accordingly, there are no riparian zones or fluvial geomorphic features that require consideration for purposes of this assessment (Appendix G).

The main surface water features that could be impacted by the Project are a series of depressions that are strung along a line (local topographic low) that runs from north of the Campaspe footprint and continues in a southerly direction traversing both deposits (Appendix G). These depressions, which vary in size, hold water after significant rainfall. Some depressions are very shallow and any water collected in them evaporates or seeps away after a few days, while larger depressions may hold water for more than a few months (Appendix G).

A temporary waterbody is located about mid-way between the Atlas and Campaspe footprints (Figure 4-7). The boundary of the Campaspe footprint is located approximately 2.5 km ‘upstream’ of this waterbody (Appendix G). The supply of runoff (i.e. ‘environmental flow’) and maintenance of water quality draining to these depressions has been considered in developing the proposed mitigation measures described in Section 4.5.3.

Surface Water Quality

Potential impacts of the Project on surface water quality include the reduction in surface water quality due to uncontrolled runoff from disturbed areas and/or release of contaminants.

Runoff and 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 to the Project are described in Section 4.3.3.

As described in Section 2.9.1, evaporation/sediment sumps would be designed, constructed and operated in accordance with the relevant requirements of *Managing Urban Stormwater: Soils & Construction* (DECC,2008a).

Cristal Mining would operate the site in accordance with the requirements of an Environment Protection Licence (EPL).

Willandra Lakes Region World Heritage Area

Based on the proposed extent of mine footprints at the Atlas-Campaspe Mine, the nearest boundary of the Willandra Lakes Region World Heritage Area is approximately 10 km to the west. The nearest boundary of Mungo National Park is approximately 5 km to the west of the Atlas-Campaspe Mine. Given the intervening topography and large separation distances, excavation into local areas of temporary surface water ponding at the Atlas-Campaspe Mine would not impact on any surface water ponding associated with the Willandra Lakes Region World Heritage Area or Mungo National Park (Appendix F).

While the vast majority of the Atlas-Campaspe Mine site drains in a southerly direction, an area approximately 1 km in length at the north-western end of the Campaspe footprint drains to the north-west, from where it could potentially flow into Lake Mungo or Lake Leaghur which lie within the World Heritage Area approximately 15 to 20 km to the west of the Atlas-Campaspe Mine site.

The landform to the west is however similar to that within the Atlas-Campaspe Mine site itself and contains numerous small depressions that would impede drainage to the west (Appendix G).

The possibility of any runoff from the Atlas-Campaspe Mine site reaching, or having any impact on, the Willandra Lakes Region World Heritage Area could only occur under heavy rainfall conditions that are unlikely to have been experienced in the region for thousands of years (Appendix G).

Post-Mining Surface Water Impacts

The potential post-mining surface water impacts primarily relate to the design of the final landform and location and extent of the final voids at the Atlas-Campaspe Mine. The final landform design (including final voids), and decommissioning and rehabilitation of the Ivanhoe Rail Facility and mineral concentrate transport route, are discussed in Section 5.

4.5.3 Mitigation Measures, Management and Monitoring

For all features of the Project, the risk of surface water impact is inherently low and would be further reduced by the proposed range of mitigation measures (Appendix G), and are summarised below.

Water Quality Management Measures

Water Management System

As described in Section 2.9.1, the on-site water management system would maintain separation between runoff from areas undisturbed by mining and water generated within active mining areas (e.g. use of up-catchment runoff controls) and capture and contain on-site any potentially contaminated mine site water.

Erosion and Sediment Control

As described in Section 2.9.1, drainage from disturbance areas within the Atlas-Campaspe Mine footprint would be directed to the evaporation/sediment sumps for containment.

Evaporation/sediment sumps would be designed, constructed and operated in accordance with the relevant requirements of *Managing Urban Stormwater: Soils & Construction* (Landcom, 2004).

Any discharge from diversions banks/channels or overflow from sediment dams would be discharged via 'level spreader' banks in order to ensure flow occurs as shallow overland flow consistent with existing surface runoff conditions.

Standard road construction erosion and sediment control practices as set out in *Managing Urban Stormwater: Soils & Construction – Volume 2C: Unsealed Roads* (Landcom, 2004) would be employed during roadworks along the mineral concentrate transport route between the Atlas-Campaspe Mine site and the Balranald-Ivanhoe Road.

Similarly, standard erosion sediment control practices would be employed during the construction of the Ivanhoe Rail Facility. During operation, the chance of any surface water discharge would be low because retained water would be used for on-site dust suppression (Appendix G). Because of the size of the proposed water retention basin any discharge that does occur can be expected to have very low concentration of sediment (Appendix G).

Water Management Plan

A Water Management Plan would be prepared for the Atlas-Campaspe Mine (Sections 7.3.1 and 7.3.2). The Water Management Plan would describe the operational site water management system and include provisions for review of the site water balance, erosion and sediment controls, surface water (and groundwater) monitoring and management.

Site Water Balance

Review and progressive refinement of the site water balance would be undertaken for the life of the Project to record the status of inflows, storage and consumption and to optimise ongoing water management performance.

The results of site water balance reviews would be reported in the Annual Review.

Erosion and Sediment Control

Erosion and sediment control plans would be developed over the life of the Project to identify activities that could cause soil erosion and generate sediment and describe the specific controls (including locations, function and structure capacities) to minimise the potential for soil erosion and transport of sediment off-site (as described above in *Water Quality Management Measures*).

Surface Water Monitoring Programme

The proposed Surface Water Monitoring Programme would involve sampling of water from a number of natural and constructed waterbodies in the vicinity of the Atlas-Campaspe Mine site, including (Figure 4-7):

- the First Mildura Tank (i.e. a reference water body not affected by the Project);
- an unnamed tank located approximately 500 m south of the Campaspe footprint;
- the natural depression located between the Atlas and Campaspe footprints; and
- Yankie Tank located approximately 3 km south-west of the Atlas footprint.

In order to establish existing baseline conditions, monitoring would be undertaken on a monthly basis (while ever there is water at the nominated locations) for a 12 month period. Water samples would be analysed for the parameters including pH, turbidity, total phosphorus, total nitrogen, chlorophyll-a, salinity and TDS. The results of monitoring would be used to develop specific local 'trigger values' that would warrant further investigation if exceeded. The development of 'trigger values' would be done in consideration of *Using the ANZECC Guideline and Water Quality Objectives in NSW* (DEC, 2006).

Water quality monitoring would be undertaken in accordance with the *Australian Guidelines for Water Quality Monitoring and Reporting* (Australian and New Zealand Environment and Conservation Council [ANZECC] and Agriculture and Resources Management Council of Australia and New Zealand [ARMCANZ], 2000) and *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC, 2004c).

In view of the highly episodic and rare occurrence of surface runoff in the region, following the initial monthly sampling for 12 months, ongoing sampling would only be undertaken every six months or whenever there had been significant rainfall leading to:

- inflow from natural catchments to the monitoring points; or
- overflow/discharge from the sediment basins at the Atlas-Campaspe Mine site.

Post-Mining Surface Water Management

As there are no existing permanent surface water features that would be affected by the mining at the Atlas-Campaspe Mine, the management of surface water resources post-mining is limited to allow for drainage across the final mine landforms and final void management, and are discussed in Section 5.3.

4.5.4 Licensing

As no water is proposed to be extracted from a regulated water source in the Benanee basin (i.e. Murray River) or the Lachlan River basin (i.e. Willandra Creek upstream of the Willandra Homestead Weir), the *Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2003* and the *Water Sharing Plan for the Lachlan Regulated River Water Source 2003* would not apply to the Project (Appendix G).

The Atlas-Campaspe Mine is located within the Lower Murray-Darling Unregulated Water Source as defined in the *Water Sharing Plan for the Lower Murray-Darling Unregulated and Alluvial Water Sources, 2011* under the *Water Management Act, 2000*. No water is proposed to be directly extracted from any rivers, lakes, estuaries or wetlands in the Lower Murray-Darling Unregulated Water Source.

As described in Section 2.9.1, objectives of on-site water management throughout the Project life would be to:

- maintain separation between runoff from areas undisturbed by mining and water generated within active mining areas;
- collect and preferentially re-use surface water runoff from disturbed areas for dust suppression, road maintenance works or processing make-up requirements (when available); and
- capture and contain on-site any potentially contaminated mine site water.

Evans & Peck (2012) has concluded that no access water licences would be required for the water containments (e.g. evaporation/sediment sumps, process water storages, off-path sand residue dams and water disposal dams) (Appendix G).

This conclusion was made on the basis that runoff water contained would either be within harvestable rights (i.e. all rain water runoff on landholdings) (in consideration of the exempt classes under the harvestable rights order for the Western Division made under section 54 of the *Water Management Act, 2000* and published on 31 March 2006 in the Government Gazette) and/or would be relevant excluded works under Schedule 1 (clauses 1 to 3) of the *Water Management (General) Regulation, 2011* (Appendix G).

The Ivanhoe Rail Facility is located within the Unregulated Effluent Creeks Water Source as defined in the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources, 2011* under the *Water Management Act, 2000*.

Evans & Peck (2012) has concluded that no access water licences would be required for the capture and use of water from the retention basin at the Ivanhoe Rail Facility (Appendix G).

This conclusion was made on the basis that runoff water contained would be within harvestable rights (i.e. all rain water runoff on landholdings) (in consideration of the exempt classes under the harvestable rights order for the Western Division made under section 54 of the *Water Management Act, 2000* and published on 31 March 2006 in the Government Gazette) and/or would be relevant excluded works under Schedule 1 (clauses 1 to 3) of the *Water Management (General) Regulation, 2011* (Appendix G).

Further details are provided in Attachment 5 (Water Licensing Addendum).

4.6 FLORA

A Flora Assessment has been prepared for the Project by Australian Museum Business Services (2013a) and is presented in Appendix A. The Flora Assessment was prepared in accordance with the DGRs for the Project.

A description of the existing environment relating to flora is provided in Section 4.6.1. Section 4.6.2 describes the potential impacts of the Project, Section 4.6.3 outlines mitigation measures, management and monitoring and Section 4.6.4 describes the biodiversity offset strategy.

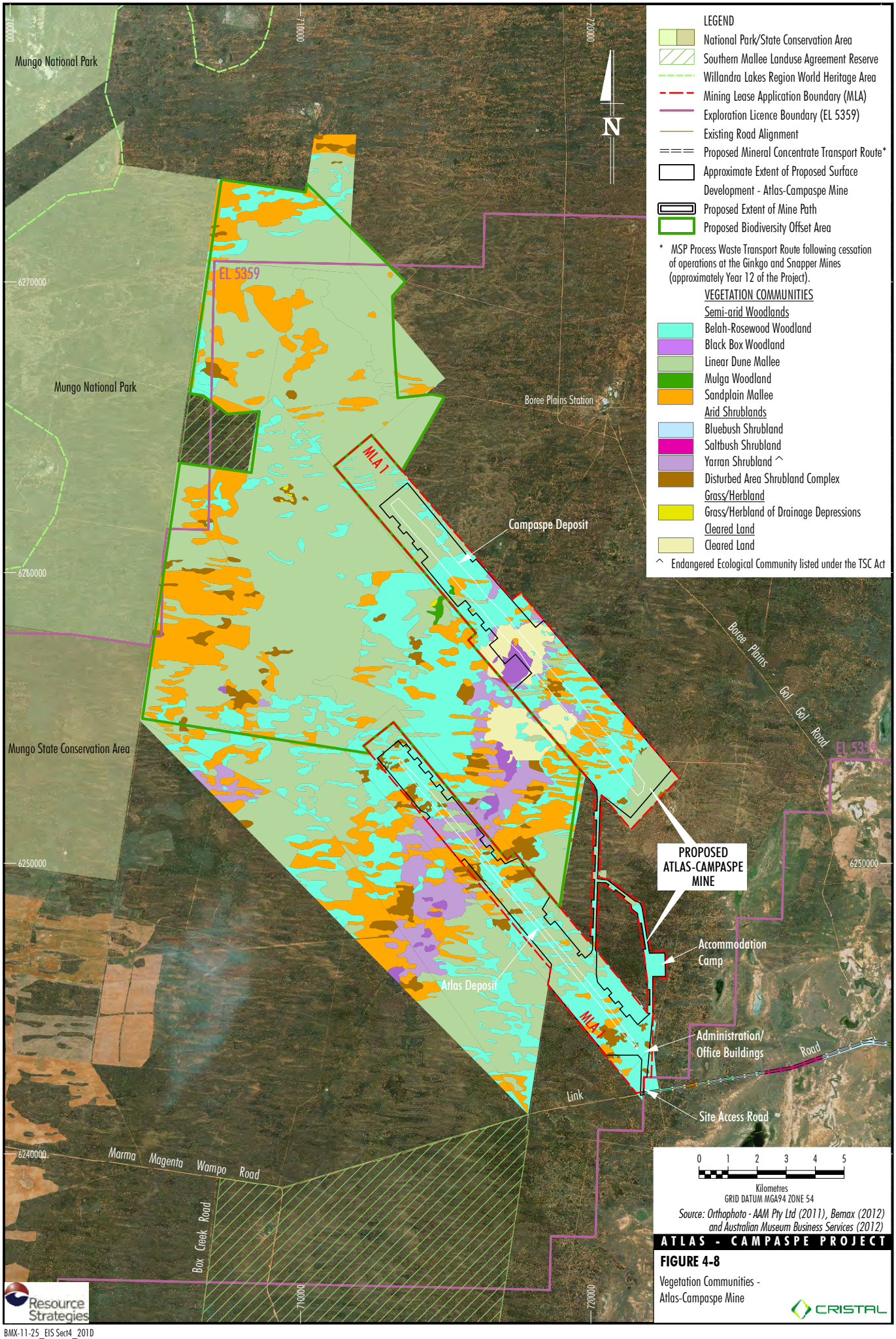
A separate document that describes how the EIS addresses the requirements of the EPBC Act is provided in Appendix C.

4.6.1 Existing Environment

Regional and Local Setting

There are various regional delineations in NSW that can be used to predict which native flora species are likely to occur within a particular area. The Atlas-Campaspe Mine is located within the Lower Murray-Darling CMA while the Ivanhoe Rail Facility is located within the Lachlan CMA. Both the Atlas-Campaspe Mine and the Ivanhoe Rail Facility are located within the Murray-Darling Depression Biogeographic Region (Thackway and Cresswell, 1995; SEWPaC, 2012a).

The Atlas-Campaspe Mine is located approximately 5 km to the east of Mungo National Park at its closest point (Figure 4-8). Two private conservation areas have also been established under Southern Mallee Landuse Agreements in the locality, one adjoining Mungo National Park and the other to the south of the Project area (Figure 4-8).



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Flora Surveys

Flora surveys of the Atlas-Campaspe Mine (including the Atlas-Campaspe Mine footprint and roadworks along the mineral concentrate transport route) were undertaken by Australian Museum Business Services. Surveys of the Atlas-Campaspe Mine footprint were undertaken during May, November and December 2011 and surveys of the roadworks along the mineral concentrate transport route were undertaken in February and April 2012. Surveys of the Ivanhoe Rail Facility area were undertaken in October 2012.

Flora surveys of the proposed biodiversity offset area were also conducted by Australian Museum Business Services during November and December 2011 and February and April 2012 (Appendix A).

Two years prior to this assessment (i.e. 2010 and 2011), the region received approximately double the annual average rainfall (Section 4.2.1). This resulted in ideal conditions during the surveys.

Flora surveys have been undertaken for the Project using standard techniques (quadrats, rapid data points, vegetation mapping, condition assessment and threatened species searches) in accordance with the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC, 2004d) as well as more contemporary techniques such as statistical analysis of vegetation assemblages. Targeted searches for potentially occurring threatened flora species and threatened ecological communities were conducted for the Project. Potential habitat for threatened flora species was evaluated based on the habitat requirements of threatened species which could possibly occur in the Project area. Subsequent targeted searches for the Cobar Greenhood Orchid (*Pterostylis cobarensis*) were undertaken by FloraSearch (Dr Colin Bower) in October 2012.

Vegetation Communities

The vegetation communities associated with the Atlas-Campaspe Mine are shown on Figure 4-8. The main vegetation communities present across the Atlas-Campaspe Mine footprint are Belah-Rosewood Woodland and mallee (Linear Dune Mallee and to a lesser extent Sandplain Mallee). Other vegetation communities are more localised, such as the Black Box Woodland and various Acacia shrublands (Mulga Woodland, Yarran Shrubland and Disturbed Area Shrubland Complex). Grass/Herbland occurs in scattered gilgai depressions that vary in size.

Larger occurrences of this vegetation community are mapped on Figure 4-8. Smaller occurrences exist as sub-components of other communities and were unmappable (Appendix A).

The Yarran Shrubland is the only threatened ecological community present in the Atlas-Campaspe footprint. It is equivalent to the *Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression Bioregions Endangered Ecological Community* (*Acacia melvillei* Shrubland EEC) listed under the NSW *Threatened Species Conservation Act, 1995* (TSC Act) (Figure 4-8) (Appendix A).

The vegetation along the mineral concentrate transport route largely occurs as roadside vegetation either side of an existing road.

Bluebush Shrubland is prevalent in the mineral concentrate transport route roadworks footprint and wider landscape with smaller areas of Saltbush Shrubland, Chenopod Shrubland Depressions and Scalded Chenopod Shrubland (Figure 4-9).

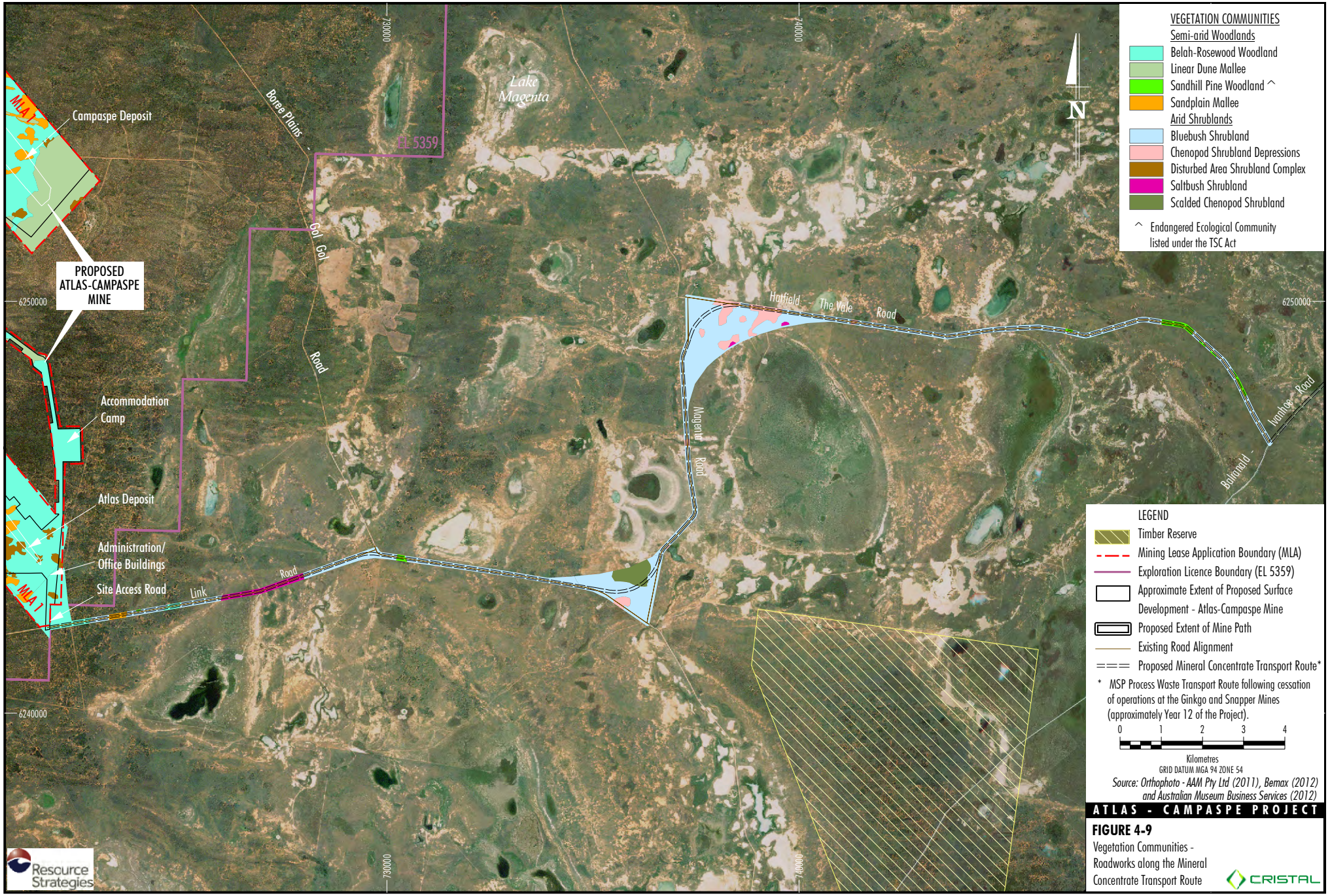
Scattered occurrences of Sandhill Pine Woodland are present along the alignment on sandy rises. This community is equivalent to the *Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW Western Slopes Bioregions Endangered Ecological Community* (Sandhill Pine Woodland EEC) listed under the TSC Act (Appendix A).

The Native Grassland/Sparse Acacia/Chenopod Shrubs and the Belah-Rosewood/Acacia Woodland was mapped in the Ivanhoe Rail Facility area (Figure 4-10).

The condition of the vegetation within the Project area ranged from good to poor depending on the level of previous clearing, grazing and fire history. A full description of the vegetation condition is provided in Appendix A.

Threatened Ecological Communities

As described previously, two threatened ecological communities are present in the Project area, namely, the *Acacia melvillei* Shrubland EEC and Sandhill Pine Woodland EEC listed under the TSC Act. The *Acacia melvillei* Shrubland EEC in the Project area and surrounds has been extensively cleared in the past for cropping and now occurs as patches of heavily grazed vegetation. Sandhill Pine Woodland EEC occurs in small patches along parts of Link Road, Boree Plains-Gol Gol Road and Hatfield-The Vale Road.



ATLAS - CAMPASPE PROJECT

FIGURE 4-9

Vegetation Communities - Roadworks along the Mineral Concentrate Transport Route

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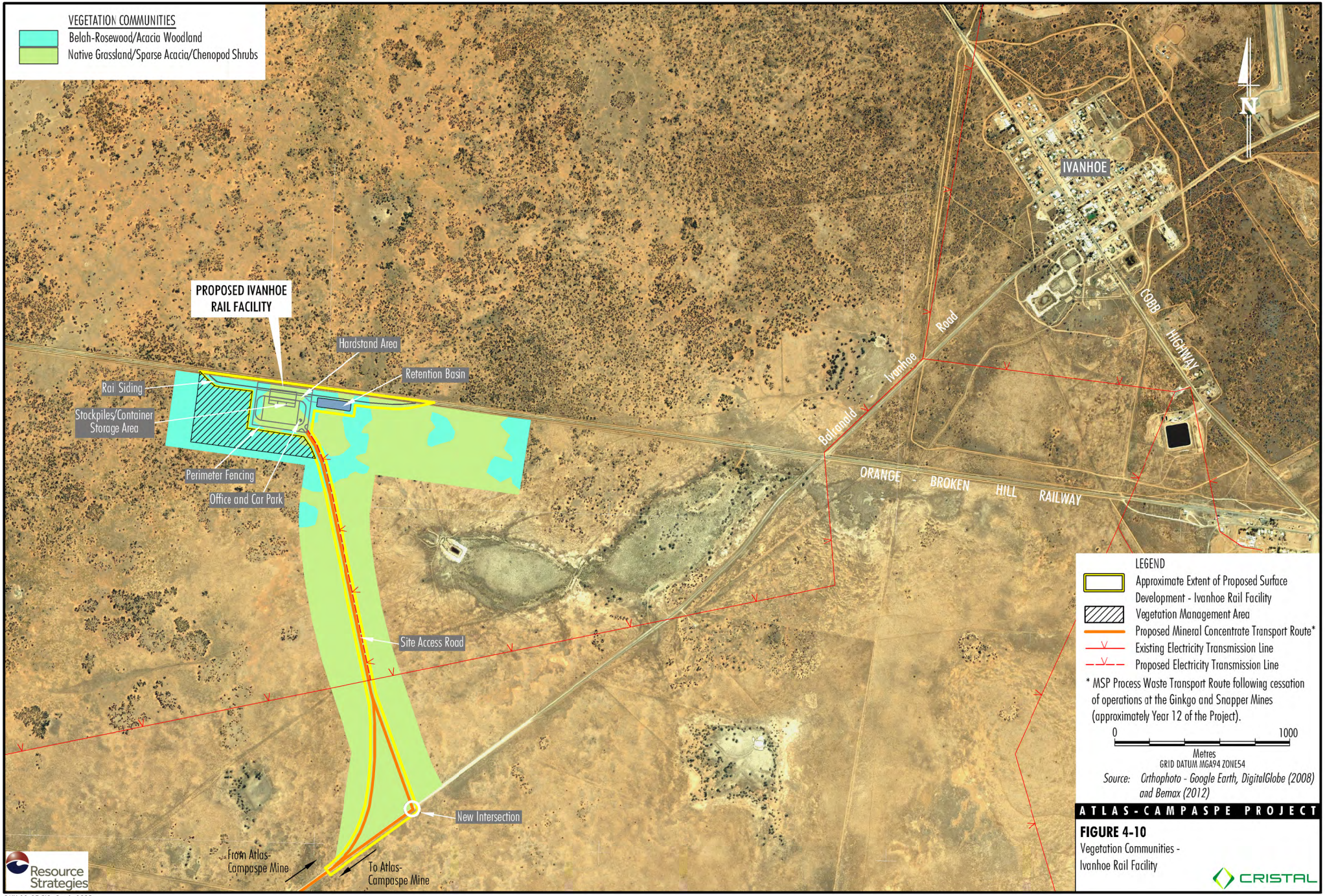

ATLAS-CAMPASPE PROJECT

FIGURE 4-10

Vegetation Communities - Ivanhoe Rail Facility

CRISTAL

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All remnants of Sandhill Pine Woodland in the study area are in very poor condition, being heavily grazed and possibly logged in the past (Appendix A).

No threatened ecological communities listed under the EPBC Act occur in the Project area or surrounds.

Regionally Significant Vegetation and Vegetation Corridors

Apart from the threatened ecological communities, the other vegetation communities in the Project area are estimated to be at least 70% of their pre-European extent in the Lower Murray Darling CMA (OEH, 2012b) (Appendix A).

The Project area is part of a more extensive area of continuous native vegetation and the vegetation communities tend to generally occur in a banded pattern running north-south. However, the Atlas-Campaspe Mine site does not form part of any recognised national landscape corridors (SEWPaC, 2012b) or local wildlife corridors (OEH, 2011a) (Appendix B).

Flora Species Composition

A total of 368 native flora species and 77 introduced species were recorded across the study areas at the Atlas-Campaspe Mine site including the mineral concentrate transport route roadworks footprint and surrounds. A total of 75 native species and 11 introduced species were recorded in the study area at the Ivanhoe Rail Facility. A complete list of flora species identified in surveys of the Project area is provided in Appendix A. The plant families with the highest numbers of native species were the daisies, grasses and chenopods (Appendix A).

Introduced Flora Species and Noxious Weeds

A total of 77 introduced species were recorded within the study areas at the Atlas-Campaspe Mine site including the mineral concentrate transport route roadworks footprint and surrounds. Six of these weed species are listed as noxious under the NSW *Noxious Weeds Act, 1993* in the Balranald LGA (DPI, 2012), namely, the Onion Weed (*Asphodelus fistulosus*), Golden Dodder (*Cuscuta campstris*), African Boxthorn (*Lycium ferocissimum*), Californian Burr (*Xanthium orientale*), Noogoora Burr (*X. occidentale*) and Bathurst Burr (*X. spinosum*) (Appendix A). A total of 11 introduced species were recorded within the study area at the Ivanhoe Rail Facility and none were noxious in the relevant LGA.

Threatened Flora Species under the TSC Act and EPBC Act

Three threatened flora species were recorded in the Project area and surrounds (Figures 4-11 and 4-12) (Appendix A):

- Winged Peppercress (*Lepidium monoplocoides*) listed as endangered under the TSC Act and EPBC Act;
- Cobar Greenhood Orchid listed as vulnerable under the TSC Act and EPBC Act; and
- Mossgiel Daisy (*Brachyscome papillosa*) listed as vulnerable under the TSC Act and EPBC Act.

The size of the plant populations were estimated and the habitat was documented and is presented in Appendix A. Threatened flora under the EPBC Act are further discussed in Appendix C.

Critical Habitat and Threatened Populations

No critical habitat or threatened populations occur in the vicinity of the Project (Appendices A and B).

Aquatic Species and Communities

There are no flora species or communities listed under the NSW *Fisheries Management Act, 1994* (FM Act) that are relevant to the Project (Appendix A).

Groundwater Dependent Vegetation

No groundwater dependent vegetation has been identified in the Project area or surrounds (Appendix A).

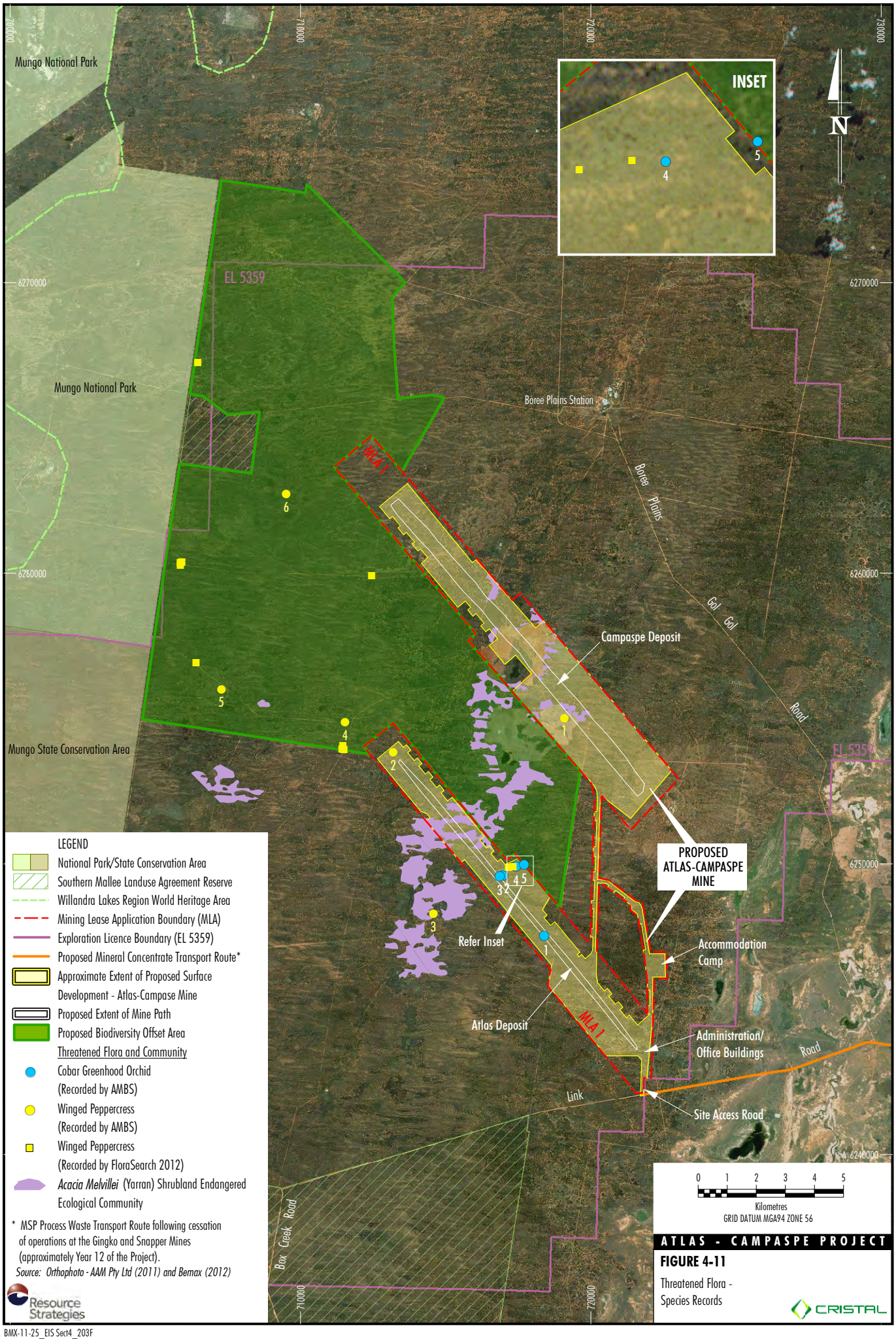
4.6.2 Potential Impacts

Vegetation Clearance

The Project would require the progressive removal of 4,158 ha of native vegetation (Table 4-4) and 305 ha of previously cleared land over approximately 20 years. The progressive clearance of native vegetation ahead of the advancing ore extraction area and active mining area would be followed by progressive rehabilitation and revegetation of the backfilled pit and overburden emplacements.

Habitat Fragmentation/Loss of Connectivity

The Atlas-Campaspe Mine would progressively reduce connectivity of surrounding habitat until revegetation of the post-mine landforms has occurred.



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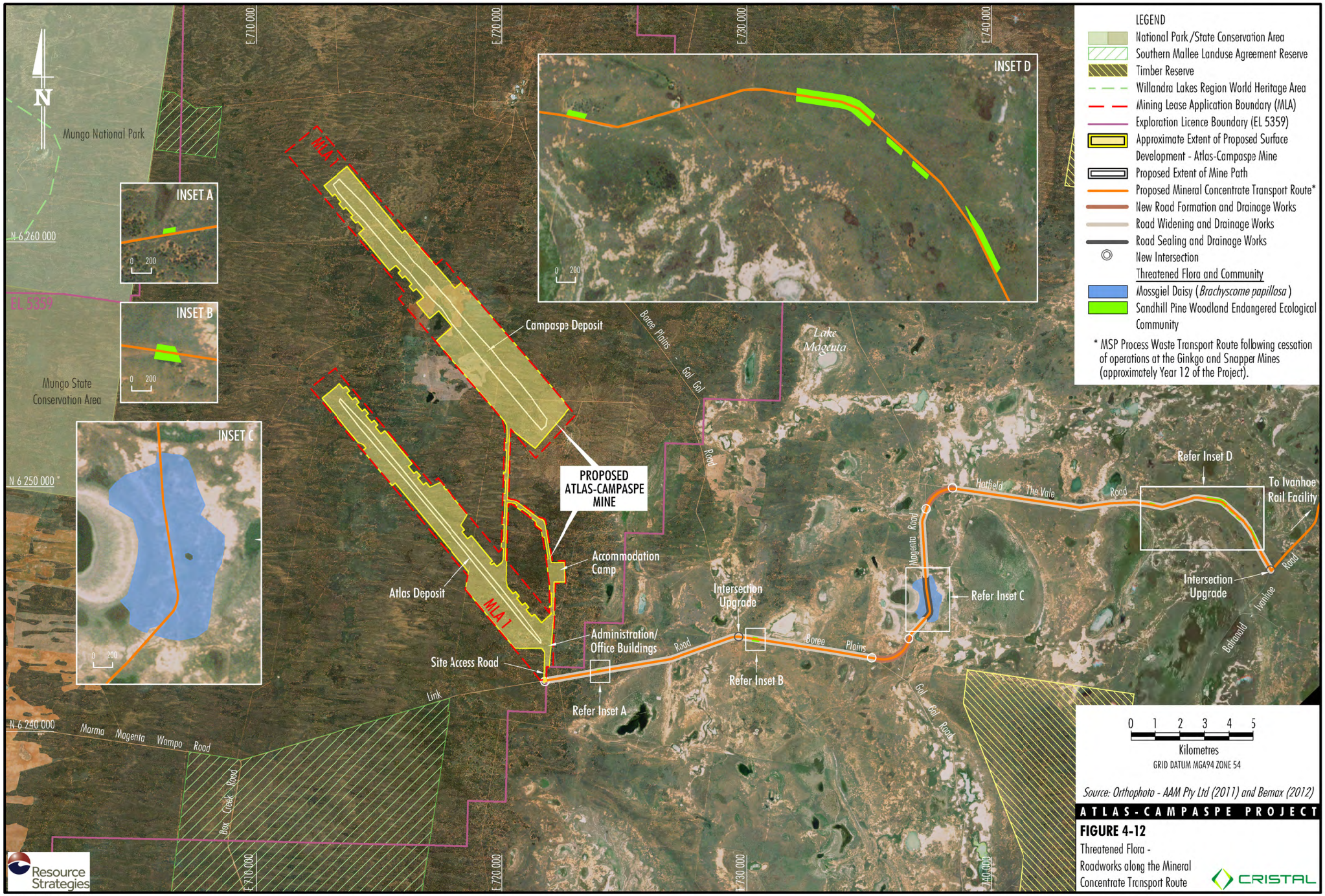

ATLAS-CAMPASPE PROJECT

FIGURE 4-12

Threatened Flora - Roadworks along the Mineral Concentrate Transport Route

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Table 4-4
Native Vegetation Required to be Cleared for the Project

Vegetation Community	Location	Approximate Area to be Cleared (ha)
Semi-arid Woodlands		
Belah-Rosewood Woodland	Occurs in the Atlas-Campaspe Mine footprint and mineral concentrate transport route roadworks footprint.	2,035
Belah-Rosewood/Acacia Woodland	In the Ivanhoe Rail Facility footprint.	10
Black Box Woodland	Predominantly in the middle of the Campaspe footprint.	50
Linear Dune Mallee	Predominantly in the middle of the Atlas footprint and in the northern end of the Campaspe footprint.	1,040
Mulga Woodland	Present in a small portion of the Campaspe footprint.	5
Sandplain Mallee	Present in scattered occurrences through the Atlas-Campaspe Mine footprint and a small area in the mineral concentrate transport route roadworks footprint.	535
Sandhill Pine Woodland[1]	Present in the mineral concentrate transport route roadworks footprint.	3
Arid Shrublands		
Bluebush Shrubland	Present in the mineral concentrate transport route roadworks footprint.	70
Chenopod Shrubland Depressions	Present in the mineral concentrate transport route roadworks footprint.	5
Scalded Chenopod Shrubland	Present in the mineral concentrate transport route roadworks footprint.	5
Saltbush Shrubland	Present in the mineral concentrate transport route roadworks footprint.	5
Yarran Shrubland[2]	Through the low-lying areas of the Atlas-Campaspe Mine footprint.	195
Disturbed Areas/Shrubland Complex	Present in scattered occurrences through the Atlas-Campaspe Mine footprint.	170
Native Grassland/Sparse Acacia/Chenopod Shrubs	Present in the Ivanhoe Rail Facility footprint.	30
	Total	**4,158**

Source: After Appendix A.

1 Sandhill Pine Woodland EEC.

2 *Acacia melvillei* Shrubland EEC.

Threatened Ecological Communities

The potential impacts on threatened ecological communities listed under the TSC Act have been assessed via an Assessment of Significance in accordance with section 5A of the EP&A Act and the *Threatened Species Assessment Guidelines – The Assessment of Significance*[1] (DECC, 2007b) (Appendix A).

Scattered patches of Sandhill Pine Woodland EEC (totalling approximately 3 ha) are located within the mineral concentrate transport route roadworks footprint (Figure 4-12).

The Project would be unlikely to significantly impact on the Sandhill Pine Woodland EEC given the small and disturbed nature of the area to be cleared and the wider occurrence of this Sandhill Pine Woodland EEC in the surrounding area (Appendix A).

Various patches of *Acacia melvillei* Shrubland EEC (totalling approximately 195 ha) are located within the footprint of the proposed Atlas-Campaspe Mine (Figure 4-11). The Project is assessed as potentially having a significant impact on *Acacia melvillei* Shrubland EEC due to the combined area of proposed clearance. However, the conservation of 390 ha of existing *Acacia melvillei* Shrubland EEC in the proposed biodiversity offset area and the removal of grazing to facilitate regeneration of a greater area of *Acacia melvillei* in the proposed biodiversity offset area has the potential to improve the quality of substantial areas of the community in the medium to long-term (Appendix A).

1 It is noted that the DGRs refer to the *Guidelines for Threatened Species Assessment*, however, this guideline is only relevant to projects assessed under Part 3A of the EP&A Act (now repealed).

Groundwater Dependent Vegetation

No groundwater dependent vegetation has been identified in the Project area or surrounds and therefore the Project would not impact any groundwater dependent vegetation (Appendix A).

Changes in Hydrology

The proposed mining of the Atlas and Campaspe deposits is expected to have limited, localised and temporary effects on areas where temporary surface ponding occurs at the Atlas-Campaspe Mine site (i.e. through excavation) (Section 4.4.2 and Appendix F).

The Flora Assessment (Appendix A) identifies that alteration to the terrain and diversion of surface water could potentially impact Black Box Woodland. Black Box (*Eucalyptus largiflorens*) trees have a higher water requirement than surrounding Eucalypts.

Although Black Box tolerate long periods of dry conditions, the periodic filling of the depressions by rain and overland water flow is required to sustain them (Appendix A).

There is a patch of Black Box Woodland (approximately 45 ha) on the edge of the Campaspe mine path (Figure 4-8) and mining of the Campaspe deposit (between Years 11 to 13) would remove part of the clay associated with the water holding capacity in the depression.

The total water holding capacity of the depression may be affected if the clay material to be removed was replaced with higher permeability overburden and process wastes after mining (i.e. higher infiltration). To minimise this, Cristal Mining would selectively place clay material in low-lying portions of the re-profiled landform within the mine path to reinstate the water holding capacity of, and run-on to adjacent depressions. The management of the rehabilitation in this way is likely to maintain the Black Box Woodland in this location (Appendix A).

Use of Saline Water for Dust Control and Road Maintenance Works

As described in Section 2.9.2, dust would be suppressed along haul roads, access roads and the unsealed sections of the mineral concentrate transport route by routinely spraying water sourced from the groundwater supply borefield (i.e. naturally saline) or from sumps which collect mine runoff water. Similarly, saline water has been used as a dust suppressant at the Ginkgo and Snapper Mines since operations commenced.

There is potential for vegetation adjacent to the haul roads, access roads and unsealed sections of the mineral concentrate transport route to be affected by salts entrained within wind-blown dust from the unsealed roads. However, Australian Museum Business Services (Appendix A) expect the subsequent impacts on vegetation from wind-blown saline dust to be negligible since the residual saline dust would be negligible compared to the total exposed areas of soils at the Atlas-Campaspe Mine and surrounds (Appendix K). This is consistent with the operational experience at the Ginkgo and Snapper Mines where Cristal Mining has observed no discernible impacts on vegetation adjacent to where saline water is used.

Also of note, the use of saline water as a dust suppressant would inherently limit the amount of dust from the unsealed roads and, as shown on Figure 4-9, the unsealed sections of the mineral concentrate transport route pass through salt-tolerant chenopod shrublands and a landscape of salt lakes which would act as a more significant salt source than the unsealed roads.

The use of saline water could potentially impact the vegetation nearby if residue salts dissolve in rainwater and wash from the roads after rain events. However, the internal roads within the active mining area would be contained (i.e. would not wash to surrounding vegetation). Further, application of saline water to internal access roads and the unsealed sections of the mineral concentrate transport route (for road maintenance works) would be infrequent and any runoff water would be directed to road verges/drains. These saline water dust suppression management practices are consistent with those applied at the operations at the Ginkgo and Snapper Mines, where Cristal Mining have observed no discernible impacts on vegetation adjacent to where saline water is used.

Vegetation and Dust

Project activities such as mining, trucks movements along the mineral concentrate transport route and loading and unloading of material may result in the generation and dispersion of atmospheric dust. With the Project dust control measures described in Section 4.10.3, the impacts on surrounding vegetation are expected to be negligible (Appendix A).

Bushfire Risk

High intensity fire from unplanned bushfires can adversely impact flora. The main sources of bushfire ignition are outlined in Section 4.3.1.The risk of a fire would be reduced through the preventative measures described in Section 4.6.3.

Introduced Flora

Vegetation clearing, soil disturbance and vehicle movement is considered likely to create opportunities for weeds and an increased potential for weed incursion into adjacent native vegetation. Similarly, areas undergoing revegetation may be susceptible to weed incursion. Measures to minimise and control weeds are described in Section 4.6.3.

Introduced Fauna

Introduced fauna can result in erosion problems (from tracks and burrows) as well as reduce recruitment and survival of native plants. The European rabbit (*Oryctolagus cuniculus*) and feral goat (*Capra hircus*) are known to occur in the Project area and surrounds. Both of these species relate to a key threatening process listed under the TSC Act. Measures to minimise and control introduced fauna are provided in Section 4.7.3.

Threatened Flora Species under the TSC Act and EPBC Act

The three threatened flora species recorded during the surveys for the Project are listed under both the TSC Act and EPBC Act. The potential impacts on threatened flora have been assessed via an Assessment of Significance under section 5A of the EP&A Act and in accordance with the relevant guideline (DECC, 2007b).

Assessments were also undertaken in accordance with the relevant Commonwealth guideline (Commonwealth Department of Environment, Water, Heritage and the Arts [DEWHA], 2009). The assessments are provided in Appendix A.

The Winged Peppercress was identified within the Atlas-Campaspe Mine area (two individual plants in two different locations) (Figure 4-11). The habitat in both locations was degraded by livestock and goats and one of the individuals was found in a small patch of isolated habitat surrounded by cleared land. A total of 299 individuals of this species were recorded at four other locations in the surrounding area (outside of the proposed surface development area at the Atlas-Campaspe Mine) and three of these locations are included in the proposed biodiversity offset area (Figure 4-11).

The occurrences of the Winged Peppercress are considered to represent a single 'population' in accordance with the relevant Commonwealth guideline (DEWHA, 2009), as the collection of records occur in a geographically distinct region. On the basis of this guideline, the species would not be significantly impacted by the Project, because only part of the population would be disturbed and the rest would be conserved in the proposed biodiversity offset area (Appendix A).

The NSW definition of a 'population' differs from the Commonwealth definition. Under the NSW assessment, an assumption that each occurrence found in the Project area represents a viable 'local population' (and not an isolated occurrence), would result in a significant impact on two confirmed local populations (records) of Winged Peppercress in accordance with section 5A of the EP&A Act (Appendix A).

Notwithstanding, based on known information about the lifecycle of other *Lepidium* species, the six confirmed local records of the Winged Peppercress could be considered to be part of one population in which case the loss of the species at two sites within the Project area is not likely to have a significant impact on the species, because only part of the population would be disturbed and the rest would be conserved in the proposed biodiversity offset area.

A large population of Mossgiel Daisy was located along Magenta Road and the design of the roadworks along the mineral concentrate transport route was subsequently modified to avoid direct disturbance to the daisy (Figure 4-12). Therefore the Project would not have a significant impact on the Mossgiel Daisy (Appendix A).

Scattered Cobar Greenhood Orchid were identified within the Atlas-Campaspe Mine area (Figure 4-11). The Project is assessed as having a significant impact on the Cobar Greenhood Orchid given the known extent of the population in the area (Appendix A). Notwithstanding, additional mitigation measures are proposed to minimise impacts on the Cobar Greenhood Orchid and are described in Section 4.6.3.

Threatened flora species under the EPBC Act are discussed further in Appendix C.

Willandra Lakes Region World Heritage Area

The values of the Willandra Lakes Region which meet the World Heritage criteria are not botanical or zoological (Section 4.8.2). Nevertheless, an assessment of the flora in the Willandra Lakes Region World Heritage Area is provided in Appendix A and the Atlas-Campaspe Mine is not likely to have an adverse impact on the Willandra Lakes Region World Heritage Area.

Mungo National Park and Mungo State Conservation Area

The Atlas-Campaspe Mine is not likely to have an adverse impact on the flora of Mungo National Park or Mungo State Conservation Area (Appendix A). Measures that would be undertaken to manage and control fires, dust and feral animals are described in Sections 4.6.3, 4.7.3 and 4.10.3.

The addition of the proposed biodiversity offset area to the existing conservation reserve system has the potential to result in a positive impact on the flora in Mungo National Park (Appendix A).

Cumulative Impacts

The impacts of the Project in the context of existing and past land uses have been considered by Australian Museum Business Services in Appendix A. An assessment of the cumulative impacts of other proposed (but not yet approved) developments in the region (i.e. the Balranald Mineral Sands Project) has also been considered (Appendix A).

Incremental impacts of the Project on flora are expected to occur as a result of additional vegetation clearance. The proposed biodiversity offset area for the Project provides for the conservation and enhancement of a larger area of vegetation. Australian Museum Business Services (Appendices A and B) conclude that the Project would maintain and improve biodiversity values in the medium to long-term.

4.6.3 Mitigation Measures, Management and Monitoring

Refinements to the Project Design to Minimise Land Clearance

Refinements to the Project design have resulted in avoiding additional impacts on flora and their habitats as listed below:

- The Campaspe footprint has been refined to avoid some direct impacts on the Black Box Woodland (Figure 4-8).
- The roadworks along the mineral concentrate transport route mostly follows existing road alignments to reduce the amount of vegetation clearance required (Figure 4-9).
- A section of the existing Magenta Road in the vicinity of the known Mossgiel Daisy population would not be widened (Figure 4-12). This section of road would be sealed to minimise erosion and dust generation.
- Refinement of the design of the stockpiles to avoid impacts on the fourth and fifth location of Cobar Greenhood Orchid (Figure 4-11) (comprising of four and 11 plants, respectively) and minimise impacts on the orchid and its habitat where practicable. The fifth location is within the biodiversity offset area, however, the mine plan would avoid the 25 m radius zone around this location (in which further individuals could occur).
- The proposed mine general arrangement would avoid the two Malleefowl nesting mounds present within the proposed surface disturbance area.

Biodiversity Management Plan

A Biodiversity Management Plan would be prepared by a suitably qualified person(s) that covers the following aspects relevant to flora:

- land clearance strategies, in relation to flora;
- weed control;
- management of vegetation within the MLA;
- management of vegetation at the Ivanhoe Rail Facility;
- land management (Boree Plains Station, Wampo Station, Iona Station and Carrawatha Station);
- dust suppression;
- management of the Black Box Woodland;
- bushfire prevention;
- awareness and education;
- mitigation measures for the Mossgiel Daisy;
- mitigation measures for the Cobar Greenhood Orchid; and
- the biodiversity offset strategy (Section 4.6.4).

Land Clearance Strategies

The following land clearing strategies would be adopted for the Project:

- clear delineation of the approved disturbance areas on the ground prior to clearing activities (e.g. flagging tape and posts) 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 would be made aware of clearing limits and restricted access areas;
- land clearance for the Project would be undertaken progressively; and
- the area cleared at any particular time would generally be no greater than that required to accommodate Cristal Mining's development needs for the following 12 months, where practicable.

The following would be adopted to salvage plant resources:

- the collection of seed from felled trees (e.g. Yarran [*Acacia melvillei*]) for seedling propagation on rehabilitated areas;
- the retention of ground cover (e.g. logs, fallen branches and leaf litter) within stripped topsoil to improve the viability of the soil when it is used in rehabilitation;
- the collection of seed bank and topsoil around the Winged Peppercress and the Cobar Greenhood Orchid populations within the Atlas-Campaspe Mine for reuse on rehabilitation, where practicable;
- pre-clearance targeted searches for the Cobar Greenhood Orchid (during mid-October) in the disturbance area and salvage of orchids for use in revegetation trials, in accordance with appropriate licenses; and
- pre-clearance targeted searches for the Winged Peppercress in the disturbance area and salvage of seed for use in revegetation trials, in accordance with appropriate licences.

The measures relating to rehabilitation are further described in Section 5.

Weed Control

Weed control measures that would be undertaken as part of the Project would include:

- regular inspections of the mining tenements (including along internal roads, surface water diversions and areas undergoing rehabilitation) to identify and demarcate areas of noxious and environmental weeds;
- mechanical removal and/or the application of approved herbicides in areas identified as being affected by weeds;
- specific control for noxious weeds; and
- follow-up site inspections to evaluate the effectiveness of weed control programmes.

Management of Vegetation within the MLA

Livestock would be excluded from the MLA area during the period the Atlas-Campaspe Mine would be in operation.

Management of Vegetation at the Ivanhoe Rail Facility

The Ivanhoe Rail Facility would include retention and management of 15 ha of existing vegetation in a Vegetation Management Area, comprising approximately 14.8 ha of Belah-Rosewood Woodland and approximately 0.2 ha of Native Grassland/Sparse Acacia/Chenopod Shrubs (Figure 4-10). The perimeter of the area would be fenced with a goat proof fence to facilitate regeneration of the native vegetation. Cristal Mining would undertake control of noxious weeds within this area.

Land Management (Boree Plains Station, Wampo Station, Iona Station and Carrawatha Station)

Cristal Mining is entering into agreements with the leaseholders for the lease of Boree Plains Station and relevant parts of Wampo Station, Iona Station and Carrawatha Station and would manage these lands in accordance with the requirements of the relevant Western Lands Lease (e.g. control of noxious weeds and management of grazing). The management of the land would be consistent with the *Guidelines for developments adjoining Department of Environment and Climate Change land* (DECC, 2008d).

Dust Suppression

Dust mitigation and management measures to be undertaken as part of the Project (e.g. watering of internal haul roads) are described in Section 4.10.3.

Management of the Black Box Woodland

The proposed mine water management system includes a range of measures to minimise any potential impacts on Black Box Woodland located immediately adjacent to, or 'downstream' of the Atlas-Campaspe Mine, *viz*:

- maintain the opportunity for runoff to the depressions during the life of the Project;
- selectively place of clay material in low-lying portions of the re-profiled landform within the mine path to reinstate the water-holding capacity of, and run-on to adjacent depressions;
- once mining is complete, restore land levels along the main flow paths to allow cross drainage to occur toward the Black Box Woodland; and
- separate runoff from areas undisturbed by mining from water generated within active mining areas.

Water management during the life of the Project is further discussed in Sections 2.9, 4.4.3 and 4.5.3.

Bushfire Prevention

Bushfire preventative measures would include:

- educating employees and contractors on general fire awareness and response procedures;
- provision and maintenance of fire fighting equipment on-site;
- fire would be controlled and outbreaks managed in consultation with the local Rural Fire Service (Lower Western Zone Bush Fire Management Committee [Atlas-Campaspe Mine] and the Central Darling Bush Fire Management Committee [Ivanhoe Rail Facility]);
- establishment and maintenance of fire breaks to contain fires within the mining tenements;
- land clearing would be minimised during periods of extreme fire danger to mitigate risk of fire ignition from machinery, where practicable;
- annual inspections to identify areas requiring bushfire control measures including assessment of surrounding fuel loads;
- if hazard reduction burns are undertaken, they would be undertaken in a manner to maintain and enhance biodiversity;
- restriction of smoking in fire prone areas; and
- appropriate management of dangerous goods.

Awareness and Education

Awareness and education measures would include:

- marking the location of threatened species and ecological communities on mine design mapping to raise awareness of their location and need to minimise impacts on them; and
- site inductions to make mine staff and contractors aware of threatened species and ecological communities.

Additional Mitigation Measures for the Mossgiel Daisy

Additional mitigation measures to minimise impacts on the Mossgiel Daisy during the life of the Project would include:

- a section of the existing Magenta Road in the vicinity of the known Mossgiel Daisy population would not be widened (Figure 4-12). This section of road would be sealed to minimise erosion and dust generation;
- erection of temporary signage and fencing in the location of the Mossgiel Daisy population and habitat (Figure 4-12) during road sealing activities;
- coverage of mineral concentrate transport truck loads to minimise dust during transport; and
- a reduction of speed limits in the area/section of the road near the Mossgiel Daisy, to reduce speed and encourage drivers to remain on the sealed surface.

Additional Mitigation Measures for the Cobar Greenhood Orchid

Additional mitigation measures to minimise impacts on Cobar Greenhood Orchid would include:

- erecting fencing and signage around a 25 m buffer from the fourth and fifth location of Cobar Greenhood Orchid (Figure 4-11) to avoid incidental incursions;
- refinement of the final design/location of the stockpiles to avoid impacts on the fourth and fifth location Cobar Greenhood Orchid (Figure 4-11) and minimise impacts on the orchid and its habitat where practicable;

- the fifth location is within the biodiversity offset area, however, the mine plan would avoid the 25 m radius zone around this location (in which further individuals could occur);
- erection of fencing to protect the known occurrences of the Cobar Greenhood Orchid from grazing by goats and rabbits (locations 4 and 5 on Figure 4-11); and
- inclusion of the Cobar Greenhood Orchid (collected from within the mining lease) into revegetation trials for rehabilitated mine landforms (Section 5.7.2).

Proposed Rehabilitation Management Plan

Cristal Mining would prepare and implement a Rehabilitation Management Plan for the Project that would describe the revegetation programme for the mine landforms. Further information on the content of the Rehabilitation Management Plan is provided in Section 5.6.

The disturbance areas associated with the Project would be progressively rehabilitated and revegetated with species characteristic of the vegetation communities proposed to be cleared. An objective of the rehabilitation programme is to restore ecosystem function to land affected by the Project development including maintaining or establishing self-sustaining ecosystems. A mix of species associated with the *Acacia melvillei* Shrubland EEC including Yarran would be used to revegetate suitable areas in the rehabilitation areas. Winged Peppercress and Cobar Greenhood Orchid would also be included in revegetation trials.

A monitoring programme would be designed to track the progress of the revegetation programme (in terms of plant growth and species diversity) and to determine the requirement of intervention measures such as ecological thinning to reduce locked-regrowth, or additional plantings that may be required. A detailed monitoring report would be prepared annually that includes a summary of previous monitoring reports.

4.6.4 Biodiversity Offset Strategy

The DGRs for the Project (Section 1.2 and Attachment 1) state that the EIS must include a description of the measures that would be implemented to offset the potential impacts of the Project and maintain or improve biodiversity values of the surrounding region in the medium to long-term. The description below describes the flora and fauna components of the offset.

Biodiversity Offset Area

The proposed biodiversity offset area for the Project is located adjacent to the proposed Atlas-Campaspe Mine (Figure 4-13) on parts of Boree Plains and Wampo Stations. It adjoins Mungo National Park, Mungo State Conservation Area and a small conservation area (a Southern Mallee Landuse Agreement Reserve) to the west of the Project area. Cristal Mining is entering into agreements with the leaseholders for the lease of relevant parts of Boree Plains and Wampo Stations.

Table 4-5 provides a summary of the disturbance areas and the proposed biodiversity offset area.

Table 4-5
Quantification of Project Disturbance Areas and the Proposed Biodiversity Offset Area

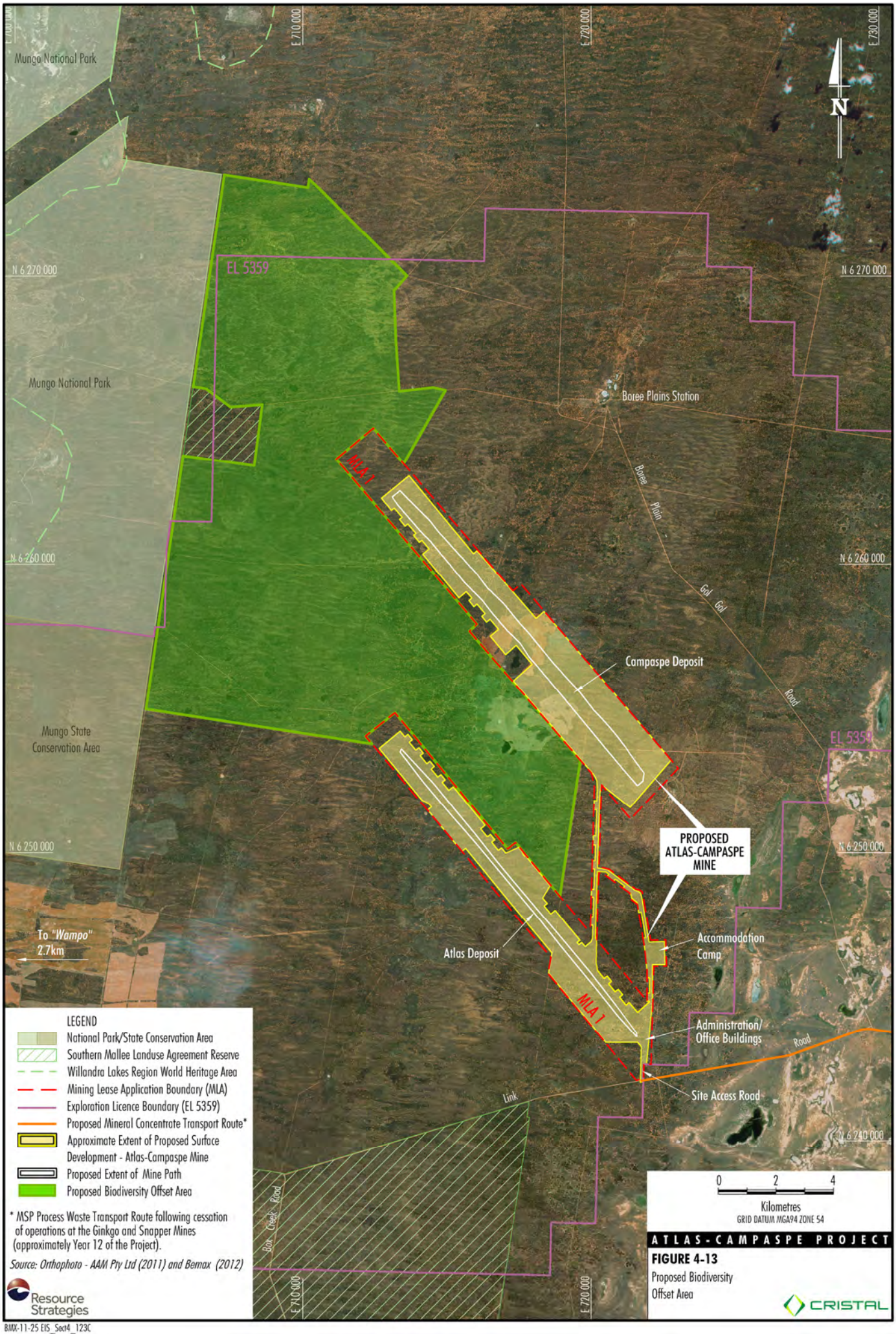
Vegetation	Additional Surface Development (ha)	Proposed Biodiversity Offset Area (ha)
Existing native vegetation	4,158	16,270
Cleared land	305	270
Total	**4,463**	**16,540**

* Approximate areas are based on vegetation mapping provided on Figure 4-8.

Methodology for Selecting the Biodiversity Offset Area

The proposed biodiversity offset area (size, location and proposed management regime) was selected using a methodology that takes into consideration a range of factors (Appendices A and B):

- the location of the proposed disturbance relative to the proposed biodiversity offsets;
- how the proposed biodiversity offset could complement the existing reserve system;
- the regional conservation priorities and vegetation most in need of conservation;
- the available land tenure on which to locate a biodiversity offset area (i.e. land controlled by Cristal Mining);
- the location of existing fence lines and tracks (to minimise the need to create new ones);
- the vegetation composition of the proposed disturbance area relative to the proposed biodiversity offset area;
- the composition of the fauna habitats of the proposed disturbance area relative to the proposed biodiversity offset area;



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- the presence of threatened fauna species and their habitat requirements;
- the flora species present (including threatened species) and the habitat needed to maintain local populations of the species;
- the size of the proposed biodiversity offset area relative to the proposed disturbance area;
- the shape of the proposed biodiversity offset area in relation to the spatial arrangement of existing vegetation in the landscape; and
- the ecosystem resilience and condition of the proposed biodiversity offset area.

In addition to the above, a reconciliation of the proposed biodiversity offsets against the relevant State requirements (OEH's *Principles for the Use of Biodiversity Offsets in NSW* [OEH, 2011b]) and Commonwealth requirements (*Environment Protection and Biodiversity Conservation Act, 1999 Environmental Offsets Policy*) (SEWPaC, 2012c) was undertaken by Australian Museum Business Services (Appendices A and B).

Vegetation Types

The proposed biodiversity offset area contains semi-arid woodlands, arid shrublands, grass/herblands and cleared land. Table 4-6 compares the vegetation communities within the disturbance areas for the Project with those within the proposed biodiversity offset area. Vegetation communities are mapped on Figure 4-8.

There are three arid shrublands that occur as road-side vegetation along parts of the mineral concentrate transport route and are not represented in the proposed biodiversity offset area (Table 4-6).

The clearance of these communities is unlikely to result in any reduction of regional biodiversity given these arid shrublands are common in the surrounding landscape. These communities also make up a relatively small component of the overall Project disturbance area (around 2%).

Table 4-6
Quantification of Native Vegetation Types in the Project and Proposed Biodiversity Offset Area

Vegetation Community	Area (ha)			
	Atlas-Campaspe Project Area			Proposed Biodiversity Offset Area
	Atlas-Campaspe Mine	Mineral Concentrate Transport Route	Ivanhoe Rail Facility	
Semi-arid Woodlands				
Belah-Rosewood Woodland	2,030	5	0	2,560
Belah-Rosewood/Acacia Woodland	0	0	10	0
Black Box Woodland	50	0	0	90
Linear Dune Mallee	1,040	0	0	9,640
Mulga Woodland	5	0	0	25
Sandplain Mallee	530	5	0	3,125
Sandhill Pine Woodland[1]	0	3	0	0
Arid Shrublands				
Bluebush Shrubland	0	70	0	0
Scalded Chenopod Shrubland	0	5	0	0
Chenopod Shrubland Depressions	0	5	0	0
Saltbush Shrubland	0	5	0	0
Yarran Shrubland[2]	195	0	0	390
Disturbed Area/Shrubland Complex	170	0	0	430
Grass/Herblands				
Grass/Herbland of Drainage Depression	0	0	0	10
Native Grassland/Sparse Acacia/Chenopod Shrubs	0	0	30	0
Total	**4,158**			**16,270**

Source: After Appendix A.

[1] Sandhill Pine Woodland EEC.

[2] *Acacia melvillei* Shrubland EEC.

Similarly, the Sandhill Pine Woodland which occurs along the mineral concentrate transport route roadworks footprint is not represented in the proposed biodiversity offset area (Table 4-6), but again the clearance is relatively minor (3 ha) and all remnants are in very poor condition, being heavily grazed and possibly logged in the past.

Cristal Mining has committed to providing financial and in-kind support to the University of Ballarat's proposed Australian Research Council (ARC) Linkage Project to investigate the regeneration of native pines (*Callitris* sp.) (a component of the Sandhill Pine Woodland EEC).

The two vegetation communities that would be cleared for the Ivanhoe Rail Facility are not represented in the proposed biodiversity offset area (Table 4-6). However, occurrences of these two communities would be managed within the Vegetation Management Area at the Ivanhoe Rail Facility (Figure 4-10).

Broad Fauna Habitat Types

The proposed biodiversity offset area contains a similar suite of fauna habitat types to that identified within the Project area. The main fauna habitat types represented in the proposed biodiversity offset area include Linear Dune Mallee, Sandplain Mallee and Belah-Rosewood Woodland (Figure 4-14).

Threatened Flora

Both threatened flora species which would be directly impacted by the Project are present in the proposed biodiversity offset area. Approximately 195 individual Winged Peppercress have been recorded in three locations in the proposed biodiversity offset area by Australian Museum Business Services as well as five records by FloraSearch (2012) (Figure 4-11).

One known location of Cobar Greenhood Orchid (comprising 11 plants) occurs in the proposed biodiversity offset area. A portion of the 25 m radius zone around this location occurs within the approximate extent of proposed surface development (Figure 4-11). The mine plan would avoid this zone. The proposed biodiversity offset area also provides approximately 12,765 ha of potential habitat (Linear Dune Mallee and Sandplain Mallee) for the Cobar Greenhood Orchid (Appendix A).

Threatened Fauna

Numerous threatened fauna species are known to inhabit the proposed biodiversity offset area including:

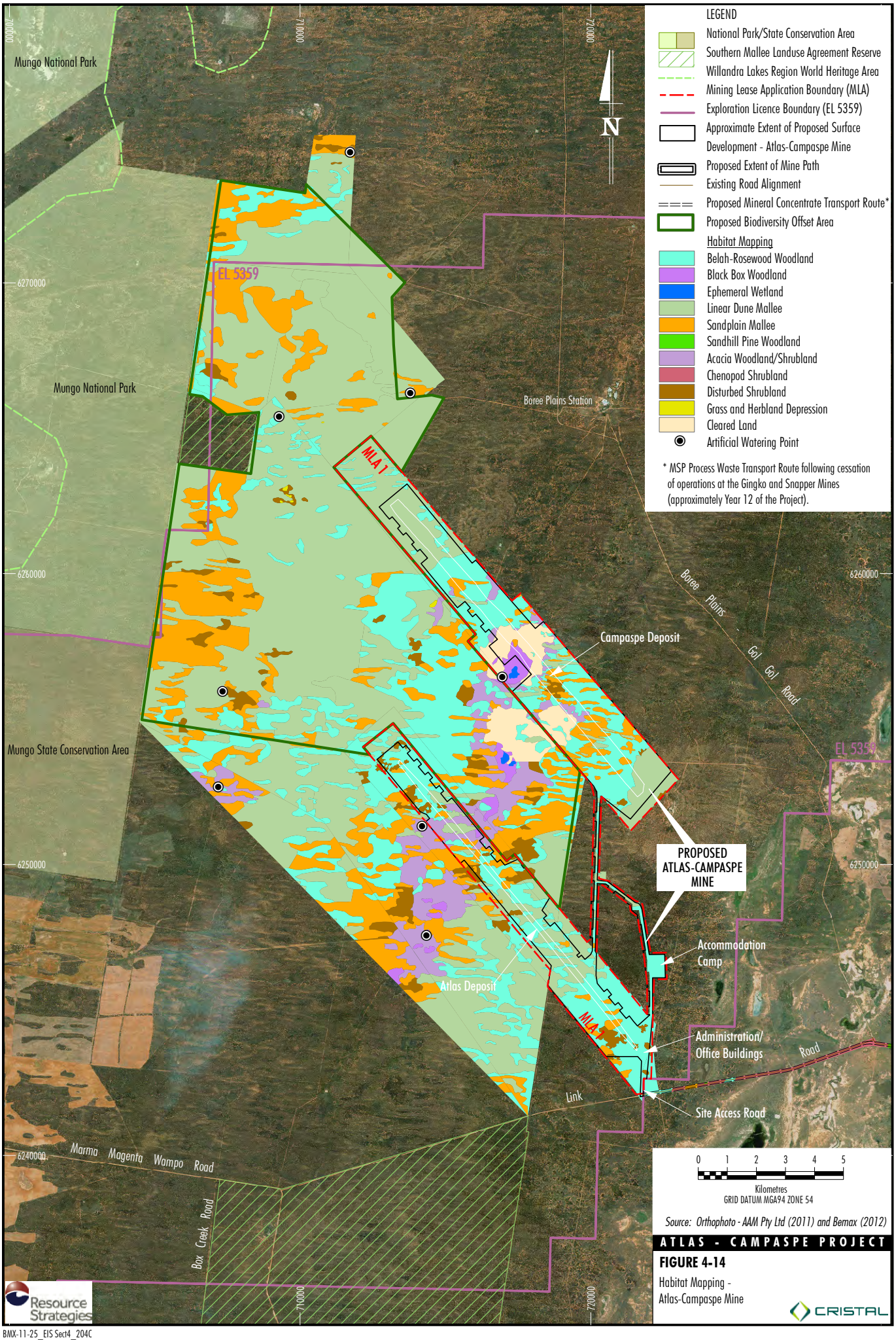
- four reptiles (Mallee Worm-lizard [*Asprasia inaurita*], Jewelled Gecko [*Strophurus elderi*], Spinifex Slender Blue-tongue Lizard [*Cyclodomorphus melanop seleongatus*] and Bardick [*Echiopsis curta*]) (Figure 4-15);
- ten birds (Malleefowl [*Leipoa ocellata*], Spotted Harrier [*Circus assimilis*], Little Eagle [*Hieraaetus morphnoides*], Major Mitchell's Cockatoo [*Lophochroa leadbeateri*], Pied Honeyeater [*Certhionyx variegastus*], White-fronted Chat [*Epthianura albifrons*], Hooded Robin [*Melanodryas cucullata cucullata*], Chestnut-backed Quail-thrush [*Cinclosoma castanotum*], Varied Sittella [*Daphoenositta chrysoptera*]and Gilbert's Whistler [*Pachycephala inornata*]) (Figures 4-16 and 4-17);
- two non-flying mammals (Southern Ningaui [*Ningaui yvonneae*] [and Western Pygmy Possum (*Cercartetus concinnus*) [probable records]) (Figure 4-18); and
- four bats (Yellow-bellied Sheathtailed-bat [*Saccolaimus flaviventris*], Corben's Long-eared Bat [*Nyctophilus corbeni*], Little Pied Bat [*Chalinolobus picatus*], Inland Forest Bat [*Vespadelus baverstocki*]) (Figure 4-19).

All of the threatened fauna species recorded in the Atlas-Campaspe Mine footprint were recorded in the proposed biodiversity offset area, with exception of two birds, namely the Bush Stone-curlew and Redthroat (*Pyrrholaemus brunneus*) (Figure 4-16) (Appendix B). There is potential habitat for the Bush Stone-curlew (*Burhinus grallarius*) in the proposed biodiversity offset area (e.g. Mallee). The Redthroat was recorded in chenopod shrubland along the mineral concentrate transport route (Figure 4-20).

Although no chenopod Shrubland occurs in the proposed biodiversity offset area, this type of habitat is more abundant in the wider landscape surrounding the mineral concentrate transport route (Appendix B).

Threatened Ecological Communities

As described in Section 4.6.2, the Project would result in the removal of 195 ha of *Acacia melvillei* Shrubland EEC. Approximately 390 ha of *Acacia melvillei* Shrubland EEC occurs within the proposed biodiversity offset area.



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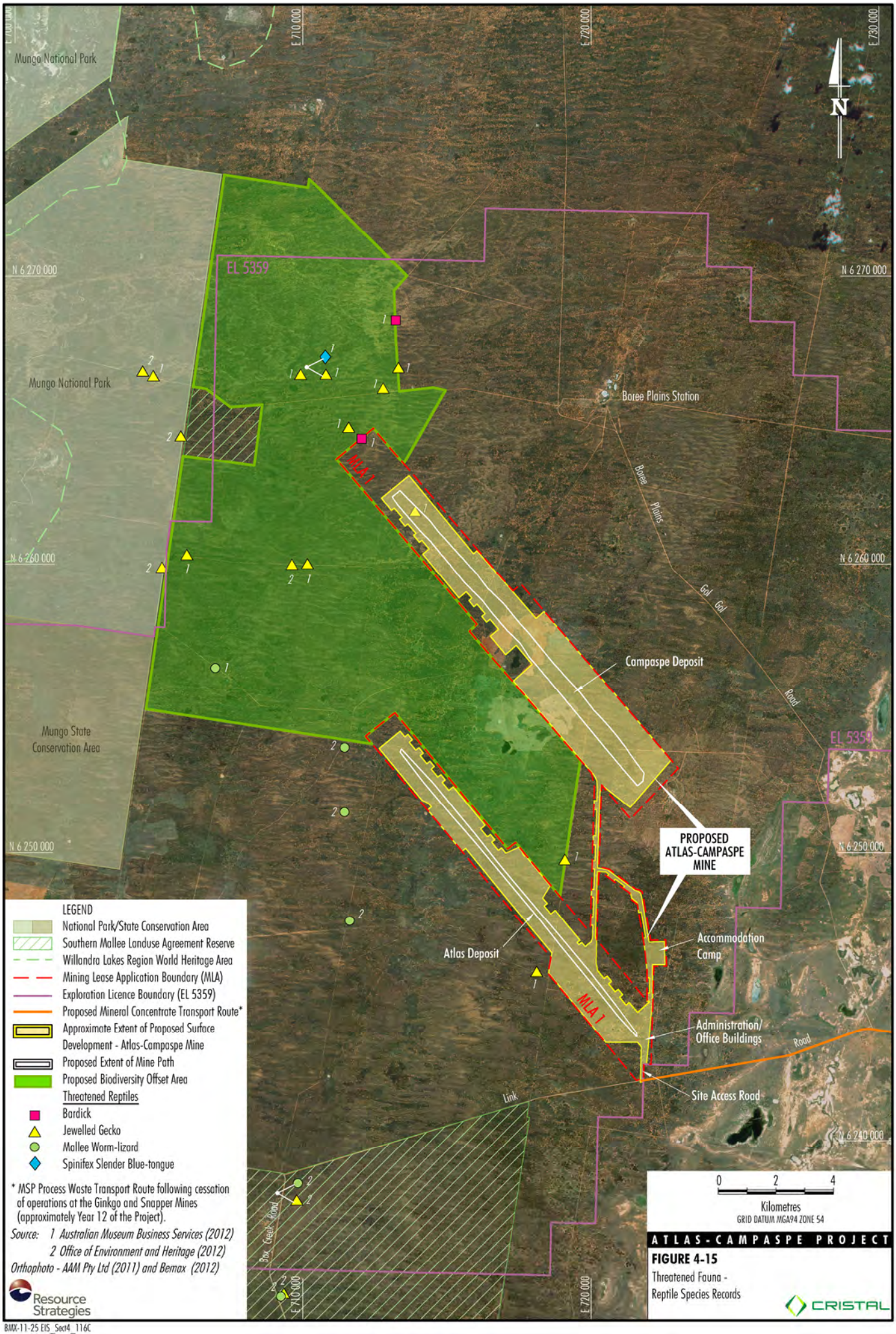

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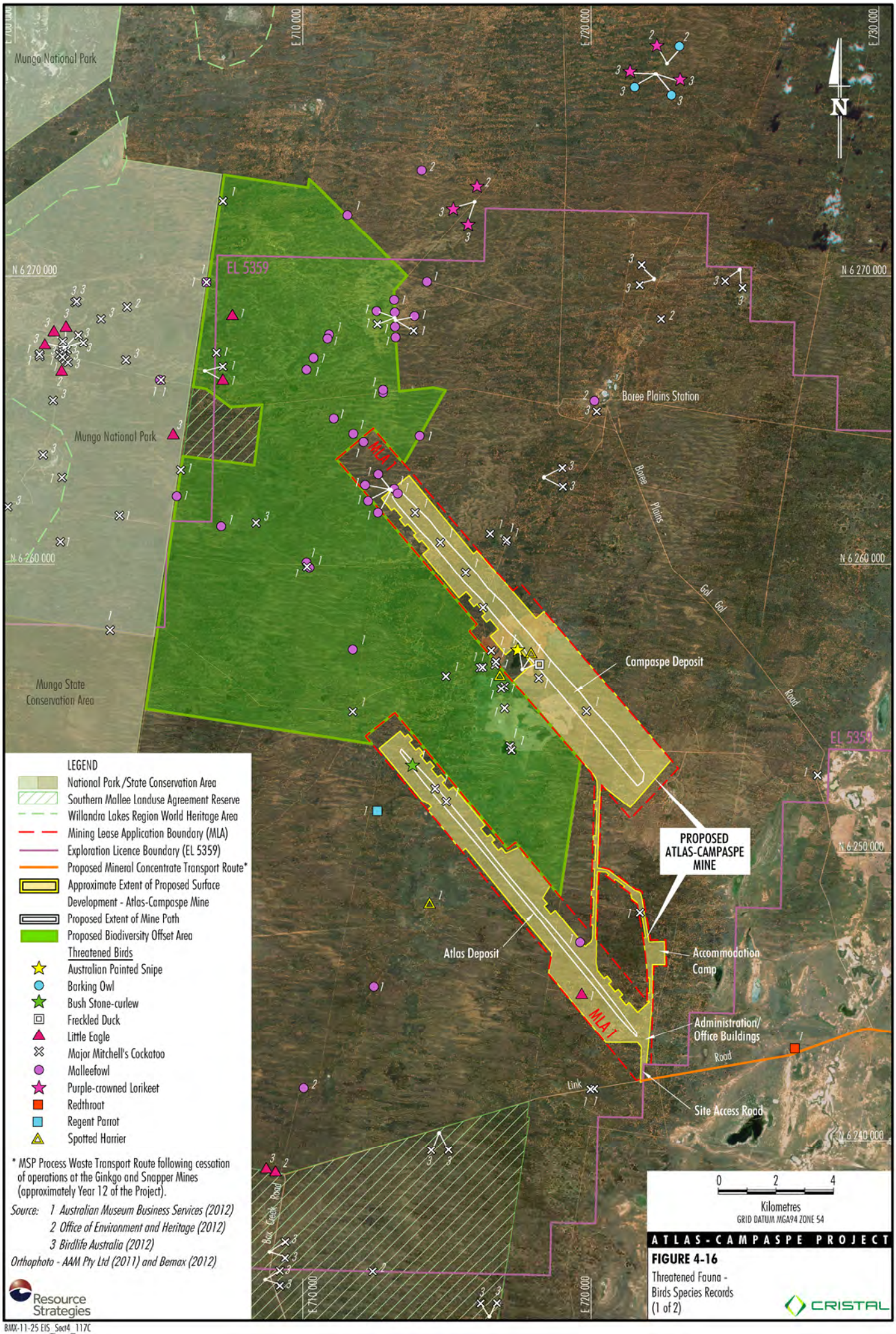

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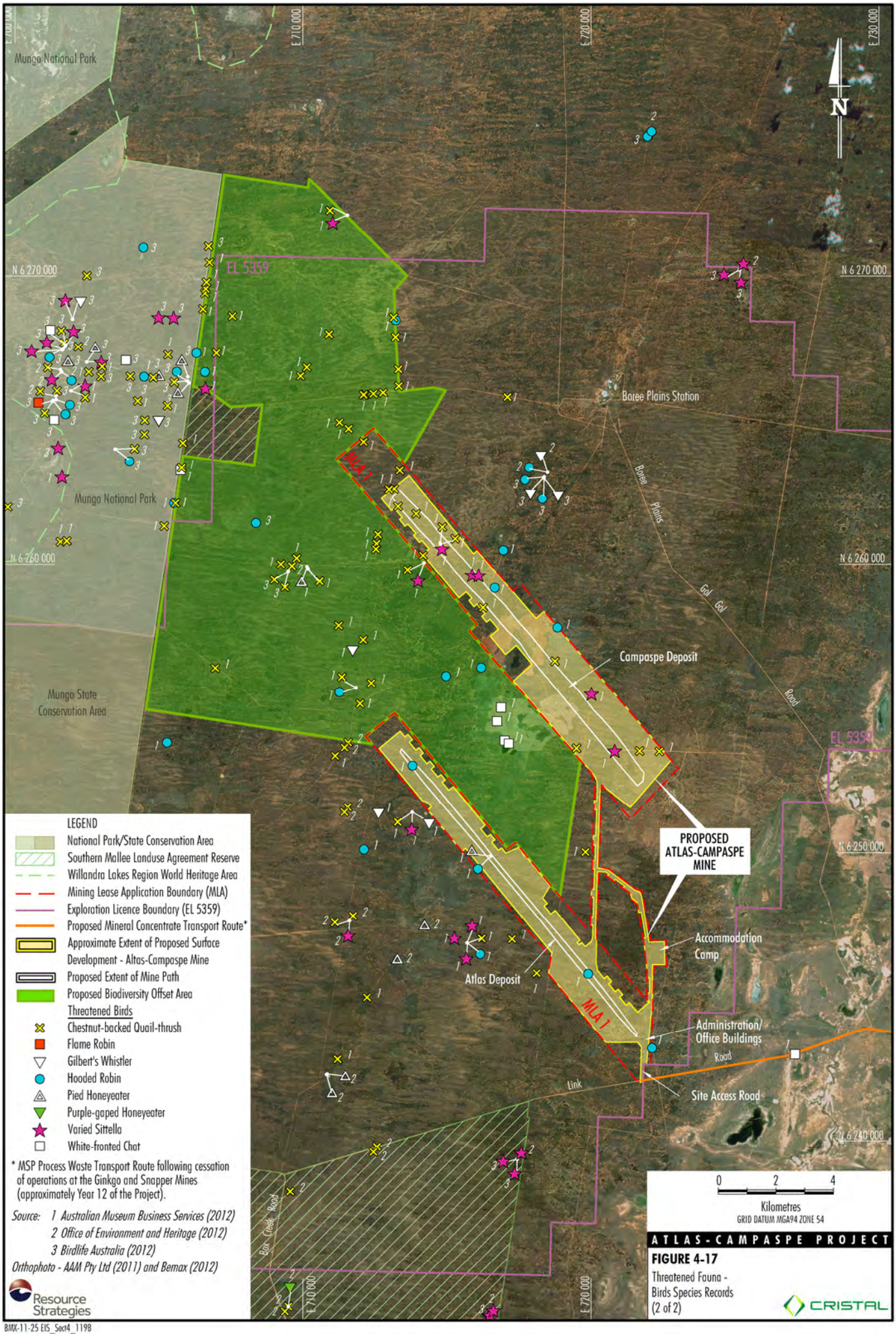

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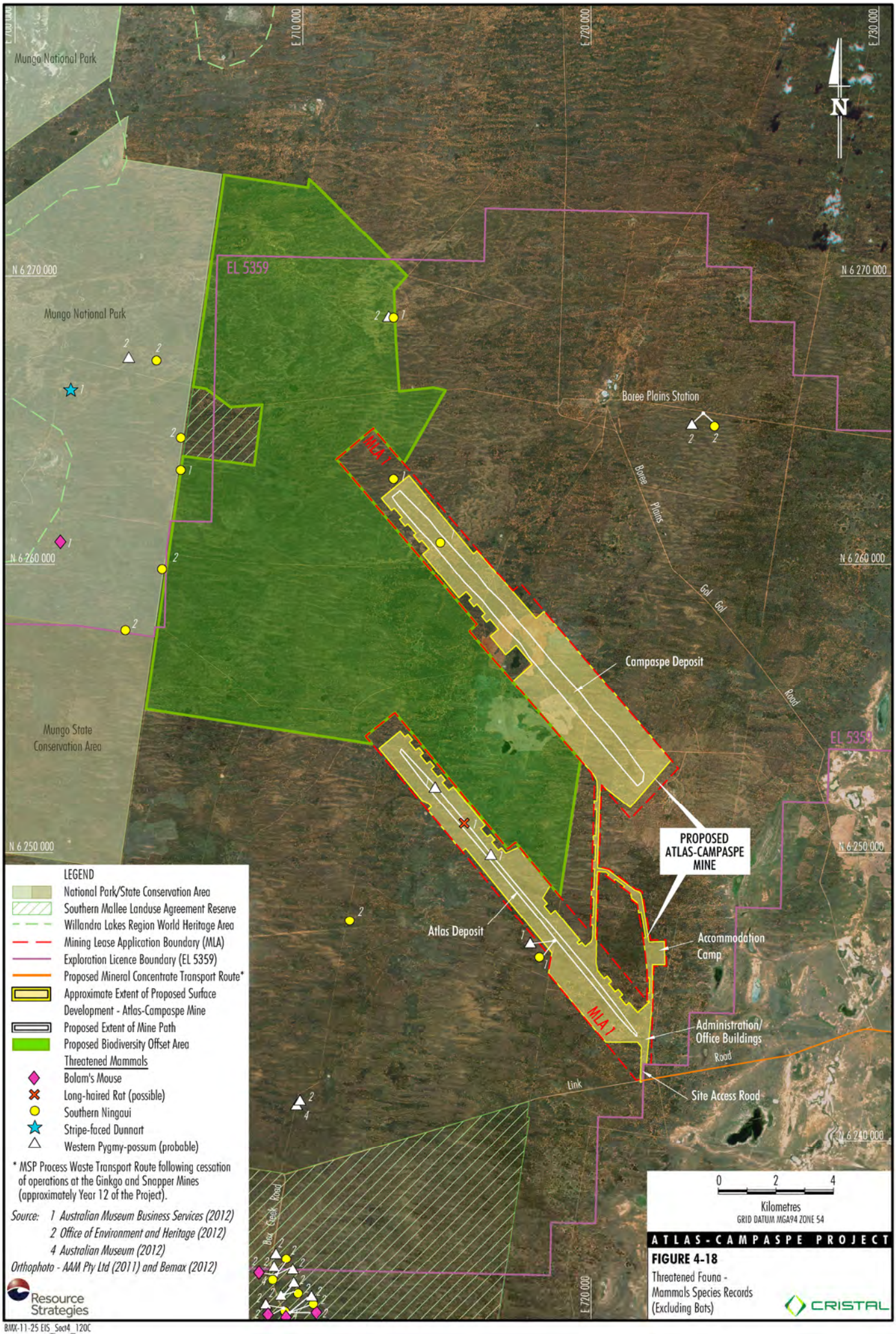

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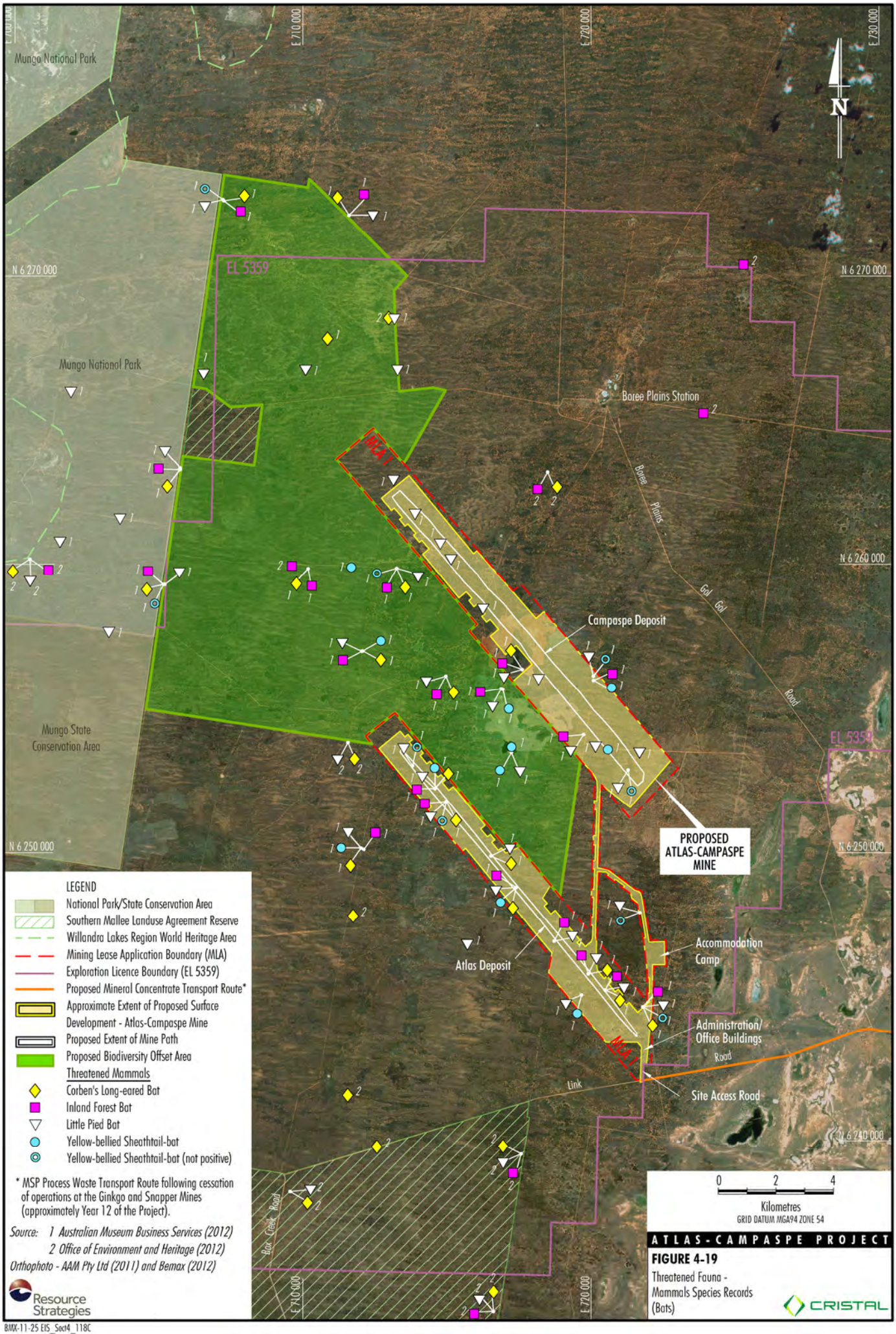

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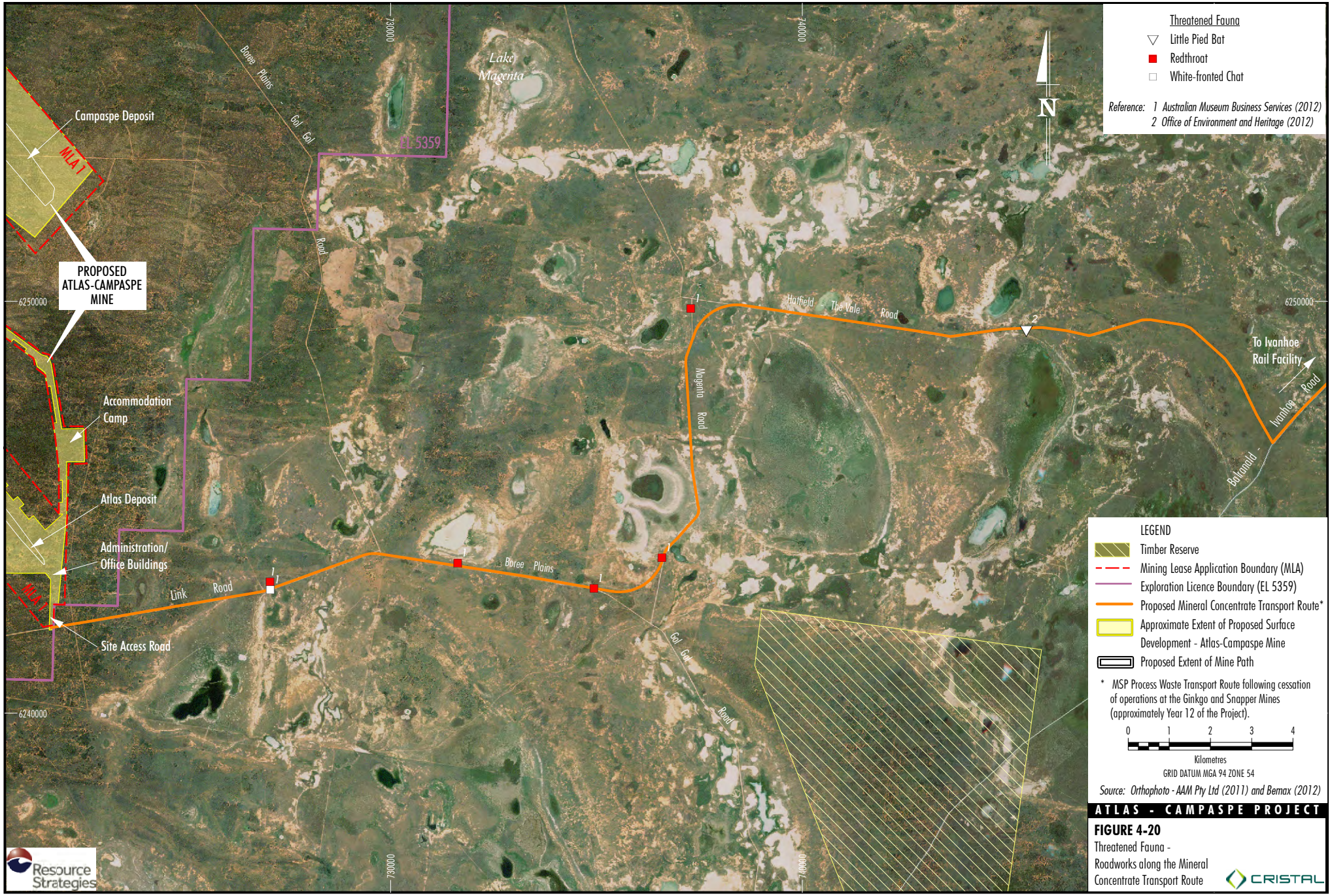

ATLAS - CAMPASPE PROJECT

FIGURE 4-20

Threatened Fauna - Roadworks along the Mineral Concentrate Transport Route

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The Sandhill Pine Woodland EEC does not occur within the proposed biodiversity offset area. However, as described within Section 4.6.1, the Sandhill Pine Woodland EEC occurs in small patches along parts of Link Road, Boree Plains-Gol Gol Road and Hatfield-The Vale Road. All remnants of Sandhill Pine Woodland EEC in the study area are in very poor condition, being heavily grazed and possibly logged in the past.

The University of Ballarat (through Emeritus Professor Martin Westbrooke) is proposing an ARC Linkage Project to investigate the regeneration of native pines (*Callitris* sp.) by evaluating conditions under which localised regeneration has occurred. This information would inform future management that will promote regeneration of native pines (*Callitris* sp.). The proposed ARC Linkage Project is relevant to the Project given the species, White Cypress Pine (*Callitris glaucophylla*), is present along the mineral concentrate transport route as a component of the Sandhill Pine Woodland EEC.

Cristal Mining has committed to providing financial and in-kind support to the University of Ballarat for the ARC Linkage Project over 2 years. The in-kind support would be provided through provision of data, on-site accommodation and involvement of Cristal Mining personnel.

Ecological Gains

Ecological gains from the proposed biodiversity offset area are listed below (Appendices A and B):

- Similar vegetation communities/fauna habitats to the Atlas-Campaspe Mine area, would be conserved/enhanced in the proposed biodiversity offset area.
- The proposed biodiversity offset area is suitably located to benefit flora and fauna populations (biodiversity values) potentially impacted by the Project.
- The proposed biodiversity offset area removes a substantial area of native vegetation from the deleterious effects of livestock grazing thereby allowing it to recover and improve over time.
- The proposed biodiversity offset area is located adjacent to Mungo National Park and a Southern Mallee Landuse Agreement Reserve and complements the existing reserve system (Figure 4-13).
- Substantial areas of *Acacia melvillei* Shrubland EEC (approximately 390 ha) occur within the proposed biodiversity offset area (Figure 4-11).
- Two threatened flora species are present in the proposed biodiversity offset area (Winged Peppercress and Cobar Greenhood Orchid) (Figure 4-11).
- A total of 20 threatened species are known to inhabit the proposed biodiversity offset area including the Jewelled Gecko, Malleefowl, Little Eagle, Major Mitchell's Cockatoo, Pied Honeyeater, White-fronted Chat, Hooded Robin, Chestnut-backed Quail-thrush, Varied Sitella, Southern Ningaui, Yellow-bellied Sheathtailed-bat, Corben's Long-eared Bat, Inland Forest Bat and Little Pied Bat (Figures 4-15 to 4-20).
- There is capacity for the ecological function of the vegetation in the proposed biodiversity offset area to significantly improve with the removal of grazing by livestock and goats, control of feral animals such as rabbits and closure of artificial watering points (Figure 4-14).

The proposed biodiversity offset area is therefore considered to be a suitable offset against the residual flora and fauna impacts associated with the Project (Appendices A and B).

Security of the Biodiversity Offset Area

An arrangement would be made for the enduring protection and management of the proposed biodiversity offset area within 12 months of grant of Development Consent. A voluntary conservation agreement pursuant to section 69B of the NSW *National Parks and Wildlife Act, 1974,* Change of Lease Purpose, or similar arrangement is proposed, which may include an agreement with the NSW Government to add the proposed biodiversity offset area to the adjoining Mungo National Park.

The proposed biodiversity offset area is located within EL 5359 held by Cristal Mining. No mining exploration would occur within the proposed biodiversity offset area.

Management of the Proposed Biodiversity Offset Area

A Biodiversity Management Plan would be prepared by suitably qualified persons that describes the management of the proposed biodiversity offset area. The Biodiversity Management Plan would be prepared within 12 months of grant of Development Consent to facilitate its management.

Based on the findings of the detailed flora and fauna surveys of the proposed biodiversity offset area, a number of management measures are proposed to enhance its flora and fauna values. These measures are outlined in Table 4-7.

Monitoring of the Proposed Biodiversity Offset Area

A programme would be undertaken to monitor and report on the effectiveness of the management measures for the proposed biodiversity offset area, with summary reporting to be carried out annually and comprehensive reporting following the independent audit of the proposed biodiversity offset area. The monitoring would be undertaken by suitably qualified persons.

Targeted terrestrial fauna surveys would also be conducted every 3 years to monitor the use of the proposed biodiversity offset area by vertebrate fauna.

Independent Audits of the Proposed Biodiversity Offset Area

The proposed biodiversity offset area would be independently audited at intervals agreed with relevant authorities. The audits would be conducted by suitably qualified persons to:

- assess compliance with the Biodiversity Management Plan;
- assess the performance of the proposed biodiversity offset area;
- review the adequacy of the management measures and monitoring programme; and
- recommend actions or measures to improve the performance of the proposed biodiversity offset area or monitoring programme, if required.

Biodiversity Offset Principles Reconciliation

Table 4-8 provides a reconciliation of the biodiversity offset strategy against *Principles for the Use of Biodiversity Offsets in NSW* (OEH, 2011b) (OEH Offset Principles).

Table 4-7
Management of the Proposed Biodiversity Offset Area

Aspect	Description
Removal of Livestock Grazing	Livestock would be removed and excluded from the proposed biodiversity offset area through the provision of appropriate stock fencing.
Closure of Artificial Watering Points	Artificial watering points would be fenced to prevent access from feral animals.
Control of Feral Animals	Feral animals (goats and rabbits) would be controlled and monitored by an appropriately qualified contractor using standard methods.
Control of Weeds	Weeds (including declared noxious weeds) would be controlled and monitored by an appropriately qualified contractor using standard methods.
Bushfire Management	Bushfire prevention measures would be detailed in the Biodiversity Management Plan. For example, fire breaks would be constructed and maintained around the perimeter of the proposed biodiversity offset area.
Revegetation of Cleared Land	Cleared land within the proposed biodiversity offset area would be allowed to naturally regenerate through the cessation of cultivation and the removal of grazing by livestock. Should the native vegetation not regenerate naturally, the cleared land would be actively managed to promote revegetation. This would include the planting or seeding of flora species represented in the surrounding vegetation communities (e.g. *Acacia melvillei* Shrubland EEC).
Threatened Flora Species	The Biodiversity Management Plan would include management strategies for threatened flora (e.g. restoration of *Acacia melvillei* Shrubland EEC).
Restriction of Entry	All mine personnel would be restricted from entering the proposed biodiversity offset area, unless authorised.

Source: After Appendices A and B.

Table 4-8
Reconciliation of the Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2011b)	Description of How the Biodiversity Offset Addresses the OEH Offset Principles
Impacts must be avoided first by using prevention and mitigation measures.	Measures to avoid and mitigate Project impacts on flora and fauna are described in Sections 4.6.3 and 4.7.3, respectively. The proposed biodiversity offset area is proposed to address residual impacts.
All regulatory requirements must be met.	Cristal Mining is required to meet all statutory requirements. The proposed biodiversity offset area is not proposed to substitute other licence/approval requirements.
Offsets must never reward ongoing poor performance.	The proposed biodiversity offset area is proposed to address residual impacts associated with the Project only.
Offsets will complement other government programs.	The biodiversity offset strategy complements the current reserve system in NSW by providing long-term security and management of a significant area of vegetation/habitat adjoining Mungo National Park. An arrangement would be made for the enduring protection and management of the proposed biodiversity offset area within 12 months of grant of Development Consent. A voluntary conservation agreement pursuant to section 69B of the *National Parks and Wildlife Act, 1974,* Change of Lease Purpose, or similar arrangement is proposed, which may include an agreement with the NSW Government to add the proposed biodiversity offset area to the adjoining Mungo National Park.
Offsets must be underpinned by sound ecological principles.	The proposed biodiversity offset area is underpinned by sound ecological principles such as: • consideration of structure, function and compositional elements of biodiversity, including threatened species through flora and fauna surveys (Appendices A and B); • enhancing biodiversity at a range of scales through a number of proposed management measures; and • measures to protect the long-term viability and functionality of biodiversity (e.g. enhancing the existing habitat as well as securing and managing the land for conservation purposes).
Offsets should aim to result in a net improvement in biodiversity over time.	A net improvement in biodiversity is likely because: • the proposed biodiversity offset area (16,540 ha) would be conserved in perpetuity; • the proposed biodiversity offset area contains a similar vegetation communities/fauna habitats to those that would be impacted; • approximately 270 ha of cleared land would be regenerated; and • measures to monitor and independently audit the proposed biodiversity offset area are provided.
Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs.	An arrangement would be made for the enduring protection and management of the proposed biodiversity offset area within 12 months of grant of Development Consent. A voluntary conservation agreement pursuant to section 69B of the *National Parks and Wildlife Act, 1974,* or similar arrangement, would be sought. Separately, Cristal Mining would seek an agreement with the NSW Government to add to the proposed biodiversity offset area to the adjoining Mungo National Park.
Offsets should be agreed prior to the impact occurring.	The proposed biodiversity offset area is proposed as part of the Project. The establishment of the proposed biodiversity offset area is likely to be a condition of the Development Consent.
Offsets must be quantifiable - the impacts and benefits must be reliably estimated.	The flora and fauna in both the proposed disturbance area and proposed biodiversity offset area has been extensively surveyed by Australian Museum Business Services (Appendices A and B). Appendices A and B provide an assessment of both including: • area of the biodiversity offsets and area of impact; • communities/species present and their conservation status; • connectivity and condition of habitat; and • management actions and security for the proposed biodiversity offset area.
Offsets must be targeted.	The proposed biodiversity offset area has been targeted to offset impacts on the basis of a like-for-like or better conservation outcome. The proposed biodiversity offset area represents ecological communities with a high conservation status. In addition, the proposed biodiversity offset area contains habitat with a high conservation status as demonstrated by the presence of numerous threatened fauna species in the proposed biodiversity offset area (Section 4.7.1).

Table 4-8 (Continued)
Reconciliation of the Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2011b)	Description of How the Biodiversity Offset Addresses the OEH Offset Principles
Offsets must be located appropriately.	The proposed biodiversity offset area is located adjacent to the Atlas-Campaspe Mine and therefore has a greater chance of maintaining and improving the biodiversity that would be impacted.
Offsets must be supplementary.	The implementation of the offset strategy is beyond existing requirements, in that the proposed biodiversity offset area is not subject to an existing conservation agreement and prior to acquisition was subject to active clearing and grazing.
Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.	Measures to monitor and independently audit the proposed biodiversity offset area are provided. The establishment of the proposed biodiversity offset area is likely to be a condition of Development Consent.

Source: Appendices A and B.

4.7 FAUNA

A Fauna Assessment has been prepared for the Project by Australian Museum Business Services (2013b) and is presented in Appendix B. The Fauna Assessment was prepared in accordance with the DGRs for the Project.

A reconciliation of the biodiversity offset strategy against the Commonwealth offset requirements is provided in Appendix C.

A description of the existing environment relating to terrestrial fauna is provided in Section 4.7.1. Section 4.7.2 describes the potential impacts of the Project, Section 4.7.3 outlines mitigation measures, management and monitoring and Section 4.7.4 describes aspects of the Project biodiversity offset strategy relevant to terrestrial fauna.

A separate document that describes how the EIS addresses the requirements of the EPBC Act is provided in Appendix C.

4.7.1 Existing Environment

Regional and Local Setting

As described in Section 4.6.1, the Atlas-Campaspe Mine is located within the Lower Murray-Darling CMA while the Ivanhoe Rail Facility is located within the Lachlan CMA. Both the Atlas-Campaspe Mine and the Ivanhoe Rail Facility are located within the Murray-Darling Depression Biogeographic Region (Thackway and Cresswell, 1995; SEWPaC, 2012a).

Fauna Surveys

Fauna surveys of the Atlas-Campaspe Mine (including the Atlas-Campaspe Mine footprint and mineral concentrate transport route roadworks footprint) and proposed biodiversity offset area were undertaken by Australian Museum Business Services between May 2011 and May 2012. The surveys were conducted over multiple seasons in consideration of the relevant State and Commonwealth guidelines.

The survey techniques included: Elliot A trapping, pitfall trapping, funnel traps, harp trapping, remote cameras, bat call recording, hair tubes, spotlighting, herpetological searches, bird census, call playback, Malleefowl transects, waterbird survey, reptile searches, ANABATs and searches for scats and tracks (Appendix B).

Two years prior to this assessment (i.e. 2010 and 2011), the region received approximately double the annual average rainfall (Section 4.2.1). This resulted in ideal conditions during the surveys.

Targeted searches for potentially occurring threatened fauna species were conducted for the Atlas-Campaspe Mine. Potential habitat for threatened fauna species was evaluated based on the habitat requirements of threatened species which could possibly occur in the Project area.

Specific transect searches were undertaken for the Malleefowl, their tracks or their mounds (Appendix B).

The south-eastern portion of Mungo National Park was also surveyed by Australian Museum Business Services using observational techniques and hair tubes. This survey was undertaken to fill gaps in existing survey effort in the Mungo National Park and to gain a better understanding of the fauna and their habitat present in the existing reserve system for evaluation of the proposed biodiversity offset area (Appendix B).

A habitat assessment was undertaken in the Ivanhoe Rail Facility footprint and surrounds and fauna opportunistically observed were recorded. Impacts on potentially occurring threatened fauna species were assessed by Australian Museum Business Services (Appendix B).

Fauna Habitat

The broad fauna habitat types associated with the Atlas-Campaspe Mine are shown on Figure 4-14. The main habitat types across the Atlas-Campaspe Mine footprint include Belah-Rosewood Woodland and Mallee (Linear Dune Mallee and to a lesser extent Sandplain Mallee). Other habitat types are more localised, such as the Black Box Woodland and associated Ephemeral Wetland, and the shrublands (Acacia Woodland/Shrubland and Disturbed Shrubland).

Chenopod Shrubland is prevalent along the mineral concentrate transport route roadworks footprint and surrounds with water temporarily accumulating in Chenopod Shrubland Depressions after rain. Scattered occurrences of Sandhill Pine Woodland are present on sandy rises along the mineral concentrate transport route roadworks footprint and surrounds (Appendix B).

The broad fauna habitat types associated with the Ivanhoe Rail Facility are Belah-Rosewood Woodland and Native Grassland (Appendix B).

Most of the broad habitat types recorded in the Project area are locally abundant, with a number protected within Mungo National Park or the Mungo State Conservation Area (e.g. Chenopod Shrublands, Belah-Rosewood Woodland and mallee communities). Acacia Woodland/Shrubland, Sandhill Pine Woodland and Black Box Woodland are less well represented in the landscape.

Two of the broad habitat types contain EEC's, namely, Sandhill Pine Woodland, which is the Sandhill Pine Woodland EEC, and parts of the Acacia Woodland/Shrubland are the *Acacia melvillei* Shrubland EEC (Appendix B).

Fauna Species Composition

A total of 228 vertebrate fauna species were recorded by Australian Museum Business Services in the Atlas-Campaspe Mine area, mineral concentrate transport route roadworks footprint and surrounds (comprising of three amphibians, 43 reptiles, 146 birds and 36 mammals) and nine introduced species (Appendix B).

Introduced Fauna Species

Nine introduced species were recorded in the Atlas-Campaspe Mine area and surrounds. These species include the House Mouse (*Mus musculus*), feral dog/Dingo (*Canis lupus familiaris*), European red fox (*Vulpes vulpes*), feral cat (*Felis catus*), Brown Hare (*Lepus capensis*), European rabbit, European cattle (*Bos taurus*), feral goat and sheep. European cattle and sheep are present as part of low intensity grazing at the Atlas-Campaspe Mine, while feral goats are opportunistically harvested at the Ivanhoe Rail Facility (Section 4.3.1).

Threatened Fauna Species under the TSC Act

Sixteen threatened fauna species listed under the TSC Act have been recorded in the Project area (Figures 4-15 to 4-20) (Appendix B). These comprise of:

- one reptile (i.e. the Jewelled Gecko);
- ten birds:
  - Malleefowl;
  - Little Eagle;
  - Bush Stone-curlew;
  - Major Mitchell's Cockatoo;
  - Redthroat;
  - Pied Honeyeater;
  - White-fronted Chat;
  - Hooded Robin;
  - Chestnut-backed Quail-thrush; and
  - Varied Sittella;
- one marsupial mouse/dasyurid (i.e. the Southern Ningaui);
- four bats:
  - Yellow-bellied Sheathtailed-bat;
  - South-eastern Long-eared Bat (also known as the Corben's Long-eared Bat);
  - Inland Forest Bat; and
  - Little Pied Bat.

All of these species were also recorded outside the Atlas-Campaspe Mine footprint during the surveys by Australian Museum Business Services, with the exception of the Bush Stone-curlew. The Bush Stone-curlew that was recorded from within the footprint was recorded via call identification on a single occasion. Potential habitat for this species is present in the locality (Appendix B).

In addition to the species listed above, secondary evidence (hair samples found in a scat and a nest) probably belonging to a Western Pygmy-possum and a hair sample possibly belonging to a Long-haired Rat (*Rattus villosissimus*) were also recorded in the Atlas mine path footprint. These species have been previously recorded in the surrounding area and potential habitat for these species is present in the locality (Appendix B).

Ten additional threatened fauna species listed under the TSC Act were recorded in the vicinity of the Atlas-Campaspe Mine during the field surveys (Figures 4-15 to 4-20). These included: Bardick, Mallee Worm-lizard, Spinifex Slender Blue-tongue, Freckled Duck (*Stictonetta naevosa*), Spotted Harrier, Australian Painted Snipe (*Rostratula australis*), Regent Parrot (eastern subspecies) (*Polytelis anthopeplus monarchoides*), Gilbert's Whistler, Stripe-faced Dunnart (*Sminthopsis macroura*) and Bolam's Mouse (*Pseudomys bolami*) (Appendix B). These species may also potentially occur in the Atlas-Campaspe Mine footprint given the proximity of the records and occurrence of similar potential habitat.

Threatened Fauna Species under the EPBC Act

Two threatened fauna species recorded in the Atlas-Campaspe Mine footprint and surrounds are also listed under the EPBC Act, namely, the Malleefowl and South-eastern Long-eared Bat (also known as Corben's Long-eared Bat) (Figures 4-16 and 4-19).

Two other fauna species listed as threatened under the EPBC Act were recorded in the vicinity of the Atlas-Campaspe Mine but outside the Atlas-Campaspe Mine footprint, namely, the Australian Painted Snipe and the Regent Parrot (eastern subspecies) (Appendix B).

Threatened fauna species under the EPBC Act are discussed further in Appendices B and C.

Migratory Species

Three migratory species listed under the EPBC Act have been recorded at the Atlas-Campaspe Mine and surrounds, namely, the Australian Painted Snipe, Malleefowl and Rainbow Bee-eater (*Merops ornatus*) (Appendices B and C).

Aquatic Species and Communities

There are no fauna species or communities listed under the *Fisheries Management Act, 1999* that are relevant to the Project (Appendix B).

Groundwater Dependent Fauna

Stygofauna are aquatic subterranean invertebrate animals found in some groundwater systems. The groundwater table in the region (ranging from 10 to 30 m below ground level) is associated with the underlying saline groundwater systems and generally sits within the Shepparton Formation or underlying Loxton-Parilla Sands (Appendix F). This groundwater system could provide habitat for stygofauna.

Lowering of the groundwater table could impact stygofauna if they were to occur in the groundwater system. The Project would result in localised groundwater drawdown in the deep underlying saline groundwater aquifer, however, this system is extensive in the Project area and surrounds and is likely to provide continuous habitat for stygofauna if present (i.e. stygofauna species that potentially occur within the Project area are also likely to occur in the surrounds).

4.7.2 Potential Impacts

Fauna Habitat Removal and Modification

The Project would require the progressive clearance of approximately 4,463 ha of mostly native vegetation over approximately 20 years (Table 4-9).

Table 4-9
Fauna Habitat Types Proposed to be Cleared for the Project

Broad Fauna Habitat Type	Area (ha)
Belah-Rosewood Woodland[1]	2,045
Linear Dune Mallee	1,040
Sandplain Mallee	535
Cleared Land	305
Acacia Woodland/Shrubland[2]	200
Disturbed Shrubland	170
Chenopod Shrubland[3]	80
Black Box Woodland	50
Chenopod Shrubland Depression	5
Sandhill Pine Woodland	3
Native Grassland	30
Total	**4,463**

Source: After Appendix B.

1 The Belah-Rosewood Woodland habitat type is equivalent to the Belah-Rosewood Woodland and Belah-Rosewood/Acacia Woodland vegetation communities.

2 The Acacia Woodland/Shrubland is equivalent to the Yarran Shrubland and Mulga Woodland vegetation communities.

3 The Chenopod Shrubland habitat type is equivalent to the Bluebush Shrubland, Saltbush Shrubland and Scalded Chenopod Shrubland vegetation communities.

The total Project clearance area includes native vegetation required to be removed for all of the various components of the Project (including within the Atlas-Campaspe Mine footprint, mineral concentrate transport route roadworks footprint and at the Ivanhoe Rail Facility footprint). The vegetation clearance for the Project equates to the clearance of the following broad fauna habitat types within the Atlas-Campaspe Mine footprint (Figure 4-14 and Appendix B).

The Project has the potential to cause mortality of some animals as a result of direct encounters with construction and development works and vehicle movements or through removal of habitat during clearing (Appendix B).

Loss of hollow-bearing trees is a key threatening processes listed under the TSC Act. A range of hollow-nesting birds, bats and arboreal mammals were recorded within the Project area, including cockatoos, parrots, possums and microbats. Threatened fauna species that nest or roost in tree hollows were recorded in the Project area (not necessarily using tree hollows) such as the Major Mitchell's Cockatoo, Western Pygmy-possum, and four bats (Appendix B).

Removal of dead wood and dead trees is a key threatening process listed under the TSC Act. Dead trees can provide tree hollows for a range of fauna as described above. In particular, Sandplain Mallee Woodland, Linear Dune Mallee Woodland, Belah-Rosewood Woodland and Black Box Woodland habitats contain large loads of fallen wood which may provide habitat resources for fauna (e.g. lizards and nesting birds) (Appendix B).

Habitat Fragmentation/Loss of Connectivity

The Atlas-Campaspe Mine is located in a landscape of mostly contiguous native vegetation. The development of the Atlas-Campaspe Mine would reduce habitat connectivity until revegetation of the post-mine landforms. The study areas at the Atlas-Campaspe Mine do not form part of any recognised national landscape corridors (SEWPaC, 2012b) or local wildlife corridors (OEH, 2011a) (Appendix B).

Changes to Hydrology

Alteration to the terrain and diversion of surface water during the life of the mine could impact on remaining vegetation if it is dependent on surface flow, subsurface flow and pooling. After substantial rain events, surface water in the locality generally flows towards depressions in the landscape. The surface water temporarily persists in these areas before evaporating or seeping into the groundwater table creating an ephemeral wetland habitat (Appendix B). During the field surveys, water was present in these areas and a number of threatened species were recorded nearby including the Australian Painted Snipe, Freckled Duck, Major Mitchell's Cockatoo and bats (Appendix B).

Mitigation measures relating to the management of the Black Box Woodland is described in Section 4.6.3.

Use of Saline Water for Dust Control and Road Maintenance Works

The potential impacts on vegetation as a result of the use of saline water for dust control and road maintenance works is outlined in Section 4.6.2.

Fauna Interaction with the Final Void

No significant impacts are expected from fauna interacting with the final voids as the depths of the final voids would remain above the groundwater table (i.e. a permanent water body would not be formed in the void) and the embankments would be sloped so as not to entrap fauna. In addition, the final voids would be fenced (Section 5.3.2).

Introduced Fauna

Many introduced fauna pose a threat to native fauna through competition for habitat resources and direct predation. The European rabbit, feral goat, European red fox, feral cat and feral dog are known to occur in the Project area and surrounds. Each of these species relate to a key threatening process listed under the TSC Act. Measures to minimise and control introduced fauna are provided in Section 4.7.3 and Appendix B.

Introduced Flora

Introduced flora can adversely alter habitat for native fauna species. Measures to minimise and control introduced flora are provided in Section 4.6.3 and Appendix A.

Fauna and Noise, Dust and Artificial Lighting

There is a potential for increased disruption to fauna surrounding the Project due to dust, noise, and artificial lighting. Measures would be adopted to minimise dust (Section 4.10.3), noise (Section 4.12.3) and artificial lighting (Section 4.14.3).

Vehicular Traffic Movements

Vehicular traffic movements associated with the Project have the potential to increase the risk of injury and mortality of some fauna species on roads (Appendix B). Vehicular speed limits at the Atlas-Campaspe Mine site would be used to minimise these potential impacts (Section 4.7.3).

High Frequency Fire

High frequency fire resulting in the disruption of lifecycle processes in plants and animals, and a loss of vegetation structure and composition is a key threatening process listed under the TSC Act. The risk of fire is greatest in mallee woodland, whereas the Belah-Rosewood Woodland is likely to be far less flammable (Bradstock and Cohn, 2002 in Appendix B). Fire preventative measures are outlined in Section 4.6.3.

Potential Impacts on Threatened Fauna under the TSC Act

A total of 16 threatened fauna listed under the TSC Act were recorded in the Project area, however, it was conservatively considered that up to 45 threatened fauna species could be potentially affected by the Project, either through loss of known or potential habitat and/or direct loss of individuals. Fourteen of these species are considered likely to be impacted and the remaining 31 species are only considered possibly to be impacted (Appendix B).

All 45 threatened fauna species have been assessed via an Assessment of Significance under section 5A of the EP&A Act in accordance with the relevant guideline (DECC, 2007b). The assessments are detailed in Appendix B. The conclusion of the assessment is that the Project would be unlikely to significantly impact on any threatened species of fauna, with the possible exception of the following species which were considered to have the potential to be significantly impacted in the short-term due to the proposed removal of habitat:

- Malleefowl (listed as Endangered under the TSC Act and Vulnerable under the EPBC Act);
- Western Pygmy-possum (listed as Endangered under the TSC Act); and
- South-eastern Long-eared Bat (also known as Corben's Long-eared Bat) (listed as Vulnerable under the TSC Act and EPBC Act).

Despite the potential impacts to these species, the local population of the species is considered likely to persist (Appendix B). The proposed biodiversity offset area has the potential to improve the conservation of these species in the medium to long-term as described in Section 4.7.4 and Appendix B.

Potential Impacts on Threatened Fauna under the EPBC Act

Five threatened fauna species listed under the EPBC Act were assessed using the criteria in the *Significant Impact Guidelines 1.1: Matters of National Significance* (DEWHA, 2009) which included the four recorded during the surveys (i.e. Malleefowl, South-eastern Long-eared Bat [also known as the Corben's Long-eared Bat], Australian Painted Snipe, Regent Parrot [eastern subspecies] and the Australasian Bittern). As stated above, two species listed under the EPBC Act were assessed as likely to be significantly impacted by the Project, namely, the Malleefowl and the South-eastern Long-eared Bat (also known as Corben's Long-eared Bat). Threatened fauna species under the EPBC Act are discussed further in Appendices B and C.

Potential Impacts on Migratory Species

Migratory species listed under the EPBC Act were assessed using the criteria in the *Significant Impact Guidelines 1.1: Matters of National Significance* (DEWHA, 2009). It was concluded that the Project is not likely to significantly impact on any listed migratory species, with exception of the Malleefowl, which is also listed as threatened (Appendix B).

State Environmental Planning Policy No. 44 – Koala Habitat Protection

The *State Environmental Planning Policy No. 44 (Koala Habitat Protection)* (SEPP 44) applies to the Central Darling LGA in which the Ivanhoe Rail Facility is located. An assessment of potential and core Koala (*Phascolarctos cinereus*) habitat for the purposes of the SEPP 44 was undertaken for the Ivanhoe Rail Facility (Appendix B). Australian Museum Business Services concluded that the habitat would not represent core, primary or potential habitat for the species (Appendix B).

Willandra Lakes Region World Heritage Area

The values of the Willandra Lakes Region World Heritage Area which meet the World Heritage criteria are not botanical or zoological (Section 4.8.2). Nevertheless, an assessment of the fauna in the Willandra Lakes Region World Heritage Area is provided in Appendix B.

Mungo National Park and Mungo State Conservation Area

The Atlas-Campaspe Mine is not likely to have an adverse impact on the fauna of Mungo National Park or Mungo State Conservation Area (Appendix B). Measures that would be undertaken to manage and control fires, feral animals and dust are described in Sections 4.6.3, 4.7.3 and 4.10.3.

The proposed addition of the proposed biodiversity offset area to the existing conservation reserve system has the potential to result in a positive impact on the fauna in Mungo National Park (Appendix B).

Cumulative Impacts

The impacts of the Project in the context of existing and past land uses have been considered by Australian Museum Business Services in Appendix B. An assessment of the cumulative impacts of other proposed (but not yet approved) developments in the region (i.e. the Balranald Mineral Sands Project) has also been conducted (Appendix B).

A number of threatened species recorded in the Project area have also been recorded during field surveys for the Balranald Mineral Sands Project (Ecotone Ecological Consultants, 2012a, 2012b). The cumulative impacts on fauna as result of the Project and the Balranald Mineral Sands Project are expected to occur as a result of habitat clearance, habitat fragmentation and the loss of individual animals. Indirect impacts on fauna such as increases in feral animal populations and weed invasion may also occur.

Australian Museum Business Services (Appendix B) describe that the proposed impact avoidance and mitigation measures are likely to assist with mitigating the cumulative impacts of the Project. In addition, the proposed biodiversity offset area for the Project provides for the conservation and enhancement of a larger area of habitat. The Project would maintain and improve biodiversity (fauna) values in the medium to long-term (Appendix B).

4.7.3 Mitigation Measures, Management and Monitoring

Refinements to the Project Design to Minimise Land Clearance

Refinements to the Project design to minimise land clearance are described in Section 4.6.3.

Biodiversity Management Plan

As described in Section 4.6.3, a Biodiversity Management Plan would be prepared by suitably qualified persons that covers the following aspects relevant to fauna:

- land clearance strategies, in relation to fauna;
- habitat supplementation;
- management of livestock;
- management of exotic animals;
- management of artificial lighting;
- management of vehicles;
- bushfire prevention;
- awareness and education; and
- management measures for the Malleefowl.

Land Clearance Strategies

The following land clearing strategies would be adopted to minimise harm to fauna, in addition to those measures listed in Section 4.6.3:

- clearing of trees and shrubs would, where practicable, be restricted to late summer or early autumn to minimise impacts to fauna breeding during spring and summer, fauna that hibernate during winter (e.g. microbats) and to avoid the main breeding period of threatened fauna, such as the Malleefowl;
- pre-clearance fauna surveys would be undertaken by suitably trained and qualified persons;
- a suitably trained and qualified person would be present during the clearing of habitat;

- options to minimise harm to fauna by modifying clearance activities would be evaluated; and
- management of fauna may include relocating the individual to adjacent habitat or treating injuries.

A specific Threatened Species Management Protocol would be developed as a component of the Biodiversity Management Plan to reduce the potential impacts of the Project on particular threatened fauna species known or likely to occur during the clearance activities.

Habitat Supplementation

Habitat features (e.g. trunks, logs, branches, small stumps and roots) would be salvaged during vegetation clearance activities and stockpiled for relocation to nearby areas (i.e. rehabilitated areas or the proposed biodiversity offset area [Section 4.6.4]). When relocated, these features are likely to provide habitat resources for a range of invertebrate and ground dwelling fauna including the South-eastern Long-eared Bat.

A nest box programme would also be implemented on the rehabilitated mine landform. Nest boxes would aim to provide potential habitat for hollow-dependent species. Nest boxes would be placed on poles if required, to provide refuge areas in advance of vegetation re-establishment. Once installed, the nest boxes would be monitored by appropriately qualified and experienced persons to observe fauna usage. A monitoring report would be prepared annually that includes a summary of previous monitoring reports, results during the monitoring period and proposed intervention strategies, if required.

Management of Livestock

Livestock would be excluded from the MLA area during mining operations at the Atlas-Campaspe Mine.

Management of Exotic Animals

Measures to control exotic animals would be undertaken within the MLA area, including:

- trapping and/or baiting of exotic animals (e.g. feral goats, European rabbits and European red foxes); and
- follow-up site monitoring to determine the effectiveness of trapping and/or baiting programmes.

Existing artificial watering points may be used as a means to trap exotic animals (e.g. goats).

Measures to control exotic animals would be implemented by appropriately qualified persons. A report would be prepared annually that includes a summary of previous monitoring and control efforts, results during the monitoring period and proposed intervention strategies, if required.

Management of Artificial Lighting

Potential artificial lighting impacts on fauna would be minimised by directing lighting toward operational areas and the accommodation camp at the Atlas-Campaspe Mine site where required and away from surrounding habitat. Further discussion of lighting management is provided in Section 4.14.3.

Management of Vehicles

The following measures would be applied to reduce the occurrence of fauna-vehicle collisions during the life of the Project:

- vehicles would remain on haul roads and internal roads, where practicable;
- the staff and contractor induction would include the hazards of driving at dusk and dawn, when road strike of nocturnally active fauna is most likely;
- installing road signs that increase awareness of fauna vehicle strike; and
- 50 km speed limits at the Atlas-Campaspe Mine site would be applied and enforced.

Bushfire Prevention

Bushfire preventative measures are outlined in Section 4.6.3.

Awareness and Education

Awareness and education measures are outlined in Section 4.6.3.

Management Measures for the Malleefowl

Pre-clearance surveys would be undertaken for active Malleefowl mounds in advance of areas to be cleared. If active mounds are found, the eggs would be allowed to hatch and the chicks move away from the nest prior to habitat clearance (where practicable). As previously described, a Threatened Species Management Protocol would be developed as a component of the Biodiversity Management Plan. This protocol would provide a procedure for minimising impacts on active Malleefowl mounds (e.g. timing habitat clearance to minimise impacts).

Detailed surveys revealed only two mounds within the proposed surface disturbance area and are avoided by the proposed mine general arrangement.

There are a number of other measures consistent with the *National Recovery Plan for Malleefowl* (Department for Environment and Heritage, 2007) that would be adopted by the Project. These include: management of livestock; management of exotic animals; management of vehicles; bushfire prevention (Section 4.7.3); as well as the protection of habitat in the biodiversity offset strategy (Section 4.6.4).

Proposed Rehabilitation Management Plan

Progressive rehabilitation and revegetation of the Project area is described in Section 5. Habitat supplementation on the post-mine landform is described above.

A key rehabilitation objective for the Project would be to selectively place clay materials in low-lying portions of the re-profiled landform within the mine path to reinstate the water holding capacity of, and run-on to adjacent depressions. This would provide for the potential for species representative of Black Box Woodlands, e.g. *Eucalyptus largiflorens*, to establish. Following the re-establishment of the depression and run-on to it, and the establishment of these species, these depressions would provide potential habitat for the Australian Painted Snipe and South-eastern Long-eared Bat.

The rehabilitated post mine landforms would contain habitat features suitable for the Malleefowl and Regent Parrot including the establishment of species representative of Linear Dune Mallee and Sandplain Mallee such as *Eucalyptus socialis, E. Dumosa* and *Callitris* sp.

4.7.4 Biodiversity Offset Strategy

As described in Section 4.6.4, the DGRs for the Project (Section 1.2 and Attachment 1) state that the EIS must include a description of the measures that would be implemented to offset the potential impacts of the Project. The proposed biodiversity offset area is described in Section 4.6.4 and in Appendices A and B. In summary, the proposed biodiversity offset area has the following values relating to fauna:

- Similar fauna habitats to the Project area would be conserved/enhanced in the proposed biodiversity offset area (Figure 4-14).
- The proposed biodiversity offset area is suitably located to benefit flora and fauna populations (biodiversity values) potentially impacted by the Project.
- The proposed biodiversity offset area removes a substantial area of native vegetation from the deleterious effects of livestock grazing thereby allowing it to recover and improve over time.
- The proposed biodiversity offset area is located adjacent to Mungo National Park and a Southern Mallee Landuse Agreement Reserve and complements the existing reserve system (Figure 4-13).
- A total of 20 threatened species are known to inhabit the proposed biodiversity offset area including the Jewelled Gecko, Malleefowl, Little Eagle, Major Mitchell's Cockatoo, Pied Honeyeater, White-fronted Chat, Hooded Robin, Chestnut-backed Quail-thrush, Varied Sitella, Southern Ningaui, Yellow-bellied Sheathtailed-bat, Corben's Long-eared Bat, Inland Forest Bat and Little Pied Bat which have all been recorded in the Project area (Figures 4-15 to 4-20).

The biodiversity offset area also provides potential habitat for other threatened fauna species, including the Bush Stone-curlew, Freckled Duck, Blue-billed Duck (*Oxyura australis*), Australasian Bittern (*Botaurus poiciloptilus*), Grey Falcon (*Falco hypoleucos*), Square-tailed Kite (*Lophoictinia isura*), Black-breasted Buzzard (*Hamirostra melanosternon*), Purple-crowned Lorikeet, Regent Parrot, Shy Heathwren (*Hylacola cautus*)and Purple-gaped Honeyeater (*Lichenostomus cratitius*) (Appendix B).

4.8 ABORIGINAL HERITAGE

An Aboriginal Cultural Heritage Assessment was undertaken for the Project by Niche Environment and Heritage (2012) and is presented in Appendix E.

The Project Aboriginal Cultural Heritage Assessment has been undertaken in accordance with the following guidelines:

- *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010a);
- *Aboriginal Cultural Heritage: Standards and Guidelines Kit* (NPWS, 1997);

- *Ask First: A Guide to Respecting Indigenous Heritage Places and Values* (Australian Heritage Commission, 2002);
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW, 2010b);
- *Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation* (DEC, 2005b);
- *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011c);
- *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects* (NSW Minerals Council, 2010); and
- The Australian International Council on Monuments and Sites (ICOMOS) *Burra Charter* (Australia ICOMOS, 1999).

A description of Aboriginal heritage (including cultural and archaeological) in the vicinity of the Project is provided in Section 4.8.1. Section 4.8.2 describes the potential impacts of the Project and Section 4.8.3 outlines mitigation measures, management and monitoring.

4.8.1 Existing Environment

Aboriginal History

Aboriginal occupation of the region dates back to 50,000 years (Hiscock, 2008). Some of the oldest evidence of Aboriginal occupation comes from the Willandra Lakes Region World Heritage Area, located approximately 10 km to the west of the Project area. Stone artefacts found at Lake Mungo within the Willandra Lakes Region World Heritage Area have been dated to between 46,000 and 50,000 years old. The burials of a male and female at Lake Mungo are 42,000 years old (Olley *et al*., 2006).

At the time of early European exploration, the region was occupied by the Aboriginal people of the Barkandji (Paakantji), Mutthi Mutthi and Ngiyampaa language groups (Sturt, 1833; Mitchell, 1838; Allen, 1974; Landskape, 2011). The language groups were closely related and shared many similarities in material culture, social practices and burial practices (Martin, 1999).

The Barkandji (Paakantji), Mutthi Mutthi and Ngiyampaa were hunter-fisher-gathers and appear to have had a semi-sedentary lifestyle. Early accounts by European observers suggest that they lived near more permanent water sources such as Darling, Lachlan and Murray Rivers and moved into the hinterland seasonally depending on the availability of resources (Allan, 1974).

Post contact, many Aboriginal people worked on pastoral stations in the area. Three Aboriginal reserves were also established in the Balranald region (Appendix E).

Natural Resources

Changing climatic conditions would have affected the availability of water, plant and animal resources in the Project area and may have influenced the way Aboriginal people moved through the landscape (Appendix E).

Rivers and relic lake systems, such as those in the Willandra Lakes Region World Heritage Area and adjacent to the proposed mineral concentrate transport route would have offered permanent sources of water for Aboriginal people. These areas would have also contained an abundance of plant and animal resources including mussels, yabbies, fish, birds and variety of mammals. Aboriginal occupation in the region would have focused around these areas (Appendix E).

The surrounding sandplains and dunefields on which the Atlas-Campaspe Mine is located would have been intermittently used by Aboriginal people (Appendix E). These areas contain a variety of plant and animal resources that would have been exploited by Aboriginal people. The presence of water in these areas is ephemeral and would have been restricted to small low-lying depressions that retained surface water following rain.

Sections 4.6 and 4.7 and Appendices A and B provide information on the flora and fauna of the Project area and surrounds.

Previous Archaeological Investigations

No Aboriginal cultural heritage surveys or assessments have been previously undertaken in the Project area. A preliminary desktop cultural heritage assessment of the Atlas-Campaspe Mine area was undertaken by Landskape (2011).

A number of Aboriginal cultural heritage surveys and assessments have been undertaken in the wider region, including:

- Edmonds (2002) *Indigenous Heritage Assessment Paxtons Mine North of Balranald Western NSW*;
- Edmonds (2003) *Salvage Collection, Excavation and Further Survey: Paxtons Mine Track North of Balranald*;
- Landskape (2007) *Snapper Mineral Sands Project Cultural Heritage Assessment*;
- Martin (1999) *Aboriginal Sites of Significance in the Western Division of NSW: A Planning Study*;
- Pardoe (2003) *The Menindee Lakes: A Regional Archaeology*; and
- Witter (1999) *Gingko Mineral Sands Project Archaeological and Aboriginal Heritage Assessment*.

In addition to the above, numerous Aboriginal heritage surveys and assessments have been undertaken in Mungo National Park and the Willandra Lakes Region World Heritage Area including: Bowler *et al*. (1970); Clarke (1979); and Johnston and Clarke (1998).

A search of the Aboriginal Heritage Information Management System (AHIMS) database identified that there were no previously recorded Aboriginal heritage sites within the Project area. A total of 101 sites have been recorded in the surrounding area, mostly within Mungo National Park and the Willandra Lakes Region World Heritage Area.

The existing information discussed above provided a regional context for the Project area and assisted in developing a model of the likely archaeological and cultural significance of the Project area.

Cultural Heritage Assessment

Assessment Programme

The Aboriginal Cultural Heritage Assessment (Appendix E) used relevant information from previous assessments and the results of the Project field surveys and associated consultation with the Aboriginal community throughout the consultation process.

Table 4-10 summarises the main stages of the Aboriginal heritage consultation/survey programme undertaken as part of the Project. A detailed account of the consultation process, including copies of correspondence to and from registered stakeholders and a detailed consultation log is provided in Appendix E.

As previously described, consultation for the Project has been undertaken in accordance with *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010a) and the *Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation* (DEC, 2005b).

The nine Aboriginal stakeholders who registered an interest in being consulted in relation to the Aboriginal Cultural Heritage Assessment process were (in alphabetical order):

- Badger Bates;
- Balranald LALC;
- Barkandji Elders Council;
- Ivanhoe Community Working Party;
- Kullila Site Consultants;
- Mutthi Mutthi Nations;
- National Koorie Site Management;
- Ngiyampaa People; and
- Willandra Lakes 2 Traditional Tribal Elders Council.

Archaeological Findings

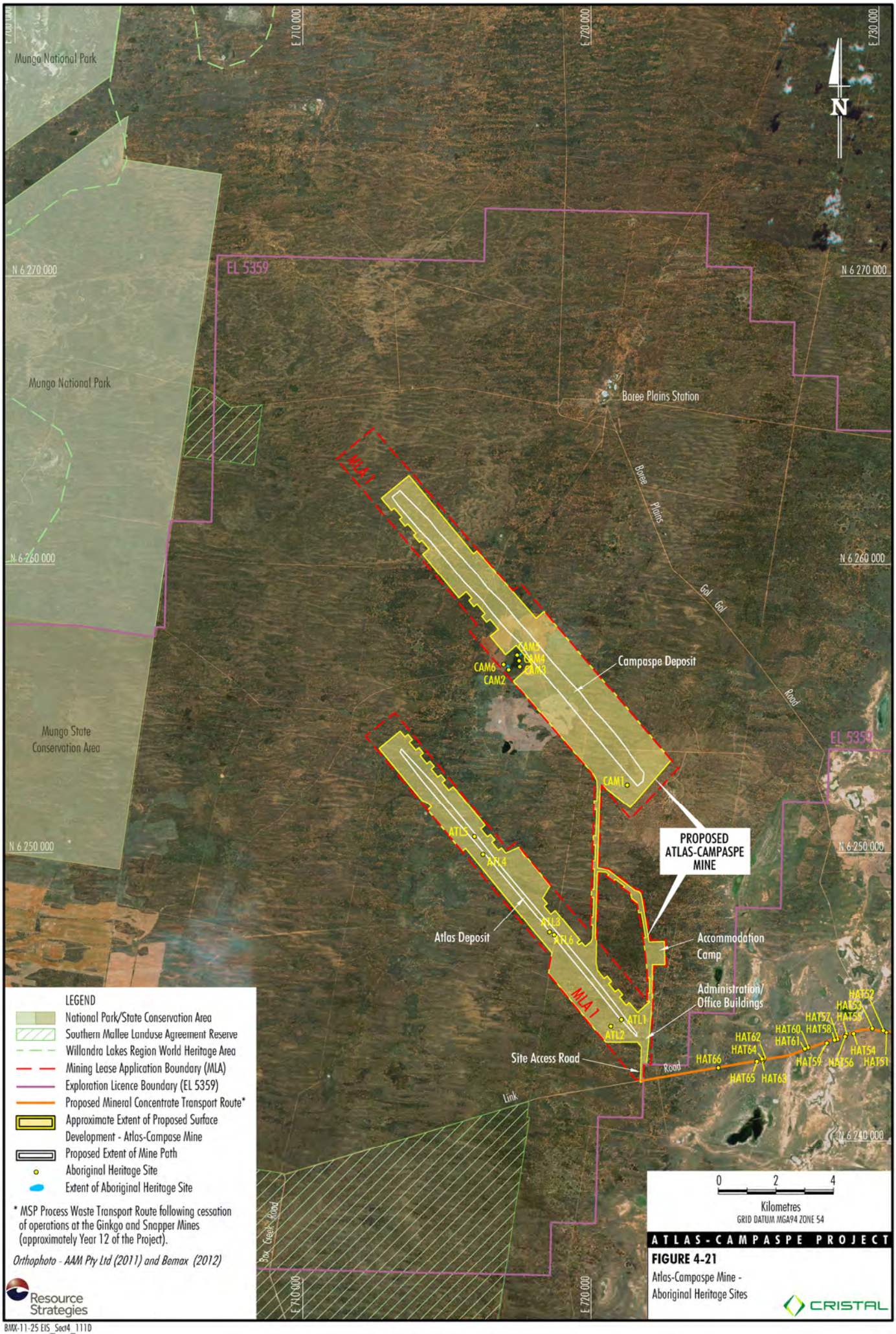
A total of 100 Aboriginal heritage sites were identified within the Project area and surrounds. These consisted of stone artefacts, a scarred tree, hearths and middens. The majority of sites were recorded adjacent to the proposed mineral concentrate transport route and were associated with the lunettes and wider relic lake system.

Each of the 100 Aboriginal heritage sites are described in detail in Appendix E. The location of the Aboriginal heritage sites are shown on Figures 4-21 to 4-23.

Table 4-10
Summary of the Project Aboriginal Heritage Consultation/Survey Programme

Date	Project Consultation/Survey Conducted
10 October 2011	Letters requesting the names of Aboriginal parties or groups that may have been interested in registering in the consultation process were sent to the Balranald LALC, Office of the Registrar, NTSCorp, OEH Queanbeyan EPRGO, the National Native Title Tribunal, Lower Murray-Darling CMA and BSC.
7 November 2011	Letters seeking registrations of interest were sent to Aboriginal parties or groups identified in the above step.
9 November 2011	Public advertisement published in the *Hay Riverine Grazier* and *Sunraysia Daily* inviting interested Aboriginal parties or groups to register.
19 December 2011	Record of names of registered stakeholders provided to OEH Queanbeyan EPRGO and Balranald LALC in accordance with DECCW (2010a).
25 January 2012	Public advertisement for the revised Project area (i.e. inclusion of the Ivanhoe Rail Facility) published in the *Hay Riverine Grazier* inviting interested Aboriginal parties or groups to register.
26 January 2012	Public advertisement for the revised Project area (i.e. inclusion of the Ivanhoe Rail Facility) published in the *Sunraysia Daily* inviting interested Aboriginal parties or groups to register.
30 January 2012	Letters requesting the names of Aboriginal parties or groups that may have been interested in registering in the consultation process for the revised Project area (i.e. inclusion of the Ivanhoe Rail Facility) were sent to the Balranald LALC, Office of the Registrar, NTSCorp, OEH Queanbeyan EPRGO, OEH Dubbo EPRGO, the National Native Title Tribunal, Lower Murray-Darling CMA, Lachlan CMA, CDSC and BSC.
30 January 2012	All additional Aboriginal parties or groups identified by the above step (i.e. those who had not previously registered in the consultation process) were contacted and asked if they wished to be involved in the consultation process.
24 February 2012	Provision of a proposed methodology for undertaking the Aboriginal Cultural Heritage Assessment distributed to registered stakeholders.
February/March 2012	Feedback from the registered stakeholders in regard to the proposed methodology sought.
9 March 2012	Record of names of registered stakeholders provided to OEH Queanbeyan EPRGO, OEH Dubbo EPRGO and Balranald LALC in accordance with DECCW (2010a).
20 March 2012	Invitation to registered stakeholders to participate in the Aboriginal cultural heritage survey based on the completion of a selection criteria.
17 – 25 April 2012; 9 – 11 May 2012; and 30 – 31 August 2012	Aboriginal and cultural heritage survey and inspection. Cultural significance of the area and Aboriginal heritage sites discussed with the Aboriginal participants.
7 September 2012	Draft Aboriginal Cultural Heritage Assessment issued to the registered stakeholders for review, including survey results, archaeological and cultural significance assessment (based on feedback received during consultation and fieldwork), potential impacts and proposed management and mitigation measures.
October 2012	Comments received from registered stakeholders on the draft Aboriginal Cultural Heritage Assessment (in relation to cultural heritage) were considered and/or addressed in the Aboriginal Cultural Heritage Assessment.
10 October 2012	Meeting held with representatives from the Ivanhoe Community Working Party to discuss the draft Aboriginal Cultural Heritage Assessment.
September/October 2012	Written and/or verbal feedback and advice received from registered stakeholders (including comments on the consultation, survey, assessment and proposed management and mitigation measures).
11 October 2012	Meeting held with representatives from Ngiyampaa People, Willandra Lakes 2 Traditional Tribal Elders Council, Willandra Lakes Region World Heritage Property Technical Scientific Advisory Committee/Community Management Council and NPWS (Mungo National Park) to discuss the draft Aboriginal Cultural Heritage Assessment.

Source: After Appendix E.



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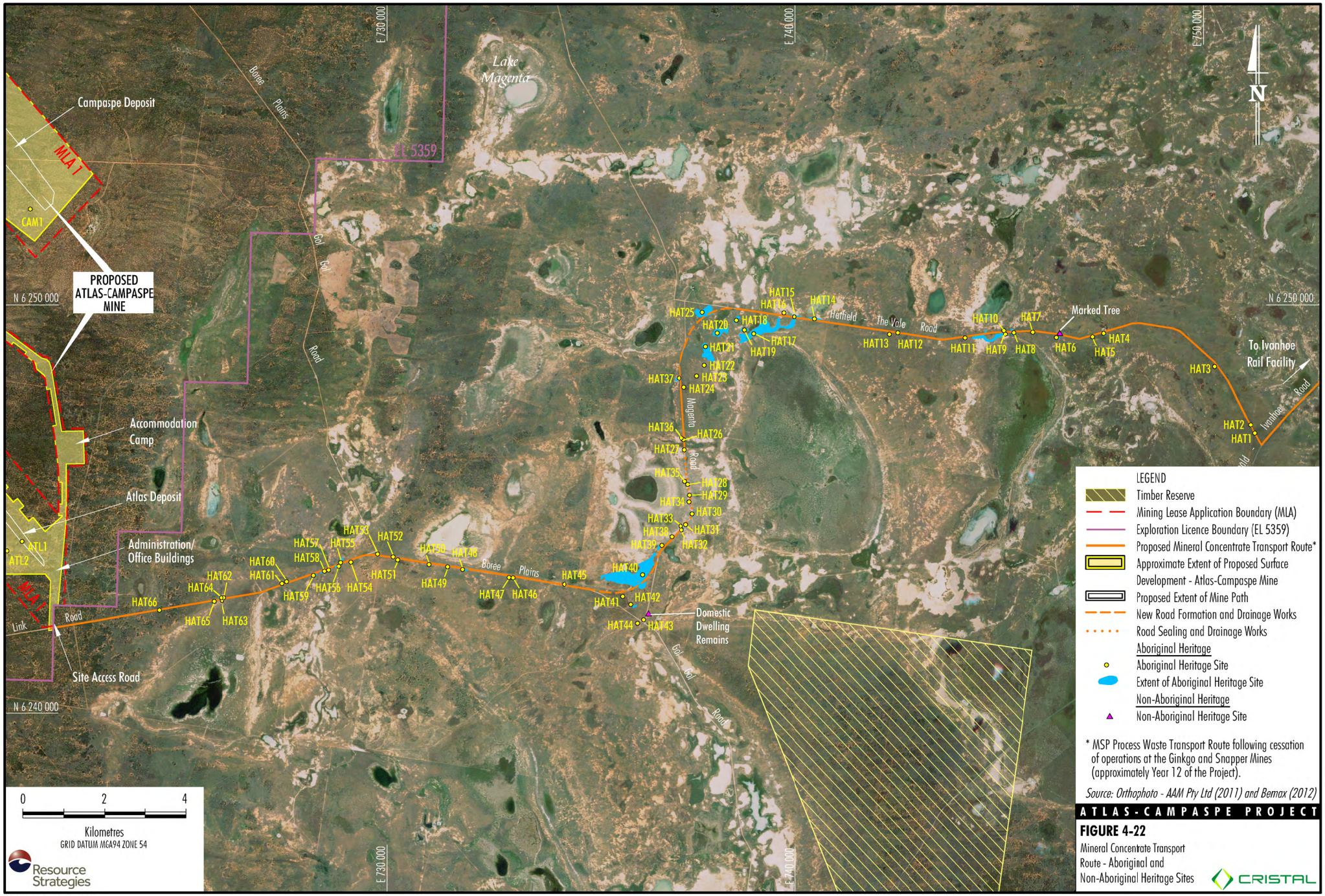

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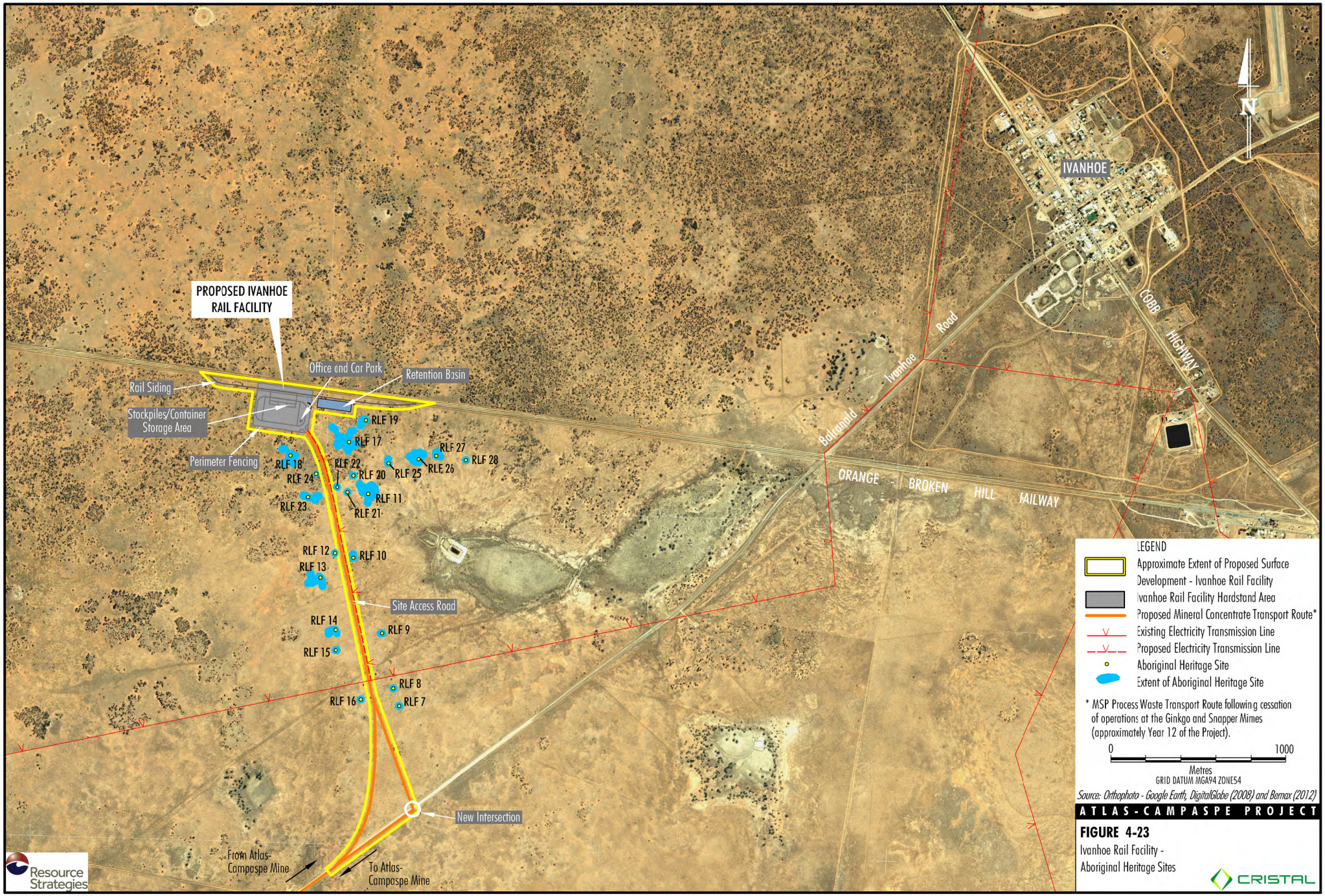

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Archaeological and Cultural Heritage Values

The archaeological significance rankings for each of the 100 sites located in the Project area and surrounds are presented in Table 4-11. Seven sites of high local archaeological significance were recorded in the Project area (Appendix E). A total of 16 sites of moderate archaeological significance and 77 sites of low archaeological significance were recorded in the Project area.

No Aboriginal heritage sites within the Project area are listed on the NSW State Heritage Inventory or the Australian Heritage Database. The Willandra Lakes Region World Heritage Area, located 10 km to the west of the Atlas-Campaspe Mine, is listed on both the NSW State Heritage Inventory and the Australian Heritage Database for its natural and cultural values.

The Aboriginal Cultural Heritage Assessment (including specific assessment of cultural significance via consultation with the Aboriginal community) was undertaken in accordance with the relevant requirements of the various advisory documents and guidelines, as listed above.

Table 4-10 summarises the main stages of the Aboriginal consultation/survey programme undertaken as part of the Project with further detail provided in Appendix E. The registered Aboriginal stakeholders were requested to contribute their cultural knowledge of the Project area, and the Aboriginal sites within it, at all stages during the consultation process (i.e. as part of the review of the proposed methodology, during the field surveys and as part of the review of the draft Aboriginal Cultural Heritage Assessment).

Comments received from the registered Aboriginal stakeholders are provided in full and addressed in Appendix E. In summary, the registered Aboriginal stakeholders identified that:

- all sites are significant to Aboriginal people as they provide a connection to the country and an educational resource for future generations;
- landforms, soil, water, flora and fauna resources are important in understanding how Aboriginal people would have used the landscape; and
- sites should remain *in-situ* to protect their cultural value to the Aboriginal community.

4.8.2 Potential Impacts

Potential Direct Impacts

The Project would result in the direct disturbance of 15 known Aboriginal heritage sites and the partial disturbance of 14 sites. Of these, seven sites are associated with the Atlas-Campaspe Mine footprint, all of which are isolated artefacts of low archaeological significance.

The 22 sites associated with the mineral concentrate transport route include three sites of high archaeological significance, three sites of moderate archaeological significance and 16 sites of low archaeological significance. These 22 sites are located either within or partially within the footprint of the roadworks along the mineral concentrate transport route (Figures 4-21 and 4-22).

The Ivanhoe Rail Facility (including the site access road) has been designed to avoid known Aboriginal heritage sites (Figure 4-23).

Table 4-11

Archaeological Significance of Relevant Aboriginal Heritage Sites

Archaeological Significance Ranking	Aboriginal Heritage Site (refer to Figures 4-21 to 4-23)	Number of Sites
High	Cam3, Hat17, Hat20, Hat21, Hat25, Hat40, Hat56	7
Moderate	Cam2, Cam4, Cam5, Cam6, Hat9, Hat10, Hat14, Hat28, Hat29, Hat30, Hat55, Rlf11, Rlf13, Rlf17, Rlf18, Rlf26	16
Low	Atl1, Atl2, Atl3, Atl4, Atl5, Atl6, Cam1, Hat1, Hat2, Hat3, Hat4, Hat5, Hat6, Hat7, Hat8, Hat11, Hat12, Hat13, Hat15, Hat16, Hat18, Hat19, Hat22, Hat23, Hat24, Hat26, Hat27, Hat31, Hat32, Hat33, Hat34, Hat35, Hat36, Hat37, Hat38, Hat39, Hat41, Hat42, Hat43, Hat44, Hat45, Hat46, Hat47, Hat48, Hat49, Hat50, Hat51, Hat52, Hat53, Hat54, Hat57, Hat58, Hat59, Hat60, Hat61, Hat62, Hat63, Hat64, Hat65, Hat66, Rlf7, Rlf8, Rlf9, Rlf10, Rlf12, Rlf14, Rlf15, Rlf16, Rlf19, Rlf20, Rlf21, Rlf22, Rlf23, Rlf24, Rlf25, Rlf25, Rlf28	77

Source: After Appendix E.

Sites that have been identified outside of, but in close proximity to, the direct disturbance areas may potentially also be subject to accidental disturbance during ongoing exploration and general land management activities, however, would not be directly impacted by the Project. For such sites, signage or fencing would be used to demarcate and reduce the risk of accidental disturbance as described in Section 4.8.3.

Potential Impacts to the Willandra Lakes Region World Heritage Area

The Willandra Lakes Region World Heritage Area includes the dunes of Lake Mungo, where the remains of a 42,000 year old male and female (i.e. Mungo Man and Mungo Lady) were discovered. Mungo Lady is believed to be the oldest site of ritual cremation in the world (NSW Department of the Environment and Water Resources [DEWR], 2007).

The Atlas-Campaspe Mine is located 10 km to the east of the Willandra Lakes Region World Heritage Area. The Willandra Lakes Region World Heritage Area is listed on the World Heritage List (DEWR, 2007) under the following criteria:

(iii) to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;

…

(viii) to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;

The Willandra Lakes Region World Heritage Area is also listed on the National Heritage List (DEWR, 2007) under the following criteria:

(a) the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history;

(b) the place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history;

(c) the place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history;

…

(g) the place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;

The natural and cultural values of the Willandra Lakes Region World Heritage Area which meet the World Heritage List criteria and National Heritage List criteria are (SEWPaC, 2012d):

Natural

- *as an outstanding example representing the major stages in the earth's evolutionary history; and*
- *as an outstanding example representing significant ongoing geological processes.*

Cultural

- *bearing exceptional testimony to a past civilisation.*

The Project would not impact on the natural and cultural heritage values of the Willandra Lakes Region World Heritage Area, based on the following:

- At its closest point the Project is located 10 km to the east of the Willandra Lakes Region World Heritage Area.
- The dunefields and sandplains on which the Atlas-Campaspe Mine is located do not contain the landscape features (i.e. relic lakes and lunettes) directly associated with the natural heritage values of the Willandra Lakes Region World Heritage Area.
- Relic lakes and lunettes landforms are present along the proposed mineral concentrate transport route, approximately 30 km south-east of the Willandra Lakes Region World Heritage Area. The proposed mineral concentrate transport route mostly follows existing public roads. The new sections of road have been designed to avoid the relic lake beds and lunettes landforms.
- As described in Section 4.8.1, consultation has been undertaken for the Project with Aboriginal stakeholders including those from the Barkandji (Paakantji), Mutthi Mutthi and Ngiyampaa tribal groups associated with the Willandra Lakes Region World Heritage Area.
- The registered Aboriginal stakeholders have not identified any of the recorded sites as being of particular cultural significance (Appendix E) or raised any concerns regarding potential impacts to the Willandra Lakes Region World Heritage Area or its cultural values.

Further assessment of the potential impacts of the Project on the World Heritage and National Heritage Values of the Willandra Lakes Region World Heritage Area is provided in Appendices C and E.

4.8.3 Mitigation Measures, Management and Monitoring

The mitigation, management and monitoring measures detailed below have been developed in consultation with the registered Aboriginal stakeholders and in consideration of the cultural and archaeological significance of the Aboriginal heritage sites to be impacted and the cultural significance of the area. The consultation process with the registered stakeholders is described in Appendix E and Section 4.8.1.

A Heritage Management Plan would be developed in consultation with the Aboriginal community and the OEH. The Heritage Management Plan would be developed prior to any works which would harm Aboriginal cultural heritage sites in the Project surface development areas.

A summary of measures expected to be included in the Heritage Management Plan and implemented over the life of the Project are provided below. Further detail is provided in Appendix E.

Surface Disturbance

The following measures would be detailed in the Heritage Management Plan and undertaken to manage potential impacts to Aboriginal heritage for surface disturbance throughout the life of the Project:

- Cristal Mining would maintain a record of known Aboriginal heritage sites (including on-site plans and in relevant Project documentation).
- Where practicable, known Aboriginal heritage sites would be avoided during Project construction and operation works.
- The location of known Aboriginal heritage sites would be considered during final detailed engineering designs of the mineral concentrate transport route.
- Where avoidance of known Aboriginal heritage sites is not practicable, site(s) would be subject to baseline recording in consultation with the registered Aboriginal stakeholders, prior to disturbance and artefacts would be salvaged for safekeeping in accordance with the stakeholders wishes.
- Sites located outside (but in close proximity) of Project disturbance areas would be suitably demarcated (e.g. signage or fencing) to reduce the risk of accidental disturbance.
- Monitoring of topsoil stripping (for archaeological material) would be undertaken during roadworks along the mineral concentrate transport route and construction of the Ivanhoe Rail Facility.

During development of the Heritage Management Plan, the Aboriginal community would be requested to provide advice on the storage of collected artefacts (e.g. at a keeping place on-site or within the Willandra Lakes Region World Heritage Area and/or the Mungo National Park) and the management of artefacts at the completion of Project activities (e.g. artefact replacement onto the post-mine landforms or retained for educational purposes).

General Management Measures

The following general approach would be taken to manage Aboriginal cultural heritage during the life of the Project:

- Ongoing consultation would be undertaken with the Aboriginal community over the life of the Project. Appropriate Aboriginal representation would be facilitated during archaeological fieldwork (e.g. salvage of artefacts prior to disturbance and monitoring of topsoil stripping during roadworks along the mineral concentrate transport route and construction of the Ivanhoe Rail Facility).
- Cristal Mining would provide opportunities for Aboriginal community members to access known Aboriginal heritage sites on land owned/leased by Cristal Mining (e.g. for cultural reasons or as part of scheduled field activities).
- Any additional Aboriginal heritage sites which may be identified during the development of the Project would be recorded and registered with the OEH in consultation with Aboriginal stakeholders. Should additional Aboriginal heritage sites be identified, they would be managed in accordance with the measures described in the Heritage Management Plan.
- A protocol would be developed in the event that burials and/or human remains are identified.
- A cultural awareness programme for employees and contract workers would be developed to assist in minimising impacts on Aboriginal heritage (e.g. through the augmentation of existing induction programmes).

The measures presented above are considered by Niche Environment and Heritage (2012) to be best practice in the mining industry. They are effective and reliable, as demonstrated by their continued use and inclusion in management plans and strategies developed in consultation with the Aboriginal community and to the satisfaction of government departments (Appendix E).

4.9 NON-ABORIGINAL HERITAGE

A Non-Aboriginal Heritage Assessment for the Project was undertaken by Niche Environment and Heritage and is presented as Appendix E.

The assessment was prepared in consideration of the relevant principles and articles contained in the *Burra Charter* (Australia ICOMOS, 1999) and the *NSW Heritage Manual* (NSW Heritage Office and NSW Department of Urban Affairs and Planning [DUAP], 1996).

A description of existing non-Aboriginal heritage within the Project area and surrounds is provided in Section 4.9.1 and Section 4.9.2 describes the potential impacts of the Project.

4.9.1 Existing Environment

Historical Overview

The explorer Captain Charles Sturt was the first European to explore south-west NSW, travelling through the Balranald region during his 1829-1831 expedition of the Murray and Murrumbidgee Rivers (Sturt, 1833). Sturt was closely followed by other expeditions lead by Major Thomas Mitchell and Edward John Eyre.

In 1847, Commissioner James McDonald arrived in the region and recommended the township of Balranald be established. A pub and general store were built and the town was officially gazetted in 1851.

George Lee took up the first pastoral lease in the region in 1850. Turlee Run was estimated to be approximately 236,000 acres encompassing much of the Atlas-Campaspe Mine area. With the passing of the *Crown Lands Act* in 1884, the eastern half Turlee Run was resumed, subdivided and reallocated as a Western Land Leasehold. The Rowe family held the Western Land Leases for Magenta Station and Solfernio Station (now Boree Plains Station) on which the Atlas-Campaspe Mine is partially located, in the 19th century (Landskape, 2011).

The township of Ivanhoe was established in the 1870s. The Ivanhoe railway station was opened in 1925. The railway line was initially used for freight and a passenger service was added in 1927.

Heritage Items of Relevance to the Project

Niche Environment and Heritage (2012) completed historical and archival research and review of heritage registers prior to survey of the Project area.

No items of state or regional non-Aboriginal heritage significance were identified in the Project area (Appendix E).

During the survey of the Project area by Niche Environment and Heritage, two items (a survey marker and the remains of a domestic dwelling) were identified as being of potential local significance. These items are located along the proposed mineral concentrate transport route and are outside the proposed disturbance areas (Figure 4-22).

The survey marker comprises of a living tree with a blaze engraved with the initials 'RD' and an upward facing arrow. The survey mark is estimated to date from the first half of the 20th century and is possibly associated with the development of the existing public road. It is assessed as being of local significance as it represents an important stage of the local area's development (Appendix E).

The remains of the domestic dwelling comprise of domestic items and building remains. The date of construction is unknown but items observed at the site suggest that it was occupied in the 1880s. It is assessed as being of local significance as it has potential to provide information about the history of the local area (Appendix E).

4.9.2 Potential Impacts

The survey marker is located on the north side of Hatfield-The Vale Road approximately 6.5 km from the intersection with Balranald Road while the remains of the domestic dwelling are located approximately 280 m north of the proposed intersection with Boree Plains-Gol Gol Road (Figure 4-22). As such, these non-Aboriginal heritage sites would not be impacted by the Project and, therefore, no specific mitigation measures, management or monitoring is proposed.

4.10 AIR QUALITY

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken by Katestone Environmental (2013) and is presented in Appendix K. The assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods) (DEC, 2005c).

A description of the existing environment relating to air quality is provided in Section 4.10.1. Section 4.10.2 describes the potential impacts of the Project, and Section 4.10.3 outlines the proposed air quality mitigation, management and monitoring measures.

Project greenhouse gas emissions are discussed in Section 4.11.

4.10.1 Existing Environment

Air Quality Criteria

Concentrations of Suspended Particulate Matter

The Project activities described in Section 2 have the potential to generate particulate matter (i.e. dust) emissions in the form of:

- total suspended particulate matter (TSP);
- particulate matter with an equivalent aerodynamic diameter of 10 micrometres (µm) or less (PM_{10}) (a subset of TSP); and
- particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$) (a subset of PM_{10}).

Exposure to suspended particulate matter can result in adverse health impacts. The likely risk of these impacts to a person depends on a range of factors including the size, chemical composition and concentration of the particulate matter, and the existing health of the person (NSW Health and NSW Minerals Council, 2011).

Relevant health based air quality criteria (i.e. set at levels to reduce the risk of adverse health effects) for particulate matter concentrations, as specified by the EPA in the Approved Methods (DEC, 2005c), are provided in Table 4-12.

Table 4-12
EPA Criteria and Ambient Air-NEPM Advisory Standards for Particulate Matter Concentrations

Pollutant	Averaging Period	Criteria (µg/m^3)
TSP[1]	Annual mean	90 (EPA)
PM_{10}[1]	24-hour maximum[3]	50 (EPA)
	Annual mean	30 (EPA)
$PM_{2.5}$[2]	24-hour maximum	25 (NEPM)
	Annual mean	8 (NEPM)

Source: After Appendix K.

µg/m^3 = micrograms per cubic metre.

1 EPA criteria.

2 Air-NEPM advisory standard.

3 Cumulative criterion (i.e. include background concentrations but exclude regional dust events such as bushfires).

The Approved Methods do not have specific criteria for $PM_{2.5}$. In the absence of $PM_{2.5}$ criteria, Katestone Environmental (2013) have assessed potential impacts associated with $PM_{2.5}$ emissions against the advisory standards specified in the *National Environment Protection Measure for Ambient Air Quality* (Ambient Air-NEPM) (National Environment Protection Council, 2003).

Dust Deposition

Particulate matter has the potential to cause nuisance (amenity) effects when it is deposited on surfaces. The amenity criteria for the maximum increase in dust deposition and maximum total dust deposition, as specified by the EPA in the Approved Methods (DEC, 2005c) are provided in Table 4-13.

Table 4-13
Criteria for Dust (Insoluble Solids) Deposition

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level (g/m^2/month)	Maximum Total Deposited Dust Level (g/m^2/month)
Deposited dust	Annual	2	4

Source: After Appendix K.

g/m^2/month = grams per square metre per month.

Existing Air Quality

Dust Deposition

The dust monitoring network at the Atlas-Campaspe Mine was installed in November 2011 and includes six dust gauges (DC01 to DC06) located in the vicinity of the Atlas-Campaspe Mine (Figure 4-24). Average dust deposition levels for these six sites are presented in Table 4-14 for the period of available records.

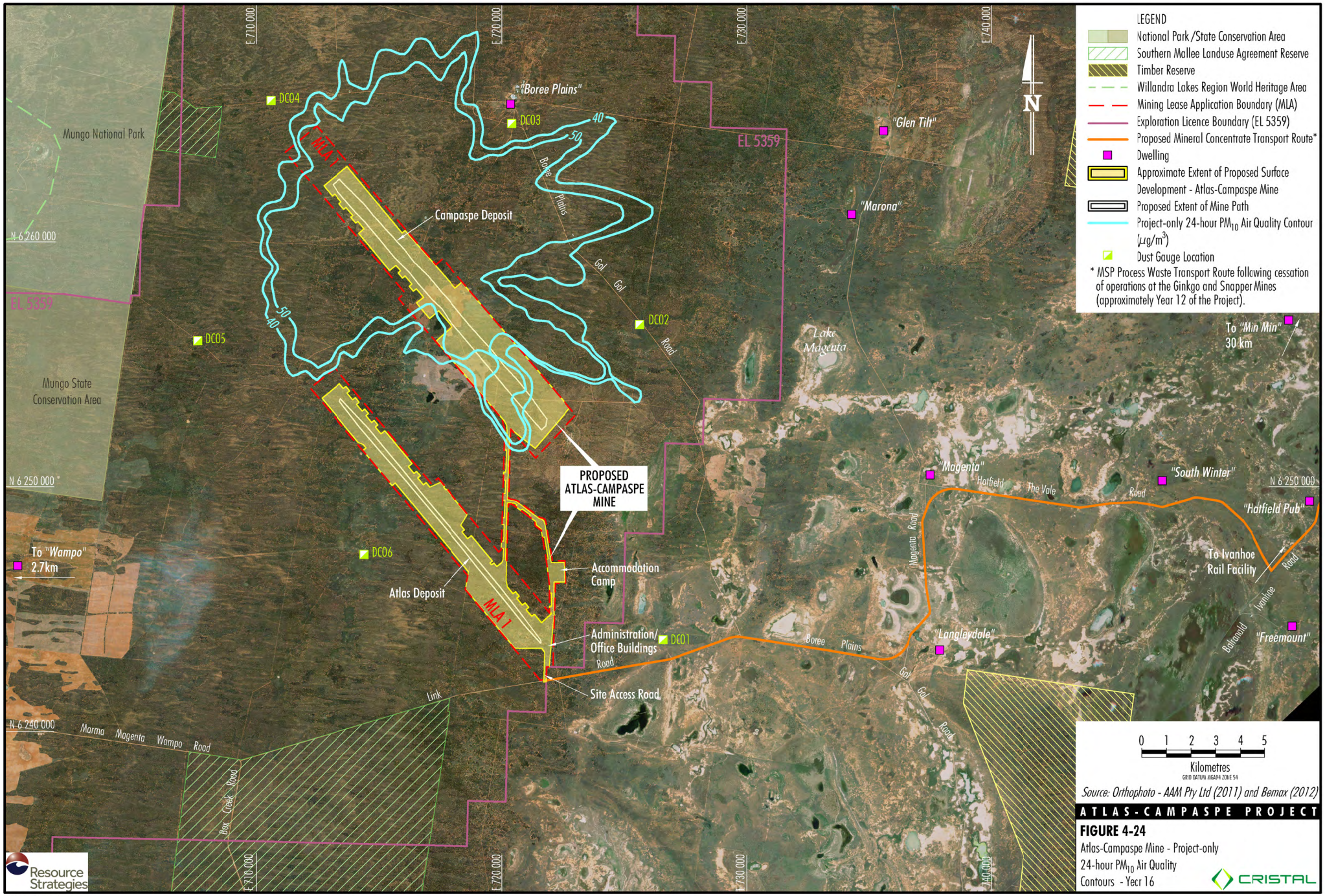

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Table 4-14
Average Dust Deposition (Insoluble Solids) Levels (g/m^2/month)

Month	DC01	DC02	DC03	DC04	DC05	DC06
November 2011	0.9	0.9	1.0	1.1	0.7	1.4
December 2011	0.9	NA	1.0	1.1	1.5	2.8
January 2012	1.0	0.6	0.6	4.1	0.3	0.3
February 2012	NA	NA	NA	NA	NA	NA
March 2012	0.6	1.0	0.1	ER*	0.2	0.2
April 2012	0.4	ER**	0.4	2.1	0.3	0.4
May 2012	0.5	0.7	0.3	NA	0.2	0.0
June 2012	0.1	0.4	0.6	0.1	0.0	0.0
July 2012	0.3	0.7	0.5	0.5	1.4	0.9
August 2012	0.1	2.2	0.3	0.1	0.4	0.1

Source: After Appendix K.

NA = Not Available.

ER = Extraneous Result.

* 22.4 g/m^2/month was recorded in March 2012 and was therefore excluded from the statistical analysis.

** A result of 10.5 g/m^2/month was recorded in April 2012 and was found to be contaminated (i.e. sticks and bird droppings) and was therefore excluded from the statistical analysis.

Suspended Particulate Matter

No monitoring of suspended particulate matter has been undertaken by Cristal Mining. Notwithstanding, conservative assumptions regarding the use of available particulate monitoring data in the establishment of background air quality for assessment purposes is outlined below.

Background Air Quality for Assessment Purposes

The assessment of Project and cumulative annual air quality impacts requires background particulate matter concentrations and dust deposition levels to be defined.

While background particulate matter concentrations are recorded by the OEH in the Project area (NSW DustWatch Programme), the absence of data which has been recorded using techniques consistent with the Approved Methods has necessitated the use of conservative background concentrations recorded in Wagga Wagga (Appendix K). A review of available data from monitoring sites in Wagga Wagga and Broken Hill found both sites experience similar dust levels. Regional dust influences move across the Project region and are generally experienced at Broken Hill followed by Wagga Wagga. As such, the use of Wagga Wagga data was considered representative of regional dust influences (Appendix K).

For assessment of annual average PM_{10}, a background concentration of 26.2 µg/m^3 has been selected to represent local and regional particulate matter sources (Appendix K).

TSP concentrations have been calculated from this level (using a 50% relationship of PM_{10} to TSP) and a background TSP concentration of 52.3 µg/m^3 has been adopted (Appendix K).

$PM_{2.5}$ concentrations have been calculated from this level (using a 20%[2] relationship of $PM_{2.5}$ to PM_{10}) and an annual average background $PM_{2.5}$ concentration of 5.23 µg/m^3 (Appendix K).

The average dust deposition at the Atlas-Campaspe Mine site has been determined to be 1.3 g/m^2/month for the period of available record (Table 4-14 and Appendix K).

In summary, for the purposes of assessing Project and cumulative impacts, Katestone Environmental (2013) assumed the following background air quality concentrations/levels:

- annual average PM_{10} concentration of 26.2 µg/m³;
- annual average $PM_{2.5}$ concentration of 5.23 µg/m³;
- annual average TSP concentration of 52.3 µg/m³; and
- annual average dust deposition of 1.3 g/m²/month.

[2] A 20% relationship of $PM_{2.5}$ to PM_{10} has been assumed to reflect the lack of significant industrial and urban combustion sources in the Project area (Appendix K).

4.10.2 Potential Impacts

Assessment Methodology

Modelling Scenarios

Potential air quality impacts at the Atlas-Campaspe Mine were modelled for Year 16 of the Project to assess the potential impact at the nearest residential receiver (Boree Plains) (Figure 4-24). Modelling for Year 16 operations was assessed whilst including the maximum overburden extraction rate from the Project life (notwithstanding that those maximum rates were scheduled to occur in Year 5) thereby providing a conservative estimate of potential air quality impacts (Appendix K).

As operations at the Ivanhoe Rail Facility would generally remain unchanged throughout the Project life, the modelled scenario was assumed to represent all operational scenarios.

Potential air quality impacts associated with transport of mineral concentrates along unsealed sections of the proposed mineral concentrate transport route were also assessed for completeness (Appendix K).

Emission Inventories

Emission inventories were prepared for Year 16 of the Atlas-Campaspe Mine operations in consideration of the anticipated mining activities for that year, including topsoil and overburden removal rates, haul road distances and routes, stockpile and pit areas and equipment operating hours. The major emission sources were associated with the following activities (Appendix K):

- overburden removal;
- on-site haulage; and
- wind erosion from exposed areas.

Potential emissions associated with the transport of mineral concentrates along the proposed mineral concentrate transport route and operations at the Ivanhoe Rail Facility were also conservatively included in separate emissions inventories (Appendix K).

A full description of the dispersion model methodology and emissions inventories is provided in Appendix K.

Dispersion Modelling

The CALMET/CALPUFF modelling system was used by Katestone Environmental (2013) to assess potential air quality impacts associated with the Project.

CALMET is a meteorological pre-processor that produces the three-dimensional meteorological fields that are used in the CALPUFF dispersion model. Katestone Environmental coupled TAPM to CALMET in order to generate simulated synoptic and regional scale meteorology for input into the CALPUFF dispersion model.

CALPUFF is a multi-layer, non-steady state dispersion model that is approved by the EPA (DEC, 2005c) and endorsed by the United States Environmental Protection Agency.

Separate TAPM/CALMET and CALPUFF modelling activities were undertaken for the Atlas-Campaspe Mine (including the mineral concentrate transport route) and the Ivanhoe Rail Facility (Appendix K).

A full description of the dispersion model methodology is provided in Appendix K.

Cumulative Impacts

Consideration of the potential cumulative impacts associated with the construction and operation of the Balranald Mineral Sands Project were conservatively incorporated in the Air Quality and Greenhouse Gas Assessment (Appendix K). The Balranald Mineral Sands Project has not yet been approved.

Potential Project Only Impacts

The results of the assessment of the Atlas-Campaspe Mine site and Ivanhoe Rail Facility demonstrate (Appendix K):

- compliance with annual average impact assessment criteria for TSP, PM_{10} and dust deposition at all sensitive receptors for the Project in isolation;
- compliance with 24-hour impact assessment criteria for TSP, PM_{10} and dust deposition at all sensitive receptors for the Project in isolation;
- compliance with annual average impact assessment criteria for TSP, PM_{10} and dust deposition for the Project with the inclusion of conservative background levels;

- compliance with relevant annual average Air-NEPM advisory standard for $PM_{2.5}$ for the Project in isolation and with the inclusion of conservative background levels; and
- compliance with relevant 24-hour Air-NEPM advisory standard for $PM_{2.5}$ for the Project in isolation and with the inclusion of conservative background levels.

Figure 4-24 shows the predicted maximum Project only 24-hour PM_{10} contours for Year 16 of operations at the Atlas-Campaspe Mine.

Potential 24-hour PM_{10} impacts would be influenced by elevated background levels due to episodic short-term (non-mining) events (such as bushfires and dust storms).

As discussed in Section 4.10.1, Wagga Wagga monitoring data was considered to be the best representation of regional dust influences at the Atlas-Campaspe Mine (Appendix K). Katestone Environmental (2013) assessed 24-hour PM_{10} impacts from the Project with the inclusion of background levels using the Wagga Wagga monitoring data. This assessment showed that exceedances of the 24-hour PM_{10} crtieria would occur at 35 residences. However, the Project contribution on the modelled days when these exceedances were predicted was between 0 and 0.2 µg/m³. The background contribution on the modelled days when these exceedances were predicted was above the 24-hour PM_{10} of 50 µg/m³. The inclusion of background levels on days when the Project contribution was at a maximum, did not result in any exceedances.

No additional exceedances of the 24-hour PM_{10} impact assessment criteria would result from the Project with the inclusion of conservative background levels (Appendix K).

Potential Cumulative Impacts

No cumulative air quality impacts are expected from the coincident construction and operation of the Project and the Balranald Mineral Sands Project (Appendix K).

Potential Construction Impacts

Construction activities would potentially generate particulate matter emissions. Particulate matter emissions from construction activities would typically be contained to specific areas, and would be of limited duration (Appendix K). Construction dust emissions would be effectively managed through best practice mitigation measures, as described in Appendix K.

Mineral Concentrate Transport

Dust emissions generated by the transport of mineral concentrates on unsealed sections of the mineral concentrate transport route are not expected to result in any exceedance of the EPA annual average PM_{10} criteria at any residence along the mineral concentrate transport route (Appendix K).

Transport of mineral concentrates is to be undertaken in covered road trailers and rail wagons for the Project. Therefore, no dust is expected to be generated from mineral concentrates during transport.

Willandra Lakes Region World Heritage Area

Although not a sensitive receptor, Belah Campground within the Mungo National Park was assessed as a sensitive receptor location (Appendix K). The results of the assessment at the Atlas-Campaspe Mine site predicted particulate matter concentrations and dust depositions levels at the Belah Campground to be minor. Contributions throughout the Willandra Lakes Region World Heritage Area which are attributable to the Atlas-Campaspe Mine are expected to be lower than those at Belah Campground (Appendix K).

4.10.3 Mitigation Measures, Management and Monitoring

Dust Suppression

Dust emissions associated with the activities at the Atlas-Campaspe Mine are proposed to be mitigated through the use of on-site watering (i.e. water carts), minimisation of disturbed areas and progressive rehabilitation.

Based on the predicted impacts from the Project, the use of watering on-site (i.e. water carts) would control emissions to an acceptable level, and as such are considered to be best practice, in accordance with the EPA best practice document *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone Environmental, 2011).

Modelling conducted for Ivanhoe Rail Facility operations did not include any mitigation measures (i.e. watering for dust suppression) and predicted compliance with relevant criteria and reporting standards (Appendix K). As such, no air quality mitigation measures are proposed at the Ivanhoe Rail Facility, except in the case where there is sufficient runoff water collected in the retention dam to enable use for dust suppression.

Management Plan

An Air Quality and Greenhouse Gas Management Plan (AQGHGMP) would be developed for the Project and would detail the management and mitigation measures relevant to air quality.

The AQGHGMP would include:

- Atlas-Campaspe Mine air quality control and management measures;
- mineral concentrate transport air quality controls;
- Ivanhoe Rail Facility air quality controls; and
- the Air Quality Monitoring Programme.

The management measures in the AQGHGMP would be implemented during construction and operation of the Project.

Dust Monitoring

The existing air quality (dust) monitoring network would be retained for the Project (Figure 4-24). The continued operation of the existing air quality (dust) monitoring network would be re-evaluated every 2 years for its continued need (Appendix K).

The DGRs require the implementation of real-time air quality monitoring as part of the Project. Given the lack of predicted impacts and sparse localities of receptors in the Project area, it is not considered reasonable to implement real-time air quality monitoring as part of the Project (Appendix K).

4.11 GREENHOUSE GAS EMISSIONS

4.11.1 Scope 1, 2 and 3 Greenhouse Gas Emissions

A quantitative assessment of Project greenhouse gas emissions is provided in Appendix K. A summary of the assessment is summarised below.

Greenhouse Gas Protocol Emission Scopes

The Greenhouse Gas Protocol (GHG Protocol) (World Business Council for Sustainable Development [WBCSD] and World Resources Institute [WRI], 2004) defines three 'scopes' of emissions (Scope 1, Scope 2 and Scope 3). Scopes 1 and 2 have been defined such that two or more entities would not account for emissions in the same scope.

Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the entity (WBCSD and WRI, 2004). Direct greenhouse gas emissions are those emissions that are principally the result of the following types of activities undertaken by an entity:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources (e.g. boilers, furnaces or turbines).
- Physical or chemical processing. Most of these emissions result from manufacture or processing of chemicals and materials (e.g. the manufacture of cement, aluminium, adipic acid and ammonia, or waste processing).
- Transportation of materials, products, waste, and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars).
- Fugitive emissions. These emissions result from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting; hydroflurocarbon emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport) (WBCSD and WRI, 2004).

Scope 2: Electricity Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that accounts for greenhouse gas emissions from the generation of purchased electricity consumed by the entity.

Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity (WBCSD and WRI, 2004). Scope 2 emissions physically occur at the facility where electricity is generated (WBCSD and WRI, 2004). Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as Scope 2.

Scope 3: Other Indirect Greenhouse Gas Emissions

Under the GHG Protocol, Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions.

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of Scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services (WBCSD and WRI, 2004).

The GHG Protocol provides that reporting Scope 3 emissions is optional (WBCSD and WRI, 2004). If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and 2. However, the GHG Protocol notes that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or projects difficult because reporting is voluntary.

Greenhouse Gas Emissions Estimation

Project direct and indirect greenhouse gas emissions have been estimated by Katestone Environmental (2013) using published emission factors from the *National Greenhouse Accounts Factors* workbooks (NGA Factors) (Commonwealth Department of Climate Change and Energy Efficiency [DCCEE], 2010; 2011a; 2012).

The NGA Factors provide greenhouse gas emission factors for carbon dioxide, methane and nitrous oxide. Emission factors are standardised for each of these greenhouse gases by being expressed as a carbon dioxide equivalent (CO_2-e) based on their Global Warming Potential. This is determined by the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation (e.g. methane has a Global Warming Potential 21 times that of carbon dioxide) (DCCEE, 2011b).

Project Greenhouse Gas Emissions

A summary of potential Project greenhouse gas emissions sources and their respective scopes is provided in Table 4-15.

Table 4-15
Summary of Potential Project Greenhouse Gas Emissions

Component	Direct Emissions	Indirect Emissions	
	Scope 1	Scope 2	Scope 3
Diesel consumption	Emissions from the combustion of diesel at the Project.	N/A	Estimated emissions attributable to the extraction, production and transport of diesel consumed at the Project, in the transport of mineral concentrate and MSP process waste and at the MSP.
Electricity consumption	N/A	Emissions from the generation of purchased electricity used at the Project.	Emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed at the Project and MSP, and the electricity lost in delivery in the transmission and distribution network.
LPG consumption	N/A	N/A	Emissions from the combustion of liquid petroleum gas (LPG) at the MSP. Estimated emissions attributable to the extraction, production and transport of LPG consumed at the MSP.
Mineral Concentrate transport	Emissions from the combustion of diesel used in mineral concentrate transport from the Atlas-Campaspe Mine to the Ivanhoe Rail Facility.	N/A	Emissions from the combustion of diesel used in rail haulage (mineral concentrates to the MSP and MSP to Port Pirie).

Source: After Appendix K.

The peak direct (i.e. Scope 1) annual emissions attributable to the Project are estimated to be approximately 0.045 Mt CO_2-e (Appendix K). Emissions from diesel consumption would be the most significant greenhouse gas source for the Project (Appendix K).

The total indirect emissions (i.e. Scopes 2 and 3) over the life of the Project are estimated to be approximately 0.42 Mt CO_2-e (Appendix K), which is an average of approximately 0.02 Mt CO_2-e per annum.

Potential Impact of Greenhouse Gas Emissions on the Environment

The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions.

The peak direct (i.e. Scope 1) annual emissions would represent approximately 0.008% of Australia's estimated greenhouse gas emissions for 2012 of 546.8 Mt CO_2-e (Appendix K), and a very small portion of global greenhouse emissions, given Australia contributed approximately 1.5% of global greenhouse gas emissions in 2005 (Commonwealth of Australia, 2011).

Increased greenhouse gas levels have the potential to alter climate variables such as temperature, rainfall and evaporation (Section 6.9.3). Projected changes to climate variables would have associated impacts, including to land, settlements and ecosystems, as described in Section 6.9.3.

4.11.2 Australian Greenhouse Gas Reduction Targets and Carbon Pricing Mechanism

The potential impacts of greenhouse gas emissions from all Australian sources will be collectively managed at a national level, through initiatives implemented by the Commonwealth Government.

The Commonwealth Government has committed to reduce greenhouse gas emissions by between 5 to 25% below 2000 levels by 2020, with the level of reduction dependent on the extent of reduction actions undertaken internationally (Commonwealth of Australia, 2011).

The Federal Opposition has committed to a 5% reduction below 1990 levels by 2020 (Liberal Party of Australia, 2010).

Greenhouse gas emissions from the Project would contribute to Australia's greenhouse gas emissions inventory, and would be considered in these emission reduction targets.

The commitment from the Commonwealth Government to reduce greenhouse gas emissions is proposed to be achieved through the introduction of a carbon pricing mechanism, as detailed in the *Clean Energy Bill, 2011*, which was introduced into Parliament by the Commonwealth Government on 13 September 2011 (Section 6.4.2).

As of 1 July 2012, this involves a fixed price on greenhouse gas emissions, with no cap on Australia's greenhouse gas emissions, or emissions from individual facilities (Commonwealth of Australia, 2011). From 1 July 2015 (i.e. during Project Year 3) an emissions trading scheme is proposed to be implemented. As such, Australia's greenhouse gas emissions, inclusive of emissions associated with the Project, would be capped at a level specified by the Commonwealth Government.

Under the emissions trading scheme, there would be no limit on the level of greenhouse gas emissions from specific individual facilities, with the incentive for facilities to reduce their greenhouse gas emissions driven by the carbon pricing mechanism (Commonwealth of Australia, 2011).

Participation in the proposed carbon pricing mechanism is triggered by the emission of 25,000 t CO_2-e per annum. Emissions resulting from the combustion of transport fuels (i.e. diesel) are not encompassed in calculations of emissions as part of the carbon pricing mechanism. Instead the Commonwealth Government has reduced fuel tax credits by an amount equal to the carbon price, through the use of the fuel tax regime (Clean Energy Future, 2012). As such, it is not expected that the Project would trigger the facility threshold of 25,000 t CO_2-e per annum for participation in the proposed carbon pricing mechanisms (Appendix K).

Notwithstanding the above, Cristal Mining would implement Project-specific greenhouse gas mitigation measures, as described in Section 4.11.3.

4.11.3 Mitigation Measures, Management and Monitoring

Project-specific greenhouse gas mitigation measures for the Project would include:

- maximisation of energy efficiency by mine planning decisions which minimise haul distances for topsoil and overburden, and associated fuel use;
- regular maintenance of plant and equipment to minimise fuel consumption;
- consideration of energy efficiency in the plant and equipment selection phase; and
- implementation of 'greenhouse' awareness training as part of induction programmes.

These measures would be described in the AQGHGMP to be developed for the Project.

The AQGHGMP would be prepared in consideration of the *Guidelines for Energy Saving Action Plans* (NSW Department of Energy, Utilities and Sustainability, 2005).

Ongoing management and monitoring of greenhouse gas emissions and energy consumption at the Project would occur through Cristal Mining's participation in the Commonwealth Government's National Greenhouse and Energy Report System (NGERS) (Section 6.4.2).

Under NGERS requirements, relevant sources of greenhouse gas emissions and energy consumption must be measured and reported on an annual basis, allowing major sources and trends in emissions/energy consumption to be identified.

Cristal Australia Pty Ltd is a participant in the Commonwealth Government's EEO Progam (Section 6.4.2). As such, Cristal Australia Pty Ltd would assess energy usage from all aspects of its operations, including the Project, and publicly report the results of energy efficiency assessments, and the opportunities that exist for energy efficiency projects with a financial payback of up to 4 years.

4.12 NOISE

A Noise Assessment for the Project was undertaken by Wilkinson Murray (2012) and is presented in Appendix J. It was conducted in accordance with the *NSW Industrial Noise Policy* (INP) (EPA, 2000b), *Environmental Assessment Requirements for Rail Traffic – Generating Developments* (EPA, 2012a) and the *NSW Road Noise Policy* (RNP) (DECCW, 2011).

Section 4.12.1 provides a description of the existing noise environment, Section 4.12.2 describes the potential impacts of the Project while Section 4.12.3 outlines mitigation measures, management and monitoring.

4.12.1 Existing Environment

Noise Measurement and Description

The assessed noise levels presented in Appendix J and summarised in this section are expressed in A-weighted decibels (dBA). The logarithmic dBA scale simulates the response of the human ear, which is more sensitive to mid to high frequency sounds and relatively less sensitive to lower frequency sounds.

Table 4-16 provides information on common noise sources in dBA for comparative reference. Hearing "nuisance" for most people begins at noise levels of about 70 dBA, while sustained (i.e. eight hours) noise levels of 85 dBA can cause hearing damage.

Measured or predicted noise levels are expressed as statistical noise exceedance levels (L_{AN}) which are the levels exceeded for a specified percentage of the interval period. For example, L_{A10} is the noise level that is exceeded for 10% of the sampling period and is considered to be the average maximum noise level.

The equivalent continuous noise level (L_{Aeq}) refers to the steady sound level, which is equal in energy to the fluctuating levels recorded over the sampling period.

Table 4-16
Relative Scale of Various Noise Sources

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 to 130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Internal demolition work (jackhammer)	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
80	Loud	Garbage disposal at 1 m, shouting at 1 m	Urban daytime noise
70	Loud	Vacuum cleaner at 3 m, normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	-
50	Moderate to quiet	Dishwasher next room, wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	-
0 to 10	Silent	Threshold of hearing	-

Source: After United States Department of the Interior (1994) and Richard Heggie Associates (1995).

Background Noise Levels

Ambient noise surveys to characterise and quantify the existing acoustic environment in the vicinity of the Project were conducted in November 2011. Three unattended noise loggers were positioned at Boree Plains, Langleydale and Min Min (Figure 4-25). An ambient noise survey was also conducted at each of the three dwellings in April 2012 (Figure 4-25).

The Rating Background Level (RBL) is the background noise level determined without the subject premises in operation, in accordance with the INP. The results of the abovementioned noise survey/monitoring were analysed in accordance with the requirements of the INP to determine the RBL. The monitored RBL was below 30 dBA for the day, evening and night periods (Appendix J).

The INP specifies that where the measured RBL is less than 30 dBA, then for the purposes of the noise assessment, a RBL of 30 dBA should be adopted.

4.12.2 Potential Impacts

The Noise Assessment (Appendix J) included assessment of the following potential impacts:

- Atlas-Campaspe Mine construction and operational noise (including the potential for sleep disturbance);
- Ivanhoe Rail Facility operational noise (including the potential for sleep disturbance);
- off-site road traffic noise; and
- off-site rail noise.

Each of these aspects are discussed further below and in Appendix J.

Operational Noise Criteria

The INP assessment procedure for industrial noise sources has two components (EPA, 2000b):

- controlling potential intrusive noise impacts in the short-term for residences; and
- maintaining noise level amenity for particular land uses, for residences and other land uses.

The INP prescribes detailed calculation routines for establishing Project-specific $L_{Aeq\ (15\ minute)}$ intrusive criteria and $L_{Aeq\ (period)}$ amenity criteria. The INP Project-specific intrusive and amenity assessment criteria for the Project are presented in Table 4-17. As the applicable Project-specific intrusive criteria are the most stringent, the Project-only noise levels are assessed against the intrusive criteria and cumulative noise levels against the amenity criteria (Appendix J).

Operational Noise Modelling

An acoustic model for the Atlas-Campaspe Mine was developed by Wilkinson Murray (2012) that simulates the components of the Atlas-Campaspe Mine using noise source information (i.e. sound power levels and locations) and predicts noise levels at relevant receiver locations. The model considers meteorological effects, surrounding terrain and the distance from source to receiver.

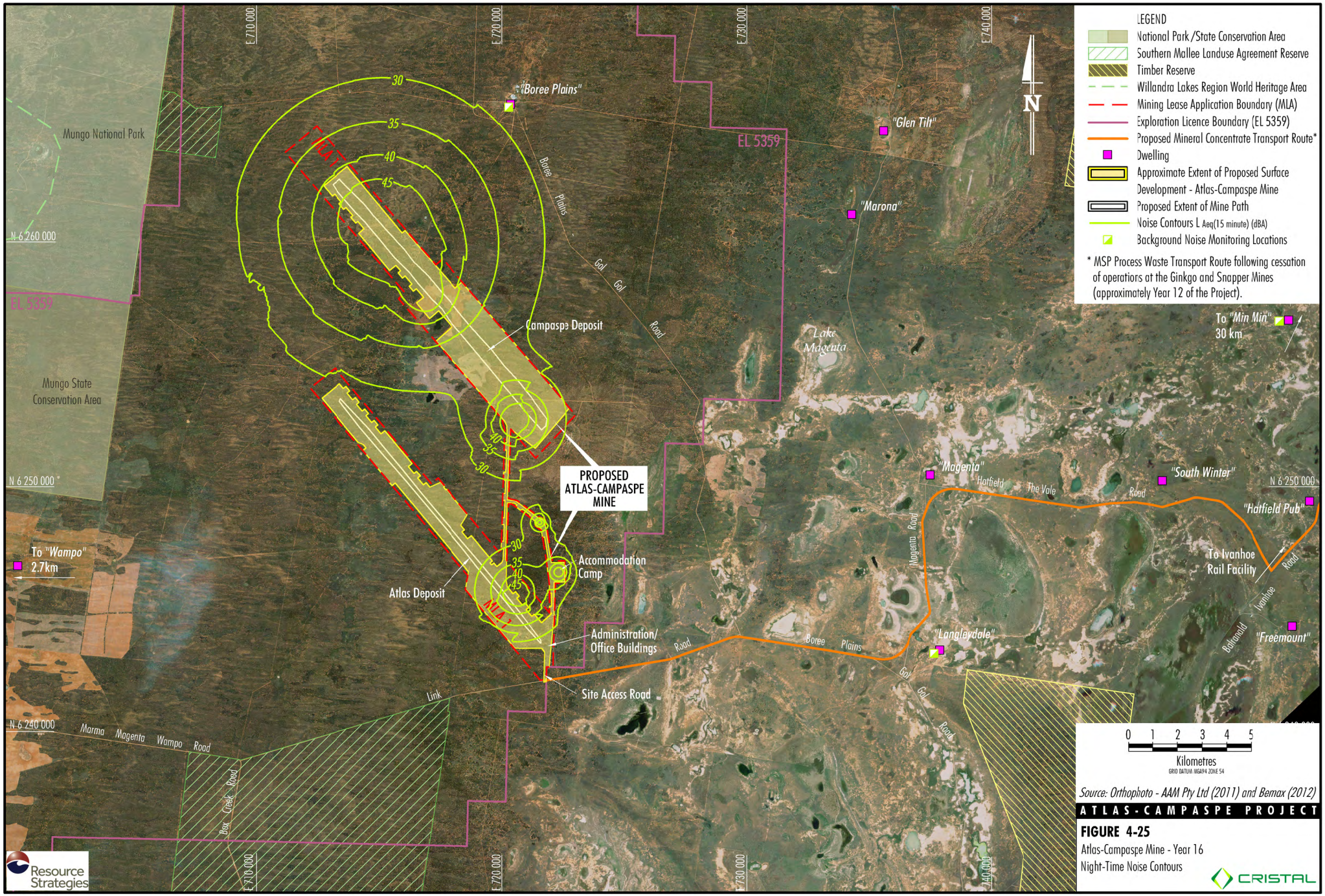

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Table 4-17
INP Project-specific Intrusive and Amenity Assessment Criteria (dBA)

Project Component	Receiver	Land Use	Intrusive $L_{Aeq\ (15\ minute)}$			Amenity $L_{Aeq\ (period)}$		
			Day	Evening	Night	Day	Evening	Night
Atlas-Campaspe Mine	All Residential Receivers	Rural Residential	35	35	35	50	45	40
	Mungo National Park/Mungo State Conservation Area		NA			50		
Ivanhoe Rail Facility	All Receivers	Suburban	35	35	35	55	45	40

Source: Appendix J.

Daytime – 7:00 am to 6:00 pm; Evening – 6:00 pm to 10:00 pm; Night – 10:00 pm to 7:00 am.

The locations of modelled receivers (i.e. dwellings) relevant to the Atlas-Campaspe Mine are shown on Figure 4-25.

Operations at the Atlas-Campaspe Mine were modelled for Year 16 of the Project to assess the maximum potential noise impact at the nearest residential receiver (Boree Plains) (Figure 4-25). Modelling for Year 16 would represent the maximum potential noise impact as the maximum Project fleet is anticipated to operate at the closest point along the mine path to the nearest residential receiver during this year.

An additional acoustic model was separately developed by Wilkinson Murray (2012) to simulate the operational components of the Ivanhoe Rail Facility. The Ivanhoe Rail Facility acoustic model predicted noise levels at relevant receiver locations using source information (i.e. sound power levels and locations). The model considered meteorological effects, surrounding terrain and the distance from source to receiver.

As operations at the Ivanhoe Rail Facility would generally remain unchanged throughout the Project life, a worst case scenario was assumed to represent all operational scenarios.

The locations of modelled receivers (i.e. dwellings) relevant to the Ivanhoe Rail Facility are shown on Figure 4-26.

Assessment of Meteorological Conditions

Conservative assumptions with respect to a combination of wind effects and temperature inversions have been included in the modelling. Details of the modelled meteorological conditions are provided in Appendix J.

Potential Operational Noise Impacts

Based on the results of the operational noise modelling at the Atlas-Campaspe Mine, compliance with the Project specific and amenity noise criteria (Table 4-17) was predicted at all receiver locations for Project Year 16 during the day, evening and night under worst-case meteorological conditions (Appendix J).

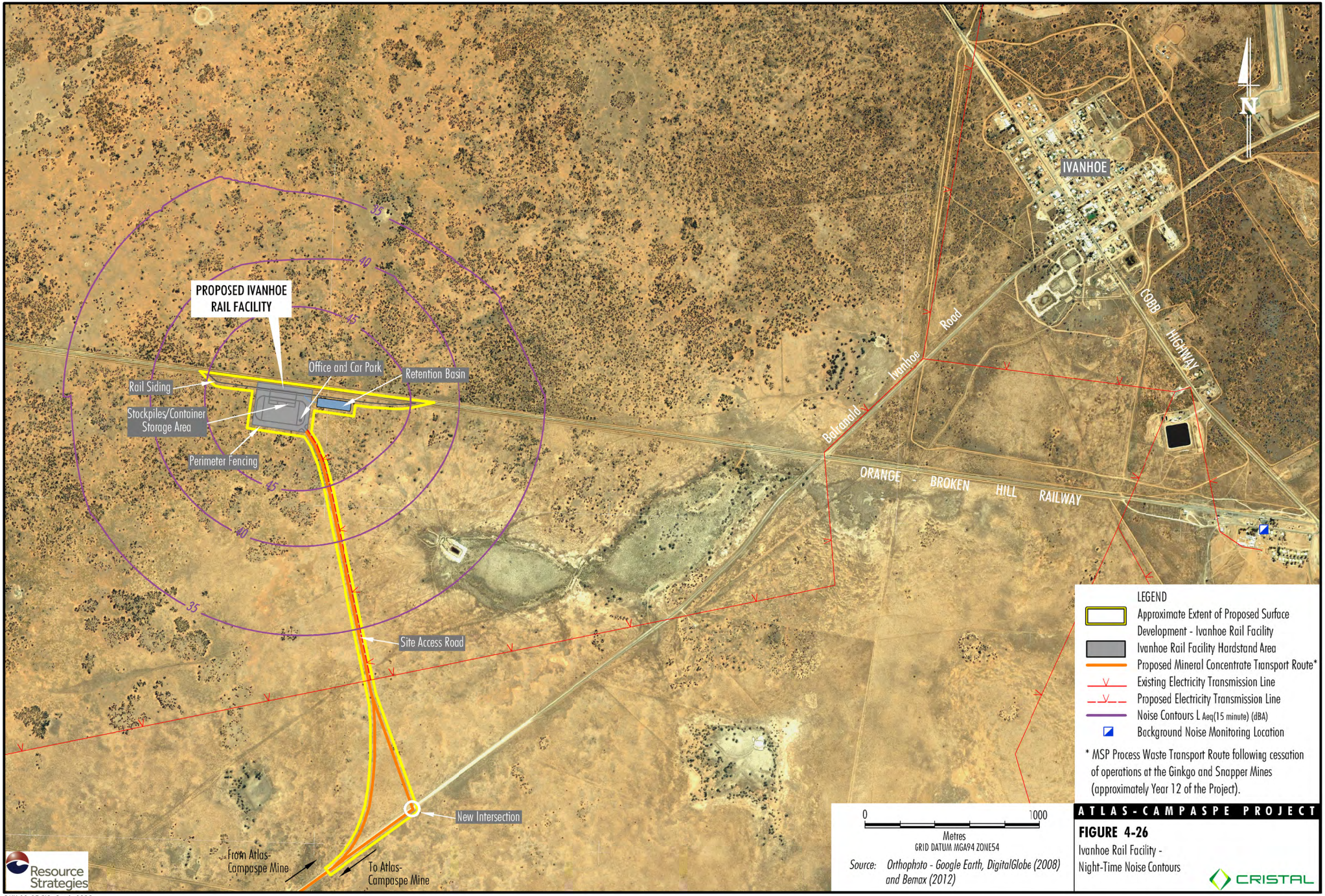
Noise contour plots for Project Year 16 operations during the night are shown in Figure 4-25. Results for all assessed receiver locations are provided in Appendix J.

Operational noise monitoring undertaken for the Ivanhoe Rail Facility predicted compliance with the Project specific and amenity noise criteria (Table 4-17) at all receiver locations during the day evening and night under worst-case meteorological conditions (Appendix J).

Noise contour plots for operations during the night at the Ivanhoe Rail Facility are shown in Figure 4-26. Results for all assessed receiver locations are provided in Appendix J.

Assessment of Feasible and Reasonable Mitigation Measures

Preliminary modelling of operations at the Atlas-Campaspe Mine conducted by Wilkinson Murray (2012) was undertaken using an unattenuated operational fleet. This preliminary modelling indicated that no exceedances of relevant criteria at the Atlas-Campaspe Mine could be expected. On this basis, no further investigation of measures to mitigate potential noise impacts was undertaken.



ATLAS-CAMPASPE PROJECT

FIGURE 4-26

Ivanhoe Rail Facility - Night-Time Noise Contours

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Wilkinson Murray (2012) conducted an investigation of feasible and reasonable noise mitigation measures for operations at the Ivanhoe Rail Facility. As outlined in Section 6.9.2, the Ivanhoe Rail Facility was relocated during the early stages of preparation of the EIS due to potential noise impacts on sensitive receptors within and surrounding the Ivanhoe township.

The Ivanhoe Rail Facility is proposed to be located approximately 4.5 km from Ivanhoe, a distance sufficient to result in no exceedances of criteria at any receptor surrounding the Ivanhoe Rail Facility (Appendix J). On this basis, no further investigation of measures to mitigate potential noise impacts was undertaken.

Sensitive Land Use Areas

Potential noise impacts on sensitive land use areas surrounding the Atlas-Campaspe Mine including the Mungo National Park, Mungo State Conservation Area and Willandra Lakes Region World Heritage Area were assessed by Wilkinson Murray (2012) (Appendix J).

No exceedances of the relevant INP amenity criteria were predicted at any of the sensitive land use areas surrounding the Atlas-Campaspe Mine (Appendix J). Operations at the Atlas-Campaspe Mine are likely to be inaudible under most meteorological conditions at sensitive land use areas surrounding the Atlas-Campaspe Mine (Appendix J).

Sleep Disturbance

Appendix J presents an assessment of potential sleep disturbance impacts for operations at the Atlas-Campaspe Mine and the Ivanhoe Rail Facility. A sleep disturbance criterion of $L_{A1(1\ minute)}$ 45 dBA has been adopted by the EPA.

The assessment concluded that no receiver would exceed the sleep disturbance criterion at the Atlas-Campaspe Mine or the Ivanhoe Rail Facility (Appendix J).

Construction Noise

Appendix J presents an assessment of the potential noise impacts associated with construction activities at the Atlas-Campaspe Mine (Appendix J).

The assessment concluded that no receiver would exceed the Project specific noise criteria (Appendix J).

Construction activities at the Ivanhoe Rail Facility are to be undertaken on a campaign basis during daytime hours only (i.e. when strong inversion conditions are less likely to be present) and as such, no modelling of construction noise was undertaken (Appendix J).

Cumulative Noise Emissions

The operation of the Balranald Mineral Sands Project is not yet approved, however, its operation was considered as a cumulative noise source in the Noise Assessment (Appendix J).

Available information regarding the Balranald Mineral Sands Project (EMGA Mitchell McLennan, 2012) suggests that the active mining areas of the Atlas-Campaspe Mine and the Balranald Mineral Sands Project would be separated by a minimum distance of approximately 21 km (Appendix J).

No potential cumulative noise impacts are expected from the coincident construction or operation of the Atlas-Campaspe Mine and the Balranald Mineral Sands Project (Appendix J).

Road Traffic Noise

Road Noise Criteria

Road traffic noise along public roads has been assessed by Wilkinson Murray (2012) in accordance with the RNP, which establishes criteria for the assessment of road noise in NSW (Appendix J). The total traffic noise criteria are provided in Table 4-18.

Table 4-18
Relevant Criteria for Road Traffic Noise – Residences

Road	Type of Development	Noise Level Criterion	
		Day (7.00 am to 10.00 pm)	Night (10.00 pm to 7.00 am)
Balranald-Ivanhoe Road	Existing residences affected by additional traffic on existing freeways/ arterial/ sub-arterial roads generated by land use developments	$L_{Aeq\ (15\ hour)}$ 60 dBA	$L_{Aeq\ (9\ hour)}$ 55 dBA
Magenta Road, Hatfield-The Vale Road	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq\ (1\ hour)}$ 55 dBA	$L_{Aeq\ (1\ hour)}$ 50 dBA

Source: Appendix J.

Predicted Road Noise Emissions

The following roadways which make up the mineral concentrate transport route were assessed for road traffic noise (Appendix J):

- Magenta Road;
- Hatfield-The Vale Road; and
- Balranald-Ivanhoe Road north of the intersection with Hatfield-The Vale Road.

In addition, the road traffic noise along Balranald-Ivanhoe Road south of the intersection with Hatfield-The Vale Road was assessed to account for Project related traffic (i.e. employee movements and deliveries).

The methodology for the road traffic noise assessment was to:

- calculate existing traffic road noise levels;
- calculate road noise levels in Project Years 1 and 20[3] due to Project and cumulative traffic movements; and
- compare these noise levels with the relevant RNP criteria.

Rail Noise

Product mineral concentrates produced at the Atlas-Campaspe Mine would be transported by rail from the Ivanhoe Rail Facility to the MSP via the Orange – Broken Hill railway. Consequently, a rail noise assessment was undertaken for the Orange – Broken Hill railway (Appendix J).

Rail Noise Criteria

The EPA's rail traffic-generating development assessment trigger levels (EPA, 2012a) are presented in Table 4-19. An assessment of rail noise impacts against the ARTC's EPL noise goals and the recently released draft EPA guideline (i.e. Draft *Rail Infrastructure Noise Guideline* [EPA, 2012b]) is presented in Appendix J.

Table 4-19
EPA Rail Noise Assessment Trigger Levels

Descriptor	Trigger Level
$L_{Aeq\ (24\ hour)}$	60 dBA
Maximum Pass-by L_{Amax} (95^{th} percentile)	85 dBA
Project-related rail noise increase	>0.5 dBA

Source: Appendix J.

It is noted that the DGRs also make reference to the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (IGANRIP). The Project is not a rail infrastructure project and the proposed Ivanhoe Rail Facility rail siding (which is not proximal to any residential or noise-sensitive receivers) can be considered "minor works" which fall outside the IGANRIP. As such, the IGANRIP has not been considered further in this EIS.

Predicted Rail Noise Emissions

A rail noise assessment was conducted in accordance with EPA requirements for rail traffic-generating development (EPA, 2012a). The rail noise assessment focused on the Orange – Broken Hill railway between the Ivanhoe Rail Facility and the MSP at Broken Hill (Appendix J).

Using data on existing, approved and proposed train movements, Wilkinson Murray (2012) modelled cumulative train movements and the distance from the rail line at which EPA trigger levels would be exceeded using predicted energy average L_{Aeq} and sound exposure level noise levels from the RailCorp NSW standard rail noise database for passenger trains, locomotives and freight wagons.

The results of the modelling indicated that increases in rail noise due to the Project would be minor and less than 2 dBA. The distance from the rail line at which the relevant EPA 24-hour trigger levels would be met is predicted to increase by a negligible 2 m as a result of the additional Project rail movements. The Project rail movements would not result in any additional sensitive receivers exceeding the relevant EPA rail noise trigger levels (Appendix J).

The L_{Amax} passby noise levels would not change due to the Project (Appendix J).

The EPA indicates that where the cumulative rail noise level exceeds the noise assessment trigger levels and Project-related noise increases of greater 0.5 dBA are predicted, then all feasible and reasonable noise mitigation measures should be implemented. Further, in all cases where the L_{Aeq} noise level increases are more than 2 dBA, strong justification should be provided as to why it is not feasible or reasonable to reduce the increase (EPA, 2012a).

[3] Year 20 projections included a conservative estimate of traffic generated by the proposed Balranald Mineral Sands Project.

The peak Project-related rail noise level increase is predicted by the model to be 0.7 dBA (therefore slightly greater than 0.5 dBA), however, no additional receivers are predicted to exceed the relevant EPA rail noise trigger levels. Therefore, it was concluded by Wilkinson Murray (2012) that the assessment of feasible and reasonable noise mitigation measures is not warranted for the Project.

Vibration

As outlined in Section 2.11, no blasting would be undertaken as part of the Project. Notwithstanding, road movements for the Project along the proposed mineral concentrate transport route are not expected to result in any perceptible level of vibration at any receiver along the mineral concentrate transport route (Appendix J).

The additional rail movements associated with the Project along the Orange – Broken Hill railway are not expected to result in any increase to the current level of vibration effects experienced at any receiver along the rail line (Appendix J).

4.12.3 Mitigation Measures, Management and Monitoring

Noise Management Plan

Notwithstanding the predicted compliance with applicable noise level criteria at the nearest residences, a range of measures would be employed to control and/or reduce noise emissions at both the Atlas-Campaspe Mine and the Ivanhoe Rail Facility, including:

- development and implementation of an equipment maintenance schedule to maintain equipment noise emission levels and reduce the likelihood of tonal noise impacts; and
- development of a noise awareness programme to educate employees on the effects of noise and quiet work practices.

These and other measures would be outlined in a Noise Management Plan (NMP) which would be prepared for the Project.

The NMP would also describe the following:

- applicable noise criteria;
- potential sources of noise emissions;
- emission mitigation and management measures;
- the noise monitoring programme;
- emission management protocols;
- stakeholder consultation; and
- reporting requirements.

Road Traffic Noise Mitigation

As described in the RNP (DECCW, 2011), projects that generate additional traffic on existing roads have limited potential for noise control, because these developments are not usually linked to road improvements.

The following road traffic noise mitigation measures and strategies would be implemented for the Project:

- Staff and drivers would be made aware of the potential for noise impact through site-specific inductions and staff education programmes to reinforce quiet driving styles/attitudes.
- The number of vehicle trips to and from the Atlas-Campaspe Mine site would be optimised by ensuring that transport trucks are loaded to their operating capacity.
- All loose and rattling truck body parts would be fixed or tightened to minimise noise emissions from 'body rumble' (i.e. when loose panels vibrate when a truck hits a bump, causing noise to emanate from the panel).

Noise Monitoring Programme

A noise monitoring programme would be developed for the Project.

The noise monitoring programme would include half yearly attended noise monitoring at locations along the mineral concentrate transport route and at the Ivanhoe Rail Facility. Following the completion of two years of attended noise monitoring, the results of this monitoring and the need for ongoing attended noise monitoring would be reviewed.

In addition, half yearly attended noise monitoring would be undertaken at the nearest residential receiver (Boree Plains) during Years 14 to 18 (i.e. when mining operations are nearest the receiver). The need for half yearly attended noise monitoring would be reviewed following five years of monitoring at Boree Plains (Appendix J).

It is noted that the DGRs suggest the implementation of real-time noise monitoring and predictive meteorological forecasting as part of the Project. Given the predicted level of impact as a result of Project operations, it is not considered reasonable to implement real-time noise monitoring nor predictive meteorological forecasting as part of the Project (Appendix J).

4.13 ROAD TRANSPORT

A Road Transport Assessment for the Project was undertaken by GTA Consultants (2012a) and is presented in Appendix D.

The assessment was prepared in accordance with the *Guide to Traffic Generating Developments* (RTA, 2002), and where relevant, makes reference to the RTA's (1996) *Road Design Guide* and Austroads standards.

Section 4.13.1 provides a description of the existing road network and traffic volumes. Section 4.13.2 provides an assessment of the potential impacts of the Project on the public road network.
Section 4.13.3 provides the proposed mitigation and management measures for road transport.

4.13.1 Existing Environment

Road Hierarchy and Conditions

State Roads

The Sturt Highway (State Highway 14) provides access to regional centres such as Buronga, Balranald, Hay, Narrandera and Wagga Wagga. In the vicinity of Balranald, the Sturt Highway has a sealed surface and a single travel lane in each direction. The Sturt Highway (Figure 4-27) runs generally east-west to the south of the Project and provides a link between the Hume Highway to Buronga in south-west NSW (Appendix D).

The Cobb Highway (State Highway 21) (Figure 4-27) provides a south-east to north-west link between Victorian border to Wilcannia in western NSW. In the vicinity of Ivanhoe, the Cobb Highway typically has a sealed carriageway (Appendix D).

The Silver City Highway (State Highway 22) links the Sturt Highway at Buronga to Broken Hill (Figure 4-27). The Silver City Highway has a sealed surface and a single travel lane in each direction (Appendix D).

Regional Roads

The Balranald-Ivanhoe Road (Main Road 67) provides access between the Sturt Highway in Balranald to the Cobb Highway at Ivanhoe (Figure 4-27). The Balranald-Ivanhoe Road is a two-lane road and has a sealed surface between Balranald and a point in the vicinity of the boundary of the Balranald LGA and the Central Darling LGA (Figure 4-27). North of this point, the road includes sections of unsealed and sealed road surface. This road is an approved route for road trains[4] (Appendix D).

Local Roads

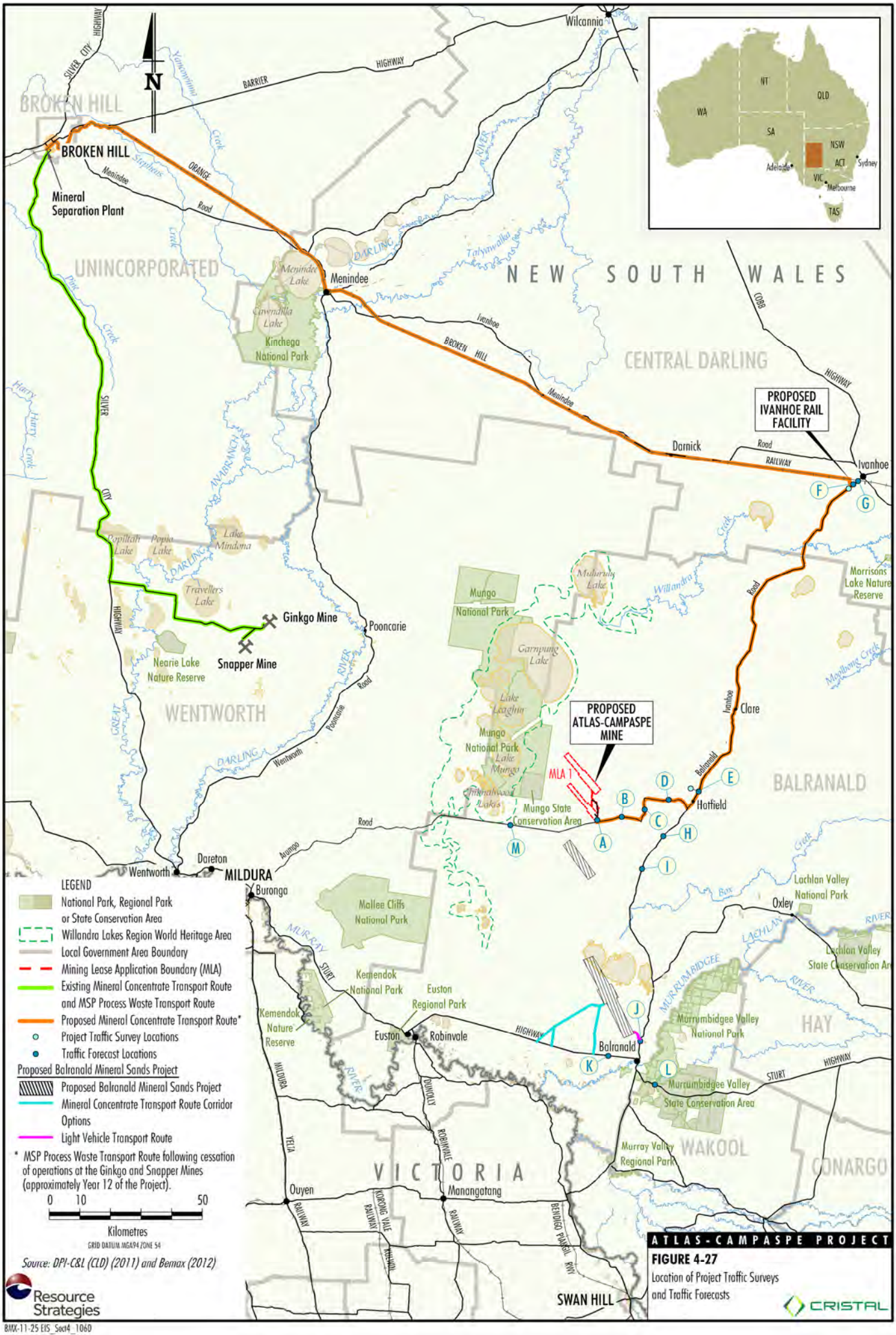
Hatfield-The Vale Road provides an east-west link between Balranald-Ivanhoe Road and Magenta Road and continues to the north past its intersection with Magenta Road (Figure 2-3). Traffic on Hatfield-The Vale Road has priority at the intersection with Magenta Road. It is unsealed with a poor road surface which does not allow for wet weather access or for two large vehicles to pass at speed (Appendix D).

Magenta Road extends in a north-south direction between Hatfield-The Vale Road and Boree Plains-Gol Gol Road (Figure 2-3). It is unsealed with a poor road surface which does not allow for wet weather access or for two large vehicles to pass at speed. The intersections at each end of Magenta Road are T-intersections, with Magenta Road as the terminating leg. Traffic on Hatfield-The Vale Road and Boree Plains-Gol Gol Road has priority at these intersections (Appendix D).

Link Road links Boree Plains-Gol Gol Road to the intersection of Marma Magenta Wampo Road and Box Creek Road (Figure 2-3). It is unsealed with a poor road surface which does not allow for wet weather access. The road width is sufficient for two large vehicles to pass (Appendix D).

Boree Plains-Gol Gol Road extends from Balranald-Ivanhoe Road to Boree Plains Station (Figure 2-3). Its intersection with Magenta Road is a T-intersection and is aligned such that Boree Plains-Gol Gol Road has priority. The Boree Plains-Gol Gol Road and Link Road intersection is also aligned such that Boree Plains-Gol Gol Road has priority. Boree Plains-Gol Gol Road is an unsealed road with a poor road surface. East of its intersection with Link Road, it has sufficient width for two large vehicles to pass (Appendix D).

[4] Type 1 road train, as defined in RMS, 2012.



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Marma Magenta Wampo Road provides an east-west link between the Link Road and Box Creek Road intersection and Arumpo Road (Figure 4-27). It is unsealed with a poor road surface which does not allow for wet weather access. The intersection of Marma Magenta Wampo Road with Link Road and Box Creek Road is a T-intersection with Link Road, with Link Road as the terminating leg (Appendix D).

Arumpo Road links from the Silver City Highway north of Buronga to the Mungo National Park (Figure 4-27). Its intersection with Marma Magenta Wampo Road is a T-intersection and is aligned such that Arumpo Road has priority. Arumpo Road is a two-lane road, and has a sealed surface between the Silver City Highway and a point approximately 18 km north-east of its intersection with the Silver City Highway. North-east of this point, it has a good quality unsealed road surface (Appendix D).

Existing Traffic Volumes

Available traffic flow data was reviewed and additional traffic counts were conducted in May 2012. The location of Project traffic counts are shown on Figure 4-27. The existing daily traffic volumes are summarised in Table 4-20.

GTA Consultants (2012b) also conducted a Road Safety Audit on the proposed mineral concentrate transport route and identified a number of safety deficiencies on Balranald-Ivanhoe Road, including:

- unprotected watercourses;
- inconsistent guideposts;
- poor linemarking;
- lack of curve guidance;
- lack of raised reflective pavement markers; and
- unprotected headwalls.

4.13.2 Potential Impacts

Potential traffic impacts of the Project on traffic generation, roadway capacity and safety are assessed in Appendix D and summarised below.

Table 4-20
Existing Average Weekday Traffic Volumes (Vehicles/Day)

Site[1]	Road and Location	Daily Traffic Volume
A	Atlas-Campaspe Mine Site Access Road	Not Applicable*
B	Link Road	20
C	Magenta Road	20
D	Hatfield-The Vale Road	20
E	Balranald-Ivanhoe Road – North of Hatfield-The Vale Road	44
F	Ivanhoe Rail Facility Site Access Road	Not Applicable*
G	Balranald-Ivanhoe Road – North of Ivanhoe Rail Facility	48
H	Balranald-Ivanhoe Road – South of Hatfield-The Vale Road	44
I	Balranald-Ivanhoe Road – North of Balranald Mineral Sands Project	44
J	Balranald-Ivanhoe Road – South of Balranald Mineral Sands Project	275
K	Sturt Highway – West of Balranald	1,029
L	Sturt Highway – East of Balranald	1,029
M	Marma Magenta Wampo Road – West of Link Road	20

Source: After Appendix D.

[1] Refer to Figure 4-27.

* Road to be constructed as a component of the Project.

Mineral Concentrate and MSP Process Waste Transport

As described in Section 2.6.6, mineral concentrate would be hauled from the Atlas-Campaspe Mine to the Ivanhoe Rail Facility via the proposed mineral concentrate route (Figures 2-3, 2-9 and 4-27). The mineral concentrate would be transported in road trains[5].

Up to a maximum 24 haulage vehicle trips (i.e. 48 haulage vehicle movements) per day would be required, with approximately 19 haulage vehicle trips (i.e. 38 haulage vehicle movements) per day on average over the life of the Project.

Road transport of mineral concentrate and MSP process waste would be undertaken 24 hours per day, seven days per week.

Up until cessation of the Ginkgo and Snapper Mine operations (approximately Year 12 of the Project), the transport of MSP process waste would be undertaken in accordance with existing/approved Transport Management Plan required under PA (06_0168) for the Snapper Mine and Traffic Code of Conduct and Transport of Hazardous Materials Plan required under Development Consent (DA 251-09-01) for the Ginkgo Mine, or as otherwise modified subject to separate assessment and approval.

From approximately Year 12 of the Project, MSP process waste in sealed containers would be unloaded from trains at the Ivanhoe Rail Facility, and temporarily held in a designated area prior to loading onto haulage vehicles for the return trip to Atlas-Campaspe Mine. Therefore no additional haulage movements for the MSP process waste, in addition to the mineral concentrate haulage vehicle movements, would be required for the Project.

As the MSP process waste is expected to be classified Hazardous under the PoEO Act (Section 2.8.3), it would be transported in accordance with the *Code of Practice for the Safe Transport of Radioactive Material* (ARPANSA, 2008).

In the event of road closures along the mineral concentrate transport route by relevant authorities (e.g. due to a significant rainfall event/ flooding), the transport of mineral concentrate would temporarily cease until the mineral concentrate transport route is re-opened.

Roadworks along Mineral Concentrate Transport Route

As described in Section 2.4.10, roadworks would be conducted on approximately 37 km of existing unsealed roads between the Atlas-Campaspe Mine site access road and the intersection with the sealed Balranald-Ivanhoe Road (Figure 2-10). In addition, a new intersection would be required for the Ivanhoe Rail Facility site access road off Balranald-Ivanhoe Road (Figure 2-9).

The roadworks would be undertaken in consultation with the BSC or CDSC and in accordance with the requirements of the *Road Design Guide* (RTA, 1996).

Additional details of the mineral concentrate transport route roadworks is provided in Section 2.4.10.

The safety deficiencies on Balranald-Ivanhoe Road identified by the Road Safety Audit (GTA Consultants, 2012b) (Section 4.13.1) would be progressively addressed in conjunction with BSC, CDSC and RMS during maintenance activities in accordance with the requirements of the relevant RMS guidelines.

Project Traffic Generation

Table 4-21 summarises the estimated existing and predicted Project daily vehicle movements (traffic in both directions). As shown in Table 4-21, Project traffic generation would be highest during Year 1 (construction).

Table 4-21
Predicted Project Traffic Volumes (Vehicles/Day)

Vehicle Type	Year 1	Year 20
Light Vehicles	244	162
Heavy Vehicles	10	10
Mineral Concentrate Transport	0	48
Total Vehicles	**254**	**220**

Source: After Appendix D.

Cumulative Traffic Increases

The Project life would be approximately 20 years. In order to conservatively consider the potential impacts of the Project in the context of potential background traffic growth and traffic growth associated with other approved and proposed projects, an annual baseline growth rate and the expected traffic generation from other key projects (i.e. proposed Balranald Mineral Sands Project) has been considered.

[5] Type 1 road train.

Historic AADT data indicates that daily traffic volumes have not altered significantly over recent years, suggesting negligible growth in background traffic over that period.

A conservative 1% per annum baseline traffic growth rate was applied to the existing traffic volumes (Appendix D). In addition, the expected traffic movements generated from the proposed Balranald Mineral Sands Project have been estimated.

Table 4-22 presents the predicted traffic flows in Year 1 (construction) and Year 20 on key roads (Figure 4-27) including Project traffic flows, traffic flows from the Balranald Mineral Sands Project and estimated background traffic growth.

With the implementation of the mineral concentrate transport route roadworks, it is expected that for all traffic forecast locations shown on Figure 4-27, the future Level of Service would be A, with the predicted traffic volumes shown in Table 4-22.

Intersection Performance

With the implementation of the mineral concentrate transport route roadworks, there is expected to be no capacity concerns regarding the future operation of intersections in the vicinity of the Project (Appendix D).

Level Crossings

The proposed mineral concentrate transport route would not cross the Orange – Broken Hill railway nor pass through the township of Ivanhoe (Figure 2-9) (i.e. only employees and other traffic would cross the Orange – Broken Hill railway or pass through the township of Ivanhoe).

GTA Consultants (2012a) considered the incremental risk of road and rail traffic interaction due to the increase in Project road movements (i.e. employees and other traffic) at the Orange – Broken Hill railway crossing south of Ivanhoe (Figure 2-9) and concluded the risk would be low (Appendix D).

GTA Consultants (2012a) also concluded that the Project rail traffic would not significantly increase the risk of road and rail traffic interaction along the Orange – Broken Hill railway between Ivanhoe and Broken Hill (Appendix D).

Road Safety Review

The Road Transport Assessment (Appendix D) found that there were no accident causation factors in the vicinity of the Project. As the increases in traffic resulting from the Project would be relatively minor, GTA Consultants (2012a) consider that the Project is unlikely to result in any safety concerns on the surrounding road network.

Table 4-22
Predicted Cumulative Traffic Volumes (Vehicles/Day)

Site[1]	Road and Location	Existing	Year 1	Year 20
A	Atlas-Campaspe Mine Site Access Road	NA*	238	214
B	Link Road	20	258	234
C	Magenta Road	20	258	234
D	Hatfield-The Vale Road	20	258	234
E	Balranald-Ivanhoe Road – North of Hatfield-The Vale Road	44	147	157
F	Ivanhoe Rail Facility Site Access Road	NA*	16	54
G	Balranald-Ivanhoe Road – North of Ivanhoe Rail Facility	48	167	119
H	Balranald-Ivanhoe Road – South of Hatfield-The Vale Road	44	245	187
I	Balranald-Ivanhoe Road – North of Balranald Mineral Sands Project	44	245	187
J	Balranald-Ivanhoe Road – South of Balranald Mineral Sands Project	275	820	633
K	Sturt Highway – West of Balranald	1,029	1,266	1,512
L	Sturt Highway – East of Balranald	1,029	1,105	1,307
M	Marma Magenta Wampo Road – West of Link Road	20	129	74

Source: After Appendix D.

[1] Refer to Figure 4-27.

* Road to be constructed as a part of the Project.

NA = Not Applicable.

With the exception of the proposed roadworks (as discussed above in *Roadworks along Mineral Concentrate Transport Route*), no specific management or mitigation measures are considered to be warranted by the Project (Appendix D).

The forecast number of mineral concentrate and MSP process waste transport movements is sufficiently low that the likelihood of interaction with other vehicles would remain low (Appendix D).

Oversize Traffic

A number of overwidth, overheight, or overweight loads may be generated during the life of the Project. These oversize vehicle movements would be associated with the transport of construction and mining equipment and infrastructure to and from the Project. All such loads would be negotiated with RMS and relevant local councils on a case-by-case basis. All oversize loads would be transported with the relevant permits obtained in accordance with *Operating Conditions: Specific permits for oversize and over-mass vehicles and loads* (RMS, 2007) and any other licences and escorts as required by the regulatory authorities.

Fatigue

Employees would generally work 12 hour shifts, starting at 7.00 am or 7.00 pm. Fatigue could potentially affect employee awareness/alertness when driving home after finishing a shift.

4.13.3 Management Measures

No significant impacts on the performance, capacity, efficiency and safety of the local road network are expected as a result of the Project.

Notwithstanding, Cristal Mining would implement the following road transport management measures:

- Roadworks would be undertaken in consultation with the BSC or CDSC and in accordance with the requirements of the *Road Design Guide* (RTA, 1996).
- The safety deficiencies identified on Balranald-Ivanhoe Road by the Road Safety Audit (GTA Consultants, 2012b) would be progressively addressed in conjunction with the BSC, the CDSC and the RMS during maintenance activities in accordance with the requirements of the relevant RMS guidelines.
- MSP process waste would be transported in accordance with the *Code of Practice for the Safe Transport of Radioactive Material* (ARPANSA, 2008).
- All oversized vehicles would have the relevant permits, licences and escorts, as required by the government agencies and the proposed route would be negotiated with the relevant local councils.
- All oversize vehicles loads would be appropriately secured and covered.

To improve driver awareness/alertness, Cristal Mining would identify potential fatigue risks in the site inductions and would encourage employees to rest/revive after finishing their shifts, and prior to driving home.

In addition, Cristal Mining would prepare and implement a Mineral Concentrate and MSP Process Waste Transport Management Plan for the Project that would cover the following aspects:

- driver training;
- operating hours;
- vehicle identification;
- driver code of conduct;
- load covering;
- labelling and placarding requirements for transporting MSP process waste;
- fatigue management;
- drug and alcohol policy; and
- vehicle maintenance and safety programme.

Cristal Mining would enter into road maintenance agreements with BSC, CDSC and RMS to address the ongoing maintenance requirements for the Project. The road maintenance agreements would specify the timing for the implementation of maintenance to address the safety deficiencies identified in the Road Safety Audit (GTA Consultants, 2012b).

With the exception of the proposed roadworks (Section 4.13.2), no specific monitoring or mitigation measures are considered warranted (Appendix D).

4.14 VISUAL CHARACTER

A description of the existing visual setting of the Project is provided in Section 4.14.1. Section 4.14.2 describes the potential visual impacts of the Project, including cumulative impacts, and Section 4.14.3 outlines visual impact mitigation and management measures.

4.14.1 Existing Environment

The Project area and surrounds comprises a number of distinct land use types and landscape units of varying levels of landscape quality. These have been defined as follows:

- Rural residences – detached dwellings located mostly to the east of the Atlas-Campaspe Mine and north-east of the Ivanhoe Rail Facility.
- Townships and settlements – including the township of Ivanhoe (located approximately 4.5 km north-east of the Ivanhoe Rail Facility).
- Agricultural areas – both the Atlas-Campaspe Mine and Ivanhoe Rail Facility are located on pastoral leasehold lands used for light intensity grazing.
- The Willandra Lakes Region World Heritage Area – located approximately 10 km west of the Atlas-Campaspe Mine footprint at its closest point.
- Mungo National Park – located approximately 5 km west of the Atlas-Campaspe Mine footprint at its closest point.
- Mungo State Conservation Area – located approximately 8 km west of the Atlas-Campaspe Mine footprint at its closest point.
- Orange – Broken Hill railway – located adjacent to the Ivanhoe Rail Facility.

Land use and key landscape features that contribute to visual character and scenic quality are described below in the context of the regional, sub-regional and local settings.

Topographic features of the Project area and surrounds are described further in Section 4.3.1.

Regional Setting (>5 km)

The regional setting of the Atlas-Campaspe Mine has attributes of moderate to high scenic quality due to the presence of a number of reserved areas (e.g. the Willandra Lakes Region World Heritage Area, Mungo National Park, Mungo State Conservation Area and other privately managed conservation reserves).

There are no townships or settlements in the regional setting of the Atlas-Campaspe Mine that are of relevance (i.e. that contribute to visual character and scenic quality).

All surrounding rural residences in proximity to the Atlas-Campaspe Mine are located in the regional setting.

The regional setting of the Ivanhoe Rail Facility has attributes of moderate to low scenic quality, due to its proximity (approximately 4.5 km) to the township of Ivanhoe and greater distances to the reserved areas in the region.

The Balranald-Ivanhoe Road (Main Road 67) is the closest major road in the regional setting of the Atlas-Campaspe Mine and Ivanhoe Rail Facility.

Sub-regional Setting (1 to 5 km)

The sub-regional settings of both the Atlas-Campaspe Mine and Ivanhoe Rail Facility comprise similar features to that found within the regional setting, and therefore have similar attributes of scenic quality.

There are no townships or settlements located within the sub-regional setting of the Atlas-Campaspe Mine. The township of Ivanhoe is located within the sub-regional setting of the Ivanhoe Rail Facility and is representative of the nearest residential area.

Boree Plains-Gol Gol Road is the closest local road within the sub-regional setting of the Atlas-Campaspe Mine. The Balranald-Ivanhoe Road is the major road in the sub-regional setting of the Ivanhoe Rail Facility and is located approximately 2.2 km from the Ivanhoe Rail Facility.

Local Setting (<1 km)

The local settings of both the Atlas-Campaspe Mine and Ivanhoe Rail Facility are characterised by limited topographical relief and cleared pastoral lands and are of low scenic quality.

The Orange – Broken Hill railway is located within the local setting of the Ivanhoe Rail Facility. Whilst the railway line is used mostly for trans-continental freight, it is also used by the Indian Pacific passenger train (weekly service between Sydney and Broken Hill, operated by Great Southern Rail) and for a weekly passenger train (operated by Country Link) (Great Southern Rail, 2012; Transport NSW, 2011).

The only local road less than 1 km from the Atlas-Campaspe Mine is Link Road. There are no existing roads in the local setting of the proposed Ivanhoe Rail Facility.

4.14.2 Potential Impacts

Landscape Alteration

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 Project would be either temporary (i.e. short-term) 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, mineral concentrate stockpiles, workshop/administration facilities, accommodation camp and sediment dams).

Permanent landscape impacts would result from the development of mine landforms that would remain post-mining including the overburden emplacements and final voids (Section 5).

The nature of the landscape impacts would vary according to the rehabilitation status both during and post-mining. The initial overburden emplacements (up to approximately 20 m high) would operate for periods during mining when there is insufficient capacity to place all overburden behind the ore extraction areas (e.g. the initial stages of mining at the Atlas and Campaspe deposits [i.e. Years 2 and 6]) and would then be rehabilitated.

Final landforms associated with rehabilitated final voids and water management infrastructure would include a shallow depression above the groundwater table. The depths of the final voids at the north-western extent of the Atlas and Campaspe mine paths would be approximately 10 to 15 m and approximately 15 to 20 m, respectively.

Water management infrastructure walls would be pushed in and re-profiled generally consistent with pre-mining topography as far as practicable.

Roads within the Atlas-Campaspe Mine site would be retained or rehabilitated following cessation of mining, depending on the results of consultation with regulatory authorities and local landholders. The roads would be largely located on natural grade and would not represent significant landform alterations.

At the Ivanhoe Rail Facility, potential temporary landscape impacts would be associated with temporary structures required during operations that would be removed or decommissioned at various stages during and following cessation of operations (e.g. office and car park, retention basin, stockpile/container storage area, vegetation management area and perimeter fencing). Permanent landscape impacts would result from the development of the rail siding that would remain following the cessation of operations.

The rehabilitation strategy for the Project is described in Section 5.

Visual Impacts

The internal roads, soil stockpiles and water management structures at the Atlas-Campaspe Mine 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 voids and water management infrastructure would not be visible from public vantage points, due to their low elevation (i.e. below ground surface level) and relatively flat topography (limited relief).

The Ivanhoe Rail Facility would not represent significant visual impacts due to the low elevations of the infrastructure components and the natural vegetation (including the vegetation management area) that would limit potential views from all surrounding areas with the exception of the Orange – Broken Hill railway.

The following assessment has been conducted to identify areas where visual impacts are most likely to occur as a result of the Project and to assist in assessing the requirement for mitigation of those impacts from sensitive viewpoints. The assessment process has focussed on the potential visual impact on views for the most sensitive visual settings/land uses where routinely accessed or readily accessible viewpoints exist.

The following locations were identified as potentially sensitive viewpoints:

- Willandra Lakes Region World Heritage Area (including Mungo National Park);
- Mungo National Park (area outside of the Willandra Lakes Region World Heritage Area);
- Mungo State Conservation Area;
- rural residences;
- local roads; and
- Orange – Broken Hill railway.

An assessment of potential visual impacts at these locations is provided below.

Willandra Lakes Region World Heritage Area (including Mungo National Park)

The Willandra Lakes Region World Heritage Area was listed on the World Heritage List in 1981 for both its outstanding cultural and natural universal values (SEWPaC, 2008). The Willandra Lakes Region World Heritage Area is located approximately 10 km from the Atlas-Campaspe Mine footprint at its closest point, although the Atlas-Campaspe Mine landform components (e.g. overburden emplacements, soil stockpiles, mineral concentrate stockpiles, workshop, administration facilities, accommodation camp and sediment dams) are located at distances greater than 10 km.

Mungo National Park is part of the Willandra Lakes Region World Heritage Area. Several recreational facilities (e.g. camp grounds and picnic areas) are available in the Mungo National Park and are described in the Plan of Management (SEWPaC, 2008).

The closest public access route within Mungo National Park is also an unsealed road available for self-guided drive tours which at its closest point, is located more than 5 km from the Atlas-Campaspe Mine footprint. The closest recreational area and elevated viewpoint along the route is Allen's Plains Tank (Land and Property Information NSW, 2003), which is also representative of the closest potential viewpoint from the Willandra Lakes Region World Heritage Area.

Other public access routes and elevated viewpoints within the Willandra Lakes Region World Heritage Area that could potentially afford views towards the Project area, include (Land and Property Information NSW, 2003):

- Vigars Well;
- the Walls of China; and
- Red Top Lookout.

In general, the Willandra Lakes Region World Heritage Area dry lake depressions (i.e. Willandra Trough) are situated at lower elevations (i.e. approximately 50 to 70 m AHD [Appendix F]) than the Atlas-Campaspe Mine, which is located at elevations ranging from approximately 60 to 100 m AHD (Section 4.3.1).

Other public recreational areas within the Willandra Lakes Region World Heritage Area (e.g. the Visitor Centre and Main Camp) are situated at elevations some 10 to 40 m lower to the west of the Walls of China (approximately 100 m AHD), which serves as an intervening landscape feature between these areas and the Atlas-Campaspe Mine. Therefore, other public recreational areas within the Willandra Lakes Region World Heritage Area (e.g. Visitor Centre and Main Camp) are not assessed further.

To assess the extent of potential views likely to be visible from the Willandra Lakes Region World Heritage Area towards the Atlas-Campaspe Mine, a three-dimensional digital terrain model was prepared by Marc&Co (2012) that included the existing landform features for the broader area and the Atlas-Campaspe Mine landform components. The model was used to undertake a three-dimensional analysis of the changes in topography as a result of the Atlas-Campaspe Mine that would be visible (intervening vegetation excluded) from the two viewpoints within the Willandra Lakes Region World Heritage Area, *viz.*:

- Allen's Plain Tank; and
- the Walls of China.

As Vigars Well and Red Top Lookout are located further away from the Atlas-Campaspe Mine at similar elevations to the Walls of China (approximately 100 m AHD), the level of potential visual impact associated with the Project is expected to be similar to or less than the impacts predicted for the Walls of China. Hence, no further assessment of these locations was undertaken.

The analysis demonstrated that the level of visual impact from key viewpoints within the Willandra Lakes Region World Heritage Area as a result of the Atlas-Campaspe Mine would be low given the:

- generally low landforms and topographic depressions characteristic of the Willandra Lakes Region World Heritage Area;
- intervening regional topography; and
- distance to the Atlas-Campaspe Mine landform components (i.e. greater than 10 km) and resultant negligible vertical change in landform elevations (i.e. there would be negligible vertical change in landform elevations at the Atlas-Campaspe Mine site from distances greater than 5 km) if visible at all.

Intervening vegetation would also screen views from key viewpoints and, therefore, further reduce the level of visual impact.

Potential night-lighting impacts from key viewpoints within the Willandra Lakes Region World Heritage Area as a result of the Atlas-Campaspe Mine are described further below.

Mungo National Park (outside of the Willandra Lakes Region World Heritage Area)

A portion of the Mungo National Park is located outside of the Willandra Lakes Region World Heritage Area. The eastern most extent of the Mungo National Park is located approximately 5 km west of the Atlas-Campaspe Mine footprint at its closest point, although the Atlas-Campaspe Mine landform components are located at distances greater than 5 km. The three-dimensional analysis undertaken by Marc&Co (2012) concluded that, despite being located closer to the Atlas-Campaspe Mine than the Willandra Lakes Region World Heritage Area, potential views from Mungo National Park (outside of the Willandra Lakes Region World Heritage Area) would be limited given the lower elevation of the area (approximately 80 m AHD), intervening regional topography and vegetation and the distance to the Atlas-Campaspe Mine landform components (i.e. greater than 5 km).

Hence, no further assessment of viewpoints from the Mungo National Park was undertaken.

Mungo State Conservation Area

The Mungo State Conservation Area is located approximately 8 km west of the Atlas-Campaspe Mine footprint at its closest point, although the Atlas-Campaspe Mine landform components are located at distances greater than 8 km.

A review of visitor facilities for the Mungo State Conservation Area did not identify any public access routes or recreational facilities within the area (NPWS, 2011).

Potential views from the Mungo State Conservation Area are considered to be limited due to intervening topography and the distance between the Mungo State Conservation Area and the Atlas-Campaspe Mine landform components (i.e. greater than 8 km). Additionally, the Mungo State Conservation Area is heavily wooded with potential views restricted by vegetation and is not readily accessible or routinely accessed by the public.

Hence, no further assessment of viewpoints from the Mungo State Conservation Area was undertaken.

Rural Residences

The Boree Plains residence is the closest residence to the Atlas-Campaspe Mine footprint and is located approximately 7 km away. Potential views from this residence are considered to be limited given the distance to the Atlas-Campaspe Mine footprint (i.e. there would be a negligible vertical change in landform elevations at the Atlas-Campaspe Mine site from distances greater than 5 km), relatively flat topography and intervening natural woodland vegetation.

Other isolated rural residences in the regional setting (e.g. the Marona residence, Glen Tilt residence, Magenta residence and Langleydale residence) are located at least 14 km away from the Atlas-Campaspe Mine footprint (Figure 1-2a). No views of the Atlas-Campaspe Mine operations are expected from these locations.

The township of Ivanhoe is representative of the closest residential area to the Ivanhoe Rail Facility. Due to the distance to the Ivanhoe Rail Facility (i.e. approximately 4.5 km) and the low elevation of the infrastructure components, no views of the Ivanhoe Rail Facility are expected from residences in the township of Ivanhoe.

Local Roads (Link Road, Boree Plains-Gol Gol Road and Balranald-Ivanhoe Road)

Link Road and Boree Plains-Gol Gol Road are the closest local roads to the Atlas-Campaspe Mine and provide access to a limited number of rural residences. The visual sensitivity for local road network users on Link Road and Boree Plains-Gol Gol Road is therefore considered low. Given the moderate elevation of the initial mine landforms and intervening vegetation, no further assessment of potential views from these locations has been undertaken.

Balranald-Ivanhoe Road is a regional road which connects the townships of Ivanhoe and Balranald. Given the distance from the Balranald-Ivanhoe Road to the Ivanhoe Rail Facility (i.e. greater than 2 km), the low elevation of the infrastructure components and the presence of intervening vegetation, no further assessment of potential views from this road location has been undertaken.

Orange – Broken Hill Railway

The rail siding at the Ivanhoe Rail Facility would be situated adjacent to the existing Orange – Broken Hill railway. Although views towards the Ivanhoe Rail Facility would be available to users of the Orange – Broken Hill railway, these views would be temporary and of short duration (i.e. during passby). The exposure of users to any potential views would also be limited by the low frequency of passengers trains (Section 4.13.1). Therefore, no further assessment of potential views the Orange – Broken Hill railway has been undertaken.

Night-Lighting

Atlas-Campaspe Mine

There are currently no significant artificial light sources in the vicinity of the proposed Atlas-Campaspe Mine.

Night-lighting at the Atlas-Campaspe Mine would be of sufficient intensity to provide a safe working environment for operators in the active mining area and supporting facilities. This lighting would alter the night-time light levels in the vicinity of the Atlas-Campaspe Mine.

Although there are no rural residences in the immediate vicinity of the Atlas-Campaspe Mine, some residences in the surrounding rural setting may experience an increased glow in the night sky, particularly during overcast weather conditions.

Willandra Lakes Region World Heritage Area (including Mungo National Park)

Due to the distance to the Atlas-Campaspe Mine landform components (i.e. greater than 10 km), no direct night-lighting impacts associated with the Atlas-Campaspe Mine are expected at key viewpoints within the Willandra Lakes Region World Heritage Area. However, an increased glow in the night sky may be experienced, particularly during overcast weather conditions.

Ivanhoe Rail Facility

There are currently no significant artificial light sources in the vicinity of the proposed Ivanhoe Rail Facility. Night-lighting at the Ivanhoe Rail Facility would be of sufficient intensity to provide a safe working environment for operators in the supporting facilities. Due to the distance to the nearest residential area (i.e. approximately 4.5 km), no direct night-lighting impacts associated with the Ivanhoe Rail Facility are expected, however, some residences may experience an increased glow in the night sky to the south-west of Ivanhoe, particularly during overcast weather conditions.

Potential Cumulative Impacts

No significant cumulative visual impacts (including potential night-lighting impacts) are anticipated to arise from the coincident development of the Atlas-Campaspe Mine, approved Snapper and Ginkgo Mines and proposed Balranald Mineral Sands Project (should it be approved), given the extensive distances between the respective locations (at least 10 km) and generally sparse settlement in the regional setting.

No significant cumulative visual impacts are anticipated to arise from the coincident development of the Ivanhoe Rail Facility and other existing rail siding facilities along the Orange – Broken Hill railway due to the temporary and short duration of any exposure to views of the facility and the low frequency of passenger trains.

4.14.3 Mitigation and Management Measures

As there are a low number of residences in the vicinity of the Atlas-Campaspe Mine site, the potential visual impacts of the Atlas-Campaspe Mine development are limited. Given the distance to the nearest homestead (Boree Plains) from the Atlas-Campaspe Mine footprint (i.e. approximately 7 km) and low usage of local public roads in the vicinity of the Atlas-Campaspe Mine, no specific visual impact mitigation measures are proposed.

Notwithstanding, progressive rehabilitation of the mine landforms would be conducted in accordance with the Rehabilitation Strategy presented in Section 5. The disturbance areas associated with the Project would be progressively rehabilitated and revegetated with species characteristic of the vegetation communities proposed to be cleared (Section 5.4.3). The Rehabilitation Strategy would aim to restore self-sustaining ecosystems including native species characteristic of vegetation communities cleared by Project development that could be used either by light intensity grazing or for nature conservation purposes (Section 5.1). The proposed final landforms are, therefore, expected to be aesthetically compatible with the surrounding landscape.

Night-Lighting

Measures that would be employed to mitigate potential impacts from night-lighting at the Atlas-Campaspe Mine would include restriction of night-lighting to the minimum required for operational and safety requirements.

Although some light spill would be anticipated on the closest local road (i.e. Link Road), no specific visual impact mitigation measures are proposed given the limited usage of this road by local users.

Given the distance to the Atlas-Campaspe Mine landform components (i.e. greater than 10 km), no direct night-lighting impacts associated with the Atlas-Campaspe Mine are expected at key viewpoints within the Willandra Lakes Region World Heritage Area (including Mungo National Park).

At the Ivanhoe Rail Facility, lighting would be directional and light shields would be used to minimise spill where practicable.

4.15 HAZARD AND RISK

A PHA to evaluate the potential hazards associated with the Project was conducted by a multi-disciplinary team, including technical advisors from Cristal Mining. The PHA was conducted in accordance with the general principles of risk evaluation and assessment outlined in the DP&I *Multi-Level Risk Assessment* (DP&I, 2011).

The PHA also addresses the requirements of *State Environmental Planning Policy No. 33 (Hazardous and Offensive Development)* (SEPP 33) and has been assessed in general accordance with *Hazardous Industry Planning Advisory Paper No. 6: Hazard Analysis* (NSW Department of Planning [DoP], 2011).

Potential incidents and hazards identified for the Project are described in Section 4.15.1. Proposed preventative and control measures to address potential hazards are discussed in Section 4.15.2.

4.15.1 Hazard Identification and Risk Assessment

Potentially hazardous materials handled at the Project include MSP process waste, hydrocarbons and chemicals (Appendix N).

In accordance with the DP&I *Multi-Level Risk Assessment* (2011), the PHA specifically covers the risks from fixed installations. As such, the main focus of the assessment was on-site storages and mineral concentrate stockpiles at the Atlas-Campaspe Mine and Ivanhoe Rail Facility and the WHIMS circuit (Appendix N).

Notwithstanding, because the Atlas-Campaspe Mine mining operations would be located in proximal to the Mungo National Park (5 km to the west) and the Willandra Lakes Region World Heritage Area (10 km to the west), some additional risks relating to mining operations (e.g. uncontrolled mobile plant excursions off-site) were included in the PHA (Appendix N).

The following generic classes of incident associated with on-site storage were identified (Appendix N):

- leaks/spills;
- fire;
- explosion;
- theft;
- accident; and
- unplanned movement off-site.

Following identification of the potential hazards associated with the Project, a qualitative assessment of the risks to the public, property and the environment associated with the Project was undertaken (Appendix N).

An assessment of the combination of the consequence and probability rankings concluded that the residual risk levels are tolerable with respect to surrounding land uses and do not preclude approval of the Project, and societal risk is negligible (Appendix N).

4.15.2 Hazard Prevention and Mitigation Measures

A number of hazard control and mitigation measures would be described in management plans for the Project, including the following (Appendix N):

- MOP.
- Environmental Management Strategy.
- Water Management Plan.
- Biodiversity Management Plan.
- Offset Management Plan.
- Heritage Management Plan.
- AQGHGMP.
- NMP.
- Radiation Management Plan.
- Radioactive Waste Management Plan.
- Mineral Concentrate and MSP Process Waste Management Plan.

- Rehabilitation Management Plan.
- Mine Closure Plan.
- Construction Environmental Management Plan – Ivanhoe Rail Facility.
- Operational Environmental Management Plan – Ivanhoe Rail Facility.

In addition, the following hazard treatment measures would be adopted for the Project (Appendix N):

- Engineering structures – mining and civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, Cristal Mining would obtain the necessary licences and permits for engineering structures.
- Contractor management – all contractors employed by Cristal Mining would be required to operate in accordance with the relevant Australian Standards and NSW legislation.
- Storage facilities – storage and usage procedures for potentially hazardous materials (i.e. fuels and lubricants) would be developed in accordance with Australian Standards and relevant legislation.
- Emergency response – emergency response procedures manuals and systems would be implemented.
- Maintenance – ongoing and timely maintenance of all mobile and fixed plant and equipment in accordance with the manufacturer's recommended maintenance schedule, and consistent with the maintenance schemes required by relevant standards. Only vehicles permitted to carry dangerous goods would be used for the transport of hazardous materials.
- Staff training – operators and drivers would be trained and (where applicable) licensed for their job descriptions. Only those personnel licensed to undertake skilled and potentially hazardous work would be permitted to do so.

4.16 REGIONAL ECONOMY

A Socio-Economic Assessment (including a regional economic impact assessment) was undertaken for the Project by Gillespie Economics (2012) and is presented in Appendix I.

The regional economic impact assessment was conducted at two different scales to assess the potential impact of the Project on the region and in NSW. The region adopted for the Project was the Far West and Murray-Darling Statistical Subdivisions (SSD).

Regional economic impact assessment is primarily concerned with the effect of a proposal on an economy in terms of specific indicators, such as gross regional output (business turnover), value-added, income and employment.

The regional economic assessment is based on analysis of 2006 input-output table developed by Gillespie Economics for the region and analysis of a 2006 input-output table developed by Monash University for NSW.

A summary of the existing regional and NSW economy is provided in Section 4.16.1. The potential impacts of the Project on the regional and NSW economies are described in Section 4.16.2, while mitigation and management measures are provided in Section 4.16.3.

4.16.1 Existing Environment

The gross regional product for the regional economy (i.e. Far West and Murray-Darling SSDs) is estimated at $1,115 million (M), comprising $573M to households as wages and salaries (including payments to self-employed persons and employers) and $542M in other value-added contributions (Appendix I).

The agriculture, mining and utilities sectors are of greater relative importance to the regional economy than they are to the NSW economy (Table 4-23), while the manufacturing and building sectors are of less relative importance than they are to the NSW economy (Table 4-23).

In terms of gross regional output and value-added, metal ores (non-ferrous) mining is the most significant sector to the regional economy (Appendix I). Imports and exports are spread across many sectors with major contributors being the metal ores (non-ferrous) mining sectors, food manufacturing sectors, utilities sectors and retail trade sectors (Appendix I).

Table 4-23
Contributions to Employment, Gross Regional Product and Output by Industry Sector – Regional and NSW Economies (2005 to 2006)

Sector	Total Employment (%)		Contribution to Gross Regional Product (%)		Contribution to Output (%)	
	Regional	NSW	Regional	NSW	Regional	NSW
Agriculture, Forestry and Fishing	14	3	9	2	10	2
Mining	7	1	19	2	15	2
Manufacturing	6	11	9	11	13	19
Utilities	2	1	6	2	11	3
Building	4	7	3	6	5	9
Services	68	77	49	71	46	65

Source: After Appendix I.

The retail trade sector is the most significant sector in terms of regional employment, while the retail trade, health, education and personal/other services sectors are the most significant sectors in terms of income (Appendix I).

4.16.2 Potential Impacts

The regional economic impact assessment presented in Appendix I included consideration of the impacts of the Project on both the regional (i.e. Far West and Murray-Darling SSDs) and NSW economies, and also potential impacts at the cessation of the Project.

Construction

The construction of the Project is predicted to have the following impacts on the regional economy (Appendix I):

- $63M in annual direct and indirect output;
- $27M in annual direct and indirect regional value added;
- $19M in annual direct and indirect household income; and
- 261 direct and indirect jobs.

In total, the construction of the Project is predicted to have the following impacts on the NSW economy (Appendix I):

- $124M in annual direct and indirect output;
- $56M in annual direct and indirect regional value added;
- $40M in annual direct and indirect household income; and
- 485 direct and indirect jobs.

Operation

The operation of the Project is predicted to have the following impacts on the regional economy (Appendix I):

- $279M in annual direct and indirect regional output or business turnover;
- $152M in annual direct and indirect regional value added;
- $20M in annual direct and indirect household income; and
- 229 direct and indirect jobs.

Businesses that can provide the inputs to the production process required by the Project and/or the products and services required by employees would directly benefit by way of an increase in economic activity. However, because of the inter-linkages between sectors, many indirect businesses would also benefit (Appendix I).

Flow-on impacts from the Project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-ons are likely to be the services to mining sector, road transport sector, ownership of dwellings sector, accommodation, cafes and restaurants sector, retail trade sector, wholesale trade sector, health services sector, personal services sector and education sector (Appendix I).

The Project would provide direct employment for 200 people during operations. Of the 200 direct jobs provided by the Project, 120 employees are assumed to reside in the region, based on existing distribution of employees (Appendix I).

In total, the operation of the Project is predicted to have the following impacts on the NSW economy (Appendix I):

- $388M in annual direct and indirect regional output or business turnover;
- $202M in annual direct and indirect regional value added;
- $54M in annual direct and indirect household income; and
- 643 direct and indirect jobs.

The potential impacts of the Project on the NSW economy are expected to be substantially greater than for the regional economy alone, as more Project and household expenditure would be captured, and there is a greater level of inter-sectoral linkages in the larger NSW economy (Appendix I).

End of Project Life

The establishment and operation of the Project would stimulate demand in the regional and NSW economy leading to increased business turnover in a range of sectors and increased employment opportunities. Cessation of the mining operations would result in a contraction in regional economic activity (Appendix I).

The magnitude of the regional economic impacts of cessation of the Project would depend on a number of interrelated factors, including the movements of workers and their families, alternative development opportunities and economic structure and trends in the regional economy at the time (Appendix I).

The Murray-Darling basin is a large sedimentary basin that contains mineral sand deposits. New mining resource developments in the region would help broaden the region's economic base and buffer against impacts of the cessation of individual activities (Appendix I).

4.16.3 Management Measures

Cristal Mining would develop a Mine Closure Plan for the Project which would include details of the mine closure strategy (Section 5.7). The Mine Closure Plan would be developed in consultation with the BSC, CDSC, DP&I and the local community, and would include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.

4.17 EMPLOYMENT, POPULATION AND COMMUNITY INFRASTRUCTURE

Gillespie Economics (2012) has considered the potential impacts of the Project on existing regional community infrastructure as a result of employment and population change (Appendix I).

Gillespie Economics (2012) has also considered the potential cumulative impacts of the proposed Balranald Mineral Sands Project (although it is yet to be approved).

For the purposes of the employment, population and community infrastructure assessment, the combined Far West and Murray-Darling SSDs were considered to be the local region. Cristal Mining's existing/approved Ginkgo Mine, Snapper Mine and MSP are located in the Far West and Murray-Darling SSDs. The assessment did not consider potential impacts on Mildura as it is located outside of NSW.

A description of the existing employment and population profiles is provided in Section 4.17.1. The potential cumulative and Project only employment, population and community infrastructure demands are described in Section 4.17.2. Proposed Project mitigation and management measures are provided in Section 4.17.3.

4.17.1 Existing Environment

Approximately 600 people (including Cristal Mining staff and on-site contractors' personnel) are employed at the Ginkgo Mine, Snapper Mine and MSP.

Cristal Mining plays an active role in the local community through sponsorships of community organisations (Section 3.3.3).

The Far West and Murray-Darling SSDs populations decreased by 10.7% to 22,399 and by 5.5% to 9,649 between 2001 and 2006, respectively (Appendix I).

A description of the existing population profile, employment, housing, health and education resources in the Far West and Murray-Darling SSDs is provided in Appendix I.

4.17.2 Potential Impacts

As the impacts of Project operations on community infrastructure are expected to be greater than Project construction (i.e. only short-term), the following discussion focuses on population and community infrastructure effects during the operation of the Project. Further detail on Project construction community infrastructure effects is provided in Appendix I.

The greatest potential community infrastructure impact is expected to occur during Project Year 5 as the Project and the proposed Balranald Mineral Sands Project operational phases would overlap with construction associated with the initial development of the Campaspe footprint (Appendix I).

As described in Section 2.4.2, an accommodation camp at the Atlas-Campaspe Mine would be constructed to accommodate the peak construction workforce (up to approximately 300 people) and would be reduced in size for Project operations to accommodate approximately 200 people. The accommodation camp allows the Project workforce and associated families to reside throughout the region and therefore minimise potential community infrastructure impacts on nearby towns (i.e. Balranald and Ivanhoe).

The estimated workforce demand, population change and potential impacts on community infrastructure that may arise from the Project (and cumulatively with the proposed Balranald Mineral Sands Project) are described below. These estimates are based on workforce projections and assumptions detailed in Appendix I.

Workforce Demand

The operation of the Project would require an operations workforce of approximately 200 employees (of which 24 are assumed to be non-local). In addition to this operations workforce, a short-term construction workforce averaging approximately 100 people (of which 40 are assumed to be non-local) would also be required during Year 5 of the Project for the initial development of the Campaspe footprint at the Atlas-Campaspe Mine (Appendix I).

The direct non-local workforce demand of the proposed Balranald Mineral Sands Project is expected to be up to approximately 250 construction employees during initial construction (coinciding with Year 2 of the Project), and up to approximately 120 operational employees thereafter (Appendix I).

Table 4-24 summarises estimated non-local employment associated with Project Year 5.

The majority of the non-local workforce demand during Project Year 5 would be associated with the short-term construction workforce. The short-term construction workforce would however have lower demands on community infrastructure than operational employees as they tend to be single or do not bring families to the region (Appendix I).

Operational direct non-local workforce demands also potentially increase the regional population when new workers bring spouses and children with them to the region, which is less common during construction activities (Appendix I).

In addition, during operations indirect employment generation from the Project and cumulatively with the proposed Balranald Mineral Sands Project (if approved) would be expected to result in more flow-on jobs in the region, a proportion of which are expected to be filled by non-locals (Appendix I).

Table 4-24
Direct Incremental Non-Local Workforce Requirements – Project Year 5

Proposal	Non-local Hires		
	Construction	Operation	Total
Project	40	24	64
Balranald Mineral Sands Project	0	14	14
Total (Cumulative)	**40**	**38**	**78**

Source: After Appendix I.

Note: Only includes non-local workforce that are assumed to relocate into the region.

These employment and population flow-on effects have been estimated in the Socio-Economic Assessment (Appendix I), and are summarised below.

Population Effects

Gillespie Economics (2012) estimates of the total population effects that may arise as a result of the Project and proposed Balranald Mineral Sands Project, separately and cumulatively in Project Year 5 are presented in Table 4-24.

The 64 Project non-local hires (Table 4-24) are predicted to be associated with the population of 102 migrating into the region. Flow-on jobs are estimated to be associated with a population of 76 migrating into the region (Appendix I). Hence, in total the maximum increase in population associated with the Project is 178 (Appendix I). The predicted Project attributable population increase of 178 would have reduced the total population decline of 3,248 experienced in the region between 1996 and 2006 (Appendix I) by 4%.

The 14 non-local hires associated with the proposed Balranald Mineral Sands Project (Table 4-24) are predicted to be associated with a population of 37 migrating into the region. Flow-on jobs are estimated to be associated with a population of 34 migrating into the region (Appendix I). Hence, in total the maximum increase in population associated with the proposed Balranald Mineral Sands Project is 71 (Appendix I).

The total cumulative population change associated with the Project and the proposed Balranald Mineral Sands Project (i.e. 249) is estimated to represent approximately 8% of the 1996 to 2006 population decline in the region (i.e. if these projects were operational during the period, the rate of decline would have been lower) (Appendix I).

The population increase associated with the Project and the proposed Balranald Mineral Sands Project would be very small and would contribute to slowing a general population decline in the region (Appendix I).

Community Infrastructure Effects

Housing

The Project would result in the direct and indirect demand for up to 46 long-term accommodation units (e.g. houses and units). This demand is also considered to be insignificant in the context of the housing market in the region (Appendix I).

The Project and the proposed Balranald Mineral Sands Project (if approved) would cumulatively result in the direct and indirect demand for up to 73 long-term accommodation units. This combined demand is also considered to be insignificant in the context of the housing market in the region (Appendix I).

Where housing supply is insufficient to meet demand, even temporarily, this may manifest itself in increased property prices and higher rent prices. While this may be seen as beneficial for property owners, it can adversely affect existing tenants, particularly those on lower incomes who can be priced out of the market (Appendix I). The Project accommodation camp would minimise increasing property prices by allowing the Project workforce and families to reside throughout the region rather than concentrating in nearby towns (e.g. Balranald and Ivanhoe).

Because of higher relative wages in the mining sector, the demand for rental accommodation and to purchase is likely to be at the higher end of the market, where supply is more limited (Appendix I).

Education and Training

The Project and proposed Balranald Mineral Sands Project (if approved) developments in the region would cumulatively contribute to greater demand for education in both the public and private sectors.

The Project would result in the direct and indirect demand for up to 35 pre-school, infants/primary and high school places. The direct and indirect increase in demand for educational facilities as a result of the Project operation is considerably less than the decline in demand between 2001 and 2006 (Appendix I). The increase in demand would therefore partially replace the recent declining demand for educational facilities.

The cumulative direct and indirect demand would be up to 56 pre-school, infants/primary and high school places. Cumulative increases in demand for education are also considerably less than the decline in demand between 2001 and 2006 (Appendix I).

The increase in demand would therefore partially replace the recent declining demand for educational facilities.

In other regions where mining has resulted in rapid population growth, it has been suggested that increasing child-aged population has ultimately had positive education benefits such as more teachers, reduced class sizes and broader curriculum (Appendix I).

Health

The estimated cumulative changes in population levels (Table 4-25) would increase demand for health services and facilities.

Table 4-25
Project and Cumulative Population Changes – Project Year 5

Project	Total Population Change (Project Year 5)
Project	178[1]
Balranald Mineral Sands Project	71
Total (Cumulative)	**249**

Source: After Appendix I.

[1] Including Project construction and operations workforce.

Provision of health services is primarily the responsibility of the public sector, although some aspects of these services are also provided by the non-government sector. It is recognised that there may be a lag between population growth and the provision of additional health services resulting in temporary health care access issues, but ultimately increased populations result in the provision of more health facilities for the community (Appendix I).

There is also the potential to indirectly positively impact on public health through the provision of employment opportunities and the reduction in unemployment (Appendix I).

Community Services and Recreation Facilities

Increase in population as a result of the Project (Table 4-25) would increase demand for community and recreation facilities (Appendix I).

The direct and indirect population increase associated with the Project would be very small and would contribute to slowing a general population decline in the region (Appendix I).

No additional investment in community services and recreation facilities infrastructure would therefore be anticipated and the population increases may help avoid threshold levels for provision of services falling below critical levels as may be expected if rates of population decline were to continue. Cumulative impacts would further offset already declining demand (Appendix I).

Social Community

The demand for mining labour can result in skilled labour being bid away from other professions (e.g. domestic trade services) which can result in shortages of these services in the region. The level of employment provided by the Project, and other projects, is a small proportion of regional workforce and is likely to have minimal impacts on skills shortages in the region (Appendix I).

A changing sense of place for existing residents may also be caused by cumulative influxes in populations associated with mining projects, as towns move away from their historical focus on servicing agricultural enterprises, to an increased focus on servicing mining activities (Appendix I).

The high wages in the mining sector relative to other sectors can also potentially result in social divisions between those involved in the mining sector and those who are not (Appendix I).

Both these effects can be heightened during construction of projects, when there are high numbers of unattached construction workforces, who may only partially integrate into the community (Appendix I). The relatively short-term nature of the Project construction phases and the provision of the accommodation camp for the construction workforce (i.e. construction workers would not have to reside in nearby towns) would minimise the duration and scale of these potential impacts for the Project.

End of Mine Life

Potential socio-economic impacts associated with the end of Project life are described in Section 4.16.2.

4.17.3 Mitigation and Management Measures

As described in Section 4.17.2, population increases would occur as a result of the Project employment and associated flow on effects.

Appendix I indicates only negligible cumulative impacts on community infrastructure demand would arise as a result of the Project and cumulatively with the proposed Balranald Mineral Sands Project (if approved).

Cristal Mining would work in partnership with the BSC and CDSC and the local community so that the benefits of the projected economic growth in the region are maximised and impacts minimised.

In this respect, a range of general and specific social impact mitigation and management measures are proposed and would include:

- construction of an accommodation camp at Atlas-Campaspe Mine (Section 2.4.2) which would minimise potential community infrastructure impacts on nearby towns;
- continuation of the current donations policy which supports education, health and community causes;
- employment of local residents preferentially (where they have the required skills and experience and demonstrate a cultural fit with the organisation), as the employment of local residents reduces potential population effects;
- purchasing local non-labour inputs to production preferentially where local producers can be cost and quality competitive; and
- establishing a code of conduct for construction workers with regard to behaviour in the contractor induction programme.

Cristal Mining would enter into a planning agreement in accordance with Division 6 of Part 4 of the EP&A Act, or suitable alternative, with the BSC and CDSC for the Project. The planning agreement, or alternative, would provide the structure of Cristal Mining contributions to the BSC and CDSC.