Murray Darling Basin Operations Modification

Environmental Assessment

Main Report and Appendices, November 2013

CRISTAL

Resource Strategies

EXECUTIVE SUMMARY

ES1.1 BACKGROUND

Cristal Mining Australia Limited's (Cristal Mining) operates the following mineral sands mining and processing operations in the Murray-Darling Basin, in western New South Wales (Figure ES-1):

- **Broken Hill Mineral Separation Plant** (**MSP**) – approved under Part 4 of the New South Wales *Environmental Planning & Assessment Act, 1979* in 2002 (Development Consent [DA 345-11-01]).
- **Ginkgo Mine** – approved under Part 4 of the *Environmental Planning & Assessment Act, 1979* in 2002 (Development Consent [DA 251-09-01]).
- **Snapper Mine** – approved under Part 3A of the *Environmental Planning & Assessment Act, 1979* in 2007 (Project Approval 06_0168).

These Cristal Mining operations are referred to as the Murray-Darling Basin Operations.

In February 2013, Cristal Mining lodged a Development Application for the Atlas-Campaspe Mineral Sands Project (SSD-5012) under Division 4.1 of Part 4 (State Significant Development) of the *Environmental Planning & Assessment Act, 1979*.

The proposed Atlas-Campaspe Mineral Sands Project would integrate with the existing/approved Murray-Darling Basin Operations in the following manner:

- mineral concentrates produced at the Atlas-Campaspe Mineral Sands Project would be transported to the MSP for processing resulting in a MSP mineral concentrate processing rate greater than the approved MSP processing rate;
- MSP process waste generated from the processing Atlas-Campaspe Mineral Sands Project mineral concentrates would be transported to the Ginkgo and Snapper Mines for disposal until their cessation; and
- MSP process waste generated as a result of processing Atlas-Campaspe Mineral Sands Project mineral concentrates would be transported to the Atlas-Campaspe Mine for disposal once operations at the Ginkgo and Snapper Mines have ceased.

ES1.2 DESCRIPTION OF THE MODIFICATION

This Environmental Assessment has been prepared to support applications to modify the MSP and Ginkgo Mine Development Consents and the Snapper Mine Project Approval under section 75W of the *Environmental Planning & Assessment Act, 1979* to allow for integration with the Atlas-Campaspe Mineral Sands Project (i.e. the Murray-Darling Basin Operations Modification) (the Modification).

Table ES-1 provides a comparative summary of the existing/approved and proposed modified Murray-Darling Basin Operations.

ES1.3 ENVIRONMENTAL REVIEW

The key potential impacts of the Modification are related to the increase in the mineral concentrate/heavy mineral concentrate processing rate at the MSP and the associated potential air quality, noise, MSP process waste, greenhouse gas, transport and regional economic impacts and changes to the existing/approved risks and hazards.

In order to assess the potential environmental impacts of the Modification, environmental reviews were completed for these issues. Table ES-2 summarises the key environmental assessment conclusions regarding the Modification.

Cristal Mining would continue to implement existing environmental management and monitoring measures at the MSP and Ginkgo and Snapper Mines to minimise the potential impacts of the Modification on existing environmental values.

Mitigation measures, management and monitoring proposed for the Modification are summarised in Table ES-2.

The Modification would result in no material changes to the existing/approved Ginkgo Mine and Snapper Mine operations (Table ES-1) and therefore there would be no material changes to existing/approved environmental impacts.

ES1.4 JUSTIFICATION OF THE MODIFICATION

The Murray-Darling Basin Operations Modification would allow the proposed Atlas-Campaspe Mineral Sands Project to integrate with the existing/approved Murray-Darling Basin Operations.

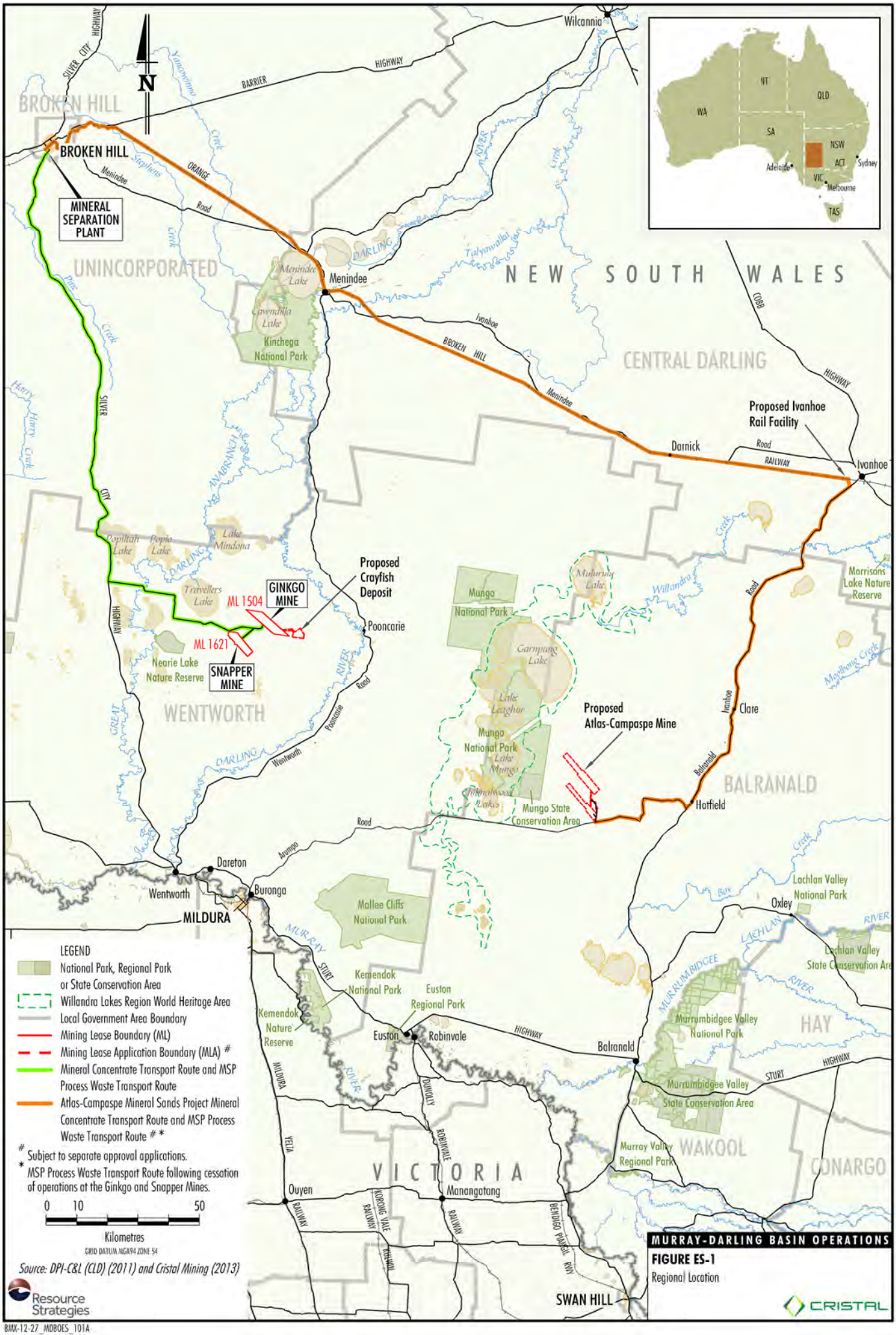
BROKEN HILL
MINERAL SEPARATION PLANT
Wilcannia
Menindee
Menindee Lake
Cawndilla Lake
Kinchega National Park
UNINCORPORATED
NEW SOUTH WALES
CENTRAL DARLING
Darnick
Ivanhoe
Proposed Ivanhoe Rail Facility
Proposed Crayfish Deposit
GINKGO MINE
ML 1504
ML 1621
SNAPPER MINE
Pooncarie
Nearie Lake Nature Reserve
WENTWORTH
Mungo National Park
Lake Leaghur
Lake Mungo
Proposed Atlas-Campaspe Mine
Mungo State Conservation Area
Hatfield
Clare
BALRANALD
Morrisons Lake Nature Reserve
Dareton
Wentworth
Buronga
MILDURA
Mallee Cliffs National Park
Kemendok National Park
Kemendok Nature Reserve
Euston
Euston Regional Park
Robinvale
Balranald
Oxley
Lachlan Valley National Park
Lachlan Valley State Conservation Area
Murrumbidgee Valley National Park
Murrumbidgee Valley State Conservation Area
HAY
WAKOOL
Murray Valley Regional Park
CONARGO
VICTORIA
Ouyen
Manangatang
SWAN HILL
NT
QLD
WA
SA
NSW
ACT
VIC
TAS
Adelaide
Sydney
Melbourne
LEGEND
National Park, Regional Park or State Conservation Area
Willandra Lakes Region World Heritage Area
Local Government Area Boundary
Mining Lease Boundary (ML)
Mining Lease Application Boundary (MLA) #
Mineral Concentrate Transport Route and MSP Process Waste Transport Route
Atlas-Campaspe Mineral Sands Project Mineral Concentrate Transport Route and MSP Process Waste Transport Route # *
Subject to separate approval applications.
* MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines.
0 10 50
Kilometres
GRID DATUM: MGA94 ZONE 54
Source: DPI-C&L (CLD) (2011) and Cristal Mining (2013)
Resource Strategies
MURRAY-DARLING BASIN OPERATIONS
FIGURE ES-1
Regional Location
CRISTAL
BMX-12-27_MDBOES_101A

Table ES-1
Comparison of the Existing/Approved and Modified Murray-Darling Basin Operations

Development Component	Existing/Approved	Modified
MSP[1]		
Project Life	• Operational life of 19 years (i.e. to 2025).	Increased operational life to approximately 26 years (i.e. 2032) to account for the integration of the Atlas-Campaspe Mineral Sands Project.
Mineral Concentrate/Heavy Mineral Concentrate Processing Rate	• Processing of up to approximately 650,000 tonnes per annum of mineral concentrates/heavy mineral concentrate from the Snapper and Ginkgo Mines.	Increased mineral concentrate/heavy mineral concentrates processing rate to approximately 1,200,000 tonnes per annum to accommodate the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates.
Mineral Product Transport	• Each train consists of approximately 50 wagons transporting approximately 3,200 tonnes of mineral concentrate product per train.	Product train size would increase to approximately 100 wagons transporting approximately 6,400 tonnes of mineral product per train.
MSP Process Waste Transport	• Transport of up to 300,000 tonnes per annum of MSP process waste generated from the processing of Ginkgo and Snapper Mine mineral concentrates via road to the Ginkgo and Snapper Mines for disposal.	• Transport of up to approximately 300,000 tonnes per annum of MSP process waste generated from the processing of mineral concentrates from the Ginkgo and Snapper Mines and the Atlas-Campaspe Mineral Sands Project initially via road to the Ginkgo and Snapper Mines for disposal. • Transport of up to approximately 50,000 tonnes per annum MSP process waste generated from the processing of mineral concentrates from the Atlas-Campaspe Mineral Sands Project via rail to the Atlas-Campaspe Mine for disposal (once the approvals at the Ginkgo and Snapper Mines expire).
Mobile Equipment	• Mobile equipment includes front end loaders, integrated tool carrier, water truck and light vehicles.	Additional mobile equipment (e.g. tip trucks and reach stacker) would be required to unload Atlas-Campaspe Mineral Sands Project mineral concentrates.
Other Development Components	• No change to existing/approved operations.	
Ginkgo[2] ***and Snapper***[3] ***Mines***		
MSP Process Waste Management	• MSP process waste from the processing of Ginkgo and Snapper Mines mineral concentrates are transported to the Ginkgo and Snapper Mines for disposal.	MSP process waste from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates in addition to Ginkgo and Snapper Mines mineral concentrates would be transported to the Ginkgo and Snapper Mines for disposal.
	• MSP process waste classified as "hazardous" in accordance with the *Waste Classification Guidelines Part 3: Waste Containing Radioactive Material* and as a "radioactive substance" under the New South Wales *Radiation Control Act, 1990*.	No change.
	• Following transport from the MSP, MSP process waste is deposited in a designated stockpile at the mine site.	No change.
	• MSP process waste is placed directly on the sand residue beach and/or with overburden above the groundwater table and under a minimum cover depth of 10 metres of overburden.	No change.
Other Development Components	• No change to existing/approved operations.	

1 Development Consent (DA 345-11-01) (as modified).
2 Development Consent (DA 251-09-01) (as modified).
3 Project Approval (06_0168) (as modified).

Table ES-2
Key Outcomes of the Environmental Review
for MSP Component of the Modification

Environmental Aspect	Summary of Environmental Assessment Conclusions	Additional Mitigation Measures, Management and Monitoring Proposed for the Modification
Air Quality	• The predicted in-stack particulate matter and nitrogen oxides concentrations comply with the relevant criteria. • Project only impacts at all receivers are predicted to comply with all relevant criteria. • Cumulative impacts are predicted to comply with the following criteria at all receivers: - annual average dust deposition criterion; - annual average total suspended particulate criterion; - annual average particulate matter less than 10 micrometres in size criterion; - annual average particulate matter less than 2.5 micrometres in size goal; - annual average nitrogen dioxide criterion; and - 1-hour average nitrogen dioxide criterion. • The potential for additional cumulative exceedances of the 24-hour particulate matter less than 10 micrometres in size criterion at the nearest receiver is very small as the maximum predicted project only 24-hour particulate matter less than 10 micrometres in size concentrations are well below the relevant criterion. • The maximum hexavalent chromium (Cr [VI]) concentrations are expected to be well below the relevant criteria.	• The MSP Air Quality Management Plan would be reviewed, and if necessary, revised to include the Modification.
Noise	• There would be no exceedances of the relevant amenity noise criteria at any receiver location. • There would be no exceedance of the project specific noise limit at any residential receiver during the day or evening, or during the night under calm meteorological conditions. • There would be a moderate exceedance of the project specific noise limit at receiver location R3 (Smith) during the most adverse weather conditions (i.e. G Class temperature inversions).	• Implementation of additional mitigation measures for existing plant, including enclosure of external auxiliary plant (e.g. fans and pumps) and attenuation of the front end loader operating at night once the MSP begins to receive trains from the Atlas-Campaspe Mineral Sands Project. • When the remaining approved processing circuits are constructed at the MSP, these circuits would be fully enclosed within a building, and all external auxiliary equipment (e.g. conveyors, pumps and fans) would also be enclosed to minimise potential noise impacts. • The MSP Noise Management Plan would be reviewed and updated for the Modification to include: - A description of activities relevant to potential noise impacts associated with the Modification. - A summary of predicted noise levels associated with Modification. - A review of noise mitigation measures. - Revised attended noise monitoring locations (e.g. R3) to reflect the land zoning defined in the *Broken Hill Local Environment Plan 2013* as well as predicted noise levels.

Table ES-2 (Continued)
Key Outcomes of the Environmental Review
for MSP Component of the Modification

Environmental Aspect	Summary of Environmental Assessment Conclusions	Additional Mitigation Measures, Management and Monitoring Proposed for the Modification
MSP Process Waste	• The Modification would not result in a change to the existing/approved MSP process waste classification or production rate (i.e. 300,000 tonnes per annum).	• The MSP Waste Management Plan and the Transport of Hazardous Materials Plan would be reviewed, and if necessary, revised to include the Modification.
Greenhouse Gas Emissions	• Total MSP full fuel cycle emissions would increase by approximately: – Scope 1 – 2.51 million tonnes of carbon dioxide equivalents; – Scope 2 – 0.04 million tonnes of carbon dioxide equivalents; and – Scope 3 – 0.45 million tonnes of carbon dioxide equivalents. This incremental increase is primarily due to the proposed increase in the MSP project life.	• No additional mitigation measures are proposed.
Transport	• No change to the frequency of mineral concentrate/heavy mineral concentrate transport or MSP process waste road transport movements. • The predicted road traffic increases (i.e. deliveries) are predicted to be negligible and as such it is considered that the Modification is unlikely to result in any capacity constraints or safety concerns on the surrounding road network.	• The Transport of Hazardous Materials Plan and the Traffic Code of Conduct would be reviewed, and if necessary, revised to include the Modification.
Regional Economy	• The Modification would increase and extend the duration of the existing/approved positive regional economic impacts (e.g. increased direct and indirect regional output, value added and household income) by seven years. • The Modification would result in retention of approximately 85 approved personnel for an additional seven years.	• No mitigation measures are proposed.
Hazard and Risk	• The following changes to potential hazards and risks are expected as a result of the Modification: - Increased frequency of liquefied petroleum gas transport to the MSP (i.e. an increase from one to two liquefied petroleum gas deliveries per week). The risks associated with the transportation and storage of liquefied petroleum gas are considered to remain low for the Modification. - Transport of mineral concentrates and MSP process waste between the Atlas-Campaspe Mineral Sands Project. There would be no significant radiological impact on the environment associated with the management of MSP process waste with the implementation of the proposed management measures.	• Existing hazard mitigation and/or preventative measures would continue to be applied at the MSP. • The MSP Emergency Response Plan and the MSP Safety Management System would be reviewed, and if necessary, revised to include the Modification. • A Fire Safety Study and Hazard and Operability Study would be prepared prior to the construction of the ilmenite kiln/roaster circuit and the rutile and zircon circuits.

The Modification would not require any significant alteration to the existing/approved Murray-Darling Basin Operations. Therefore, the Modification is a natural extension to the existing approved Murray-Darling Basin Operations.

The Modification is also expected to increase and extend the duration of the existing/approved positive regional economic impacts (e.g. increased direct and indirect regional output, value added and household income) and retain approximately 85 approved personnel for seven years.

In addition, this Environmental Assessment has demonstrated that the Modification can be conducted with minimal additional environmental impacts above those already approved for the Murray-Darling Basin Operations.

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1 INTRODUCTION

This document is an Environmental Assessment (EA) for proposed modifications to the following Cristal Mining Australia Limited[1] (Cristal Mining) mineral sands mining and processing operations located in the Murray-Darling Basin, in western New South Wales (NSW) (Figure 1):

- **Broken Hill Mineral Separation Plant** (**MSP**) – approved under Part 4 of the NSW *Environmental Planning & Assessment Act, 1979* (EP&A Act) in 2002 (Development Consent [DA 345-11-01]).
- **Ginkgo Mine** – approved under Part 4 of the EP&A Act in 2002 (Development Consent [DA 251-09-01]).
- **Snapper Mine** – approved under Part 3A of the EP&A Act in 2007 (Project Approval 06_0168).

These Cristal Mining operations are herein referred to as the Murray-Darling Basin Operations (the MDBO).

In February 2013, Cristal Mining lodged a Development Application for the Atlas-Campaspe Mineral Sands Project (SSD-5012) under Division 4.1 of Part 4 (State Significant Development) of the EP&A Act.

The proposed Atlas-Campaspe Mineral Sands Project would integrate with the existing/approved MDBO in the following manner:

- mineral concentrates produced at the Atlas-Campaspe Mineral Sands Project would be transported to the MSP for processing resulting in a MSP mineral concentrate processing rate greater than the approved MSP processing rate;
- MSP process waste generated from the processing Atlas-Campaspe Mineral Sands Project mineral concentrates would be transported to the Ginkgo and Snapper Mines for disposal until their cessation; and
- MSP process waste generated as a result of processing Atlas-Campaspe Mineral Sands Project mineral concentrates would be transported to the Atlas-Campaspe Mine for disposal once operations at the Ginkgo and Snapper Mines have ceased.

[1] Cristal Mining is a wholly owned subsidiary of The National Titanium Dioxide Company Limited.

The MDBO Modification (the Modification) is required to integrate the proposed Atlas-Campaspe Mineral Sands Project with the existing/approved MDBO.

1.1 OVERVIEW OF THE EXISTING/APPROVED MURRAY-DARLING BASIN OPERATIONS

Broken Hill Mineral Separation Plant

The MSP is located on the south-western outskirts of Broken Hill, in western NSW and approximately 170 kilometres (km) north of the Ginkgo and Snapper Mines (Figures 1 and 2) and is currently approved to:

- have an operational life of approximately 19 years (i.e. to 2025);
- receive up to approximately 735,000 tonnes per annum (tpa) of mineral concentrate/heavy mineral concentrate (HMC) via road haulage from the Ginkgo and Snapper Mines;
- process up to 650,000 tpa of mineral concentrate or HMC from the Ginkgo and Snapper Mines;
- transport up to 300,000 tpa MSP process waste to the Ginkgo and Snapper Mines for disposal; and
- rail to market up to 3,200 tonnes (t) of mineral products per train (i.e. non-magnetic concentrates, leucoxene, rutile[2], zircon[2], sulphate and roasted ilmenite[3]) from the MSP to South Australia, with a maximum of six train movements per week (i.e. three trains).

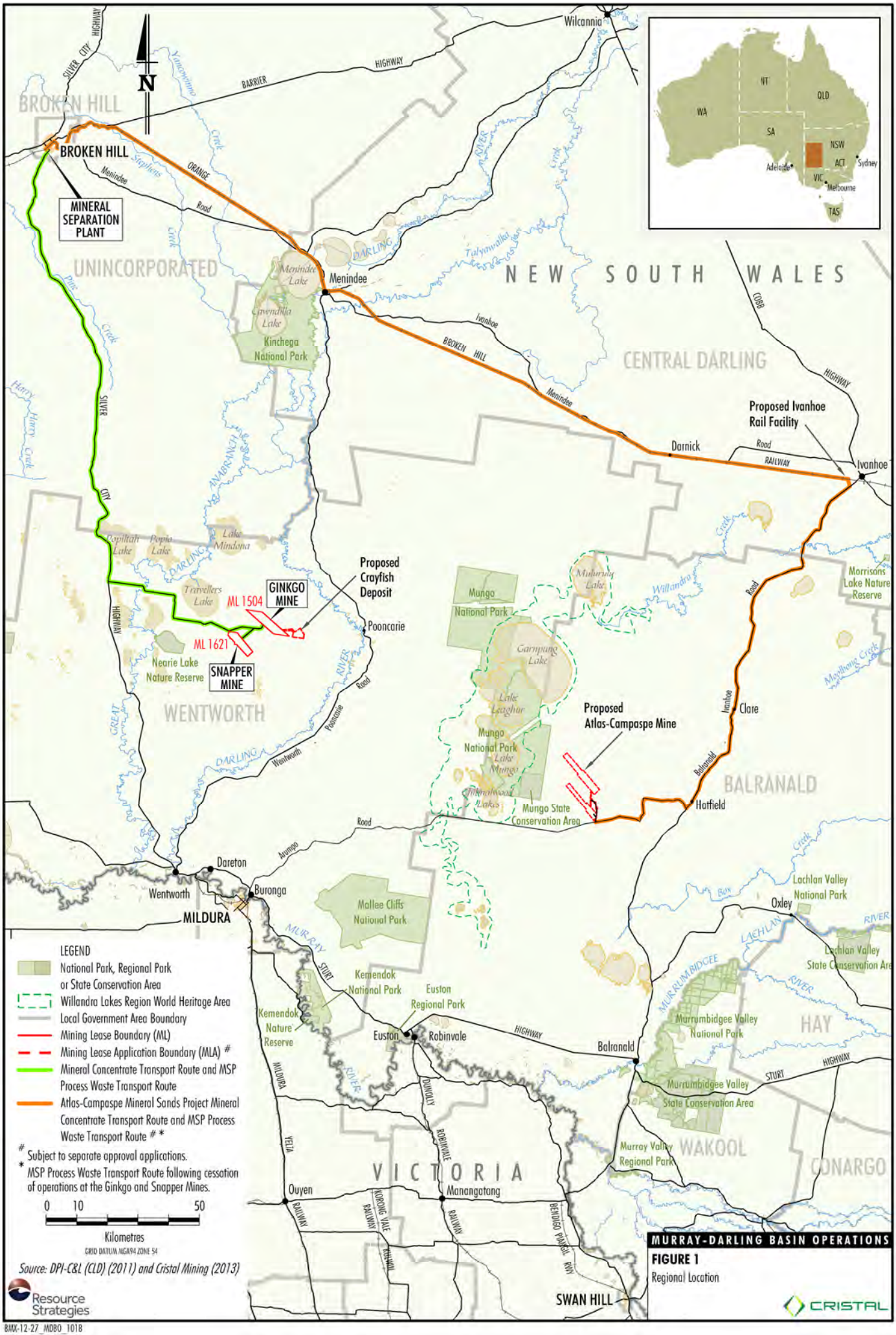
Gingko Mine

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

- have an operational life of approximately 14 years (i.e. to 2016);
- extract up to 13 million tonnes per annum (Mtpa) of mineral sands ore, producing a maximum 576,000 tpa of mineral concentrate for processing at the MSP; and
- receive MSP process waste for designated stockpiling, prior to depositing on the sand residue beach and/or with overburden.

[2] Rutile and zircon mineral products not produced until addition of the rutile and zircon circuits at the MSP.

[3] Roasted ilmenite mineral product not produced until addition of the ilmenite kiln/roaster circuit at the MSP.



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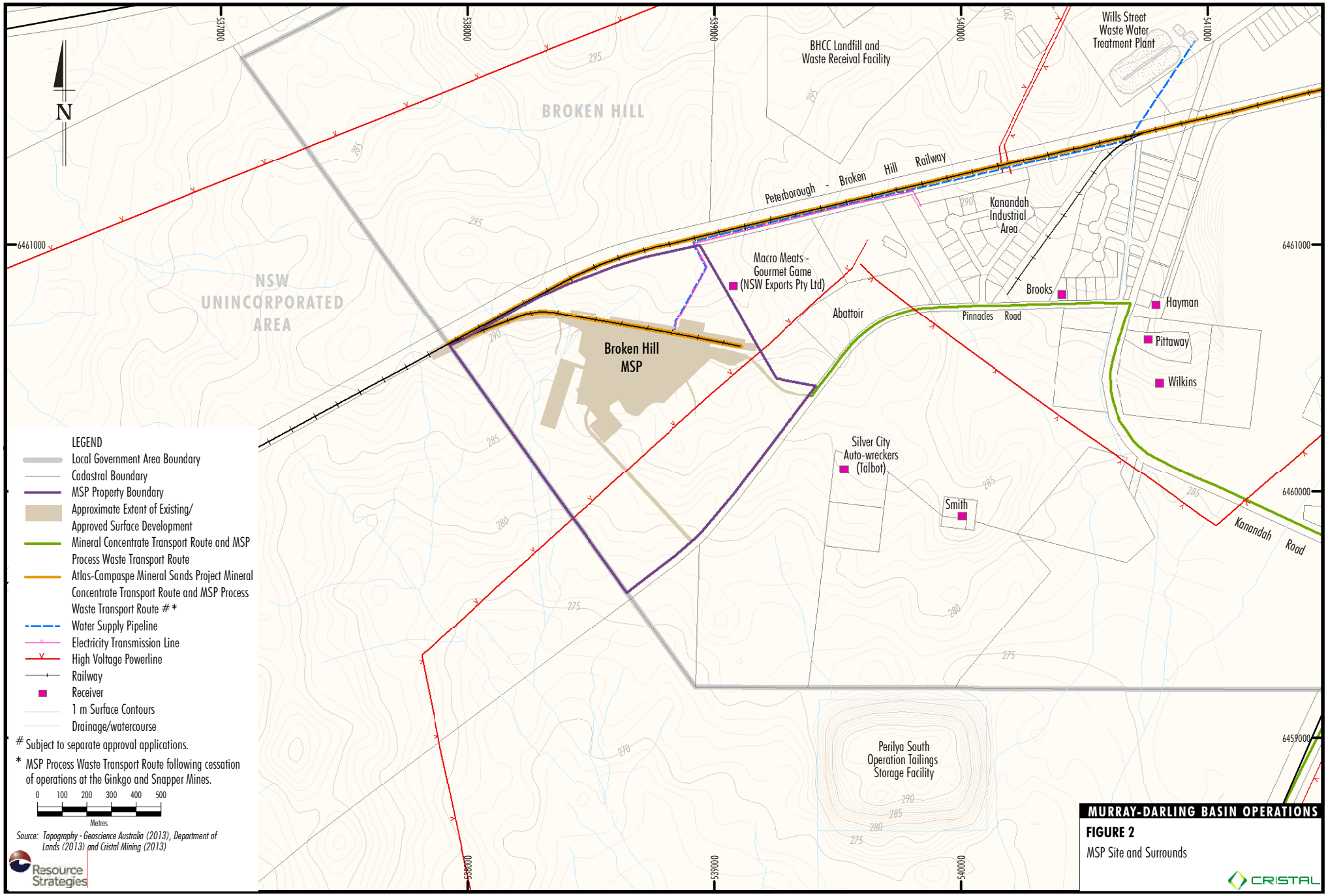

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Cristal Mining lodged a separate application to modify the Ginkgo Mine Development Consent (DA 251-09-01) under section 75W of the EP&A Act in November 2012 (the November 2012 Modification). This separate application is unrelated to this Modification. The proposed November 2012 Modification is relevant to the development of the satellite Crayfish deposit and would not result in an increase to the approved Ginkgo Mine maximum mineral concentrate production rate (i.e. 576,000 tpa) or the approved mineral concentrate/HMC transport rate to the MSP (i.e. 735,000 tpa).

Snapper Mine

The Snapper Mine is located approximately 10 km south-west of the Ginkgo Mine in western NSW (Figure 1) and is currently approved to:

- have an operational life of approximately 15 years (i.e. to 2025);
- extract up to 9.1 Mtpa of mineral sands ore, producing a maximum 621,000 tpa of mineral concentrate for processing at the MSP; and
- receive MSP process waste for designated stockpiling, prior to depositing on the sand residue beach and/or with overburden.

1.2 OVERVIEW OF PROPOSED ATLAS-CAMPASPE MINERAL SANDS PROJECT

The Atlas-Campaspe Mineral Sands Project includes the development of a mineral sands mining operation (herein referred to as the Atlas-Campaspe Mine), together with the construction and operation of a rail load out facility located near the township of Ivanhoe (herein referred to as the Ivanhoe Rail Facility) (Figure 1). As described in Section 1, the Atlas-Campaspe Mineral Sands Project would integrate with existing/approved MDBO.

Mineral concentrates generated as a result of operations at the proposed Atlas-Campaspe Mine would be trucked to the Ivanhoe Rail Facility for transfer to train wagons, which would then be railed to the MSP for processing. The additional mineral concentrates would result in a MSP mineral concentrate processing rate greater than the approved MSP processing rate.

MSP process waste generated as a result of the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates at the MSP would be transported to the Ginkgo and Snapper Mines for disposal until the approvals at the existing operations expire. No increase in the approved mineral concentrate/MSP process waste transport frequency would be required as the MSP process waste would be transported in existing mineral concentrate transport vehicles returning to the Ginkgo and Snapper Mines.

At that time, the MSP process waste generated as a result of processing mineral concentrates from the Atlas-Campaspe Mine would be transported in sealed containers via the Orange-Broken Hill railway to the Ivanhoe Rail Facility for subsequent road transport in sealed containers to the Atlas-Campaspe Mine for unloading, stockpiling and placement behind the advancing ore extraction areas.

1.3 CONSULTATION

Consultation has been conducted with surrounding landholders, key state government agencies, the Broken Hill City Council (BHCC), the Wentworth Shire Council (WSC) and the Australian Rail Track Corporation (ARTC) during the preparation of this EA. A summary of this consultation is provided below.

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

Surrounding Landholders

Cristal Mining met with surrounding landholders to discuss a briefing package that provided information on the Modification, the environmental approval process and the scope of the EA in October 2013.

NSW Government Agencies

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

Department of Planning and Infrastructure

Cristal Mining initiated consultation regarding the Modification with the NSW Department of Planning and Infrastructure (DP&I) in August 2013 when an overview of the proposed Modification was provided to the DP&I and key assessment requirements and the proposed timing for EA lodgement were discussed.

Environment Protection Authority

A meeting was held with the NSW Environment Protection Authority (EPA) on 24 October 2013 to provide an overview of the Modification and to discuss the scope and key findings of the MSP Noise Assessment and MSP Air Quality Assessment.

Other NSW Government Agencies

Cristal Mining provided a briefing package that included information on the Modification and offering a further briefing if requested to the following NSW Government agencies in October 2013:

- Office of Water;
- Office of Environment and Heritage;
- Roads and Maritime Service (RMS);
- Division of Resource and Energy; and
- Crown Lands Directorate (Catchment and Lands Division).

Local Government

Broken Hill City Council

The MSP is located within the Broken Hill Local Government Area (LGA) (Figure 1).

A meeting was held with the BHCC on 24 October 2013 to provide an overview of the Modification and to discuss the scope of the EA.

Wentworth Shire Council

The Ginkgo and Snapper Mines are located within the Wentworth LGA (Figure 1).

Cristal Mining provided information on the Modification and offered a further briefing if requested to the WSC in October 2013. A meeting to discuss the Modification is scheduled for 8 November 2013.

Australian Rail Track Corporation

Cristal Mining regularly consults with the ARTC on a regular basis in relation to its existing and proposed rail operations.

1.4 STRUCTURE OF THIS DOCUMENT

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

Section 1	Provides an overview of the existing/approved MDBO, the proposed Atlas-Campaspe Mineral Sands Project, the Modification and the consultation undertaken in relation to the Modification.
Section 2	Provides a description of existing/approved MDBO.
Section 3	Provides a description of the Modification.
Section 4	Provides an environmental assessment of the MSP component of the Modification and describes the existing environmental management systems and measures available to manage and monitor any potential impacts.
Section 5	Provides an environmental assessment of the Gingko and Snapper Mines components of the Modification and describes the existing environmental management systems and measures available to manage and monitor any potential impacts.
Section 6	Describes the general statutory context of the proposed Modification.
Section 7	References.

Appendices A and B provide supporting information as follows:

Appendix A	MSP Air Quality Assessment.
Appendix B	MSP Noise Assessment.

2 EXISTING/APPROVED MURRAY-DARLING BASIN OPERATIONS

A description of the existing/approved MDBO is provided in this section.

As the majority of the changes to the MDBO proposed in the Modification are related to the MSP (i.e. only limited changes are proposed for the Ginkgo and Snapper Mines), the description of the existing/approved MDBO provided in this section focuses on the MSP.

2.1 APPROVALS HISTORY

The MSP and the Ginkgo Mine were approved under Part 4 of the EP&A Act in 2002 (Development Consent [DA 345-11-01] and Development Consent [DA 251-09-01], respectively).

The Snapper Mine was approved under Part 3A of the EP&A Act in 2007 (Project Approval 06_0168).

A summary of the modifications to the MDBO approvals is provided in Table 1.

Table 1
Summary of Modifications to the MDBO Approvals

MDBO Approval	Modifications
MSP Development Consent (DA 345-11-01)	• February 2006 under section 96(2) of the EP&A Act – to facilitate alterations to the MSP as a result of the detailed design process and feasibility studies. • July 2007 under section 96(2) of the EP&A Act – to enable the processing of mineral concentrates from the Snapper Mine.
Gingko Mine Development Consent (DA 251-09-01)	• September 2003 under section 96(2) of the EP&A Act – to facilitate the re-alignment of sections of the Highway Access Road (HAR) and the re-alignment of the electricity transmission line (ETL). • May 2005 under section 96(2) of the EP&A Act – to allow for an increase in mineral concentrate production rate, addition of HMC treatment facility, addition of a reverse osmosis plant, relocation of the accommodation camp and the use of double road trains. • April 2006 under section 96(1A) of the EP&A Act – to change the method of overburden replacement and classification of MSP process waste disposed at the Ginkgo Mine. • April 2007 under section 96(2) of the EP&A Act – to extend the dredge pond and initial sand residue dam, addition of a secondary overburden emplacement and to allow the treatment of process water in a series of water treatment dams or in the sand residue dam. • December 2008 under section 96(1A) of the EP&A Act – to allow for administrative changes to the Ginkgo Mine Development Consent (DA 251-09-01) including simplification and removal of consent conditions. • April 2009 under section 96(1A) of the EP&A Act – to reduce the depth of material required to cap slurried overburden. • December 2009 under section 96(1A) of the EP&A Act – to allow for receival and processing of ore from the Snapper Mine and the disposal of additional sand residues. • October 2010 under section 75W of the EP&A Act – to increase the total ore mined at the Ginkgo deposit, increase the life of mine and receive ore and HMC from the Snapper Mine.
Snapper Mine Project Approval (06_0168)	• June 2009 under section 75W of the EP&A Act – to modify the approved offset area for the offset of environmental impacts associated with the Snapper Mine. • December 2009 under section 75W of the EP&A Act – to allow for the road transport of ore to the Ginkgo Mine for processing. • October 2010 under section 75W of the EP&A Act – to increase the total ore mined at the Snapper deposit, increase the maximum annual production of mineral concentrates, reduce the life of mine and transport high grade ore from the Snapper Mine to the Ginkgo Mine.

2.2 BROKEN HILL MINERAL SEPARATION PLANT

2.2.1 General Arrangement

The existing/approved MSP includes the following major site components:

- Wet High Intensity Magnetic Separator (WHIMS)[4] circuit;
- feed preparation circuit;
- leucoxene circuit;
- ilmenite circuit;
- ilmenite kiln/roaster circuit (not constructed to date);
- rutile circuit (not constructed to date);
- zircon circuit (not constructed to date);
- mineral concentrate/HMC stockpiles;
- mineral product stockpiles;
- mineral product storage sheds;
- gas storage;
- coal storage (not constructed to date);
- MSP process waste storage area;
- rail spur;
- access road;
- secondary access road;
- ETL;
- water management infrastructure;
- water supply pipeline;
- processing water treatment plant;
- sewage treatment plant;
- effluent utilisation areas;
- process water dam;
- laydown area; and
- administration, laboratory and workshop buildings.

The existing/approved MSP general arrangement is shown on Figure 3.

2.2.2 Operational Life and Hours of Operation

The MSP has an approved operational life of approximately 19 years (i.e. to 2025).
MSP operations occur up to 24 hours per day, seven days per week.

[4] The WHIMS is currently approved to be located at either the MSP or at the Ginkgo and Snapper Mines. The WHIMS is currently located at the Gingko Mine.

2.2.3 Mineral Concentrates/HMC Transport

Mineral concentrates/HMC are transported in double road trains or other RMS-approved vehicles (e.g. AB-triple vehicles) from the Ginkgo Mine and Snapper Mine to the MSP.

The mineral concentrate and MSP process waste transport route comprises the following roads (Figure 1):

- Gingko and Snapper Mines access road;
- HAR (including a section of Old Roo Roo Road);
- Silver City Highway;
- Kanandah Road;
- Pinnacles Road; and
- MSP access road.

Road transport of mineral concentrates/HMC is undertaken 24 hours per day, seven days per week.

Up to approximately 735,000 tpa of mineral concentrates/HMC are currently approved to be transported from the Ginkgo and Snapper Mines to the MSP.

Either mineral concentrates or HMC are transported from the Gingko and Snapper Mines to the MSP depending on the location of the WHIMS. Mineral concentrates are currently transported to the MSP as the WHIMS is located at the Gingko Mine.

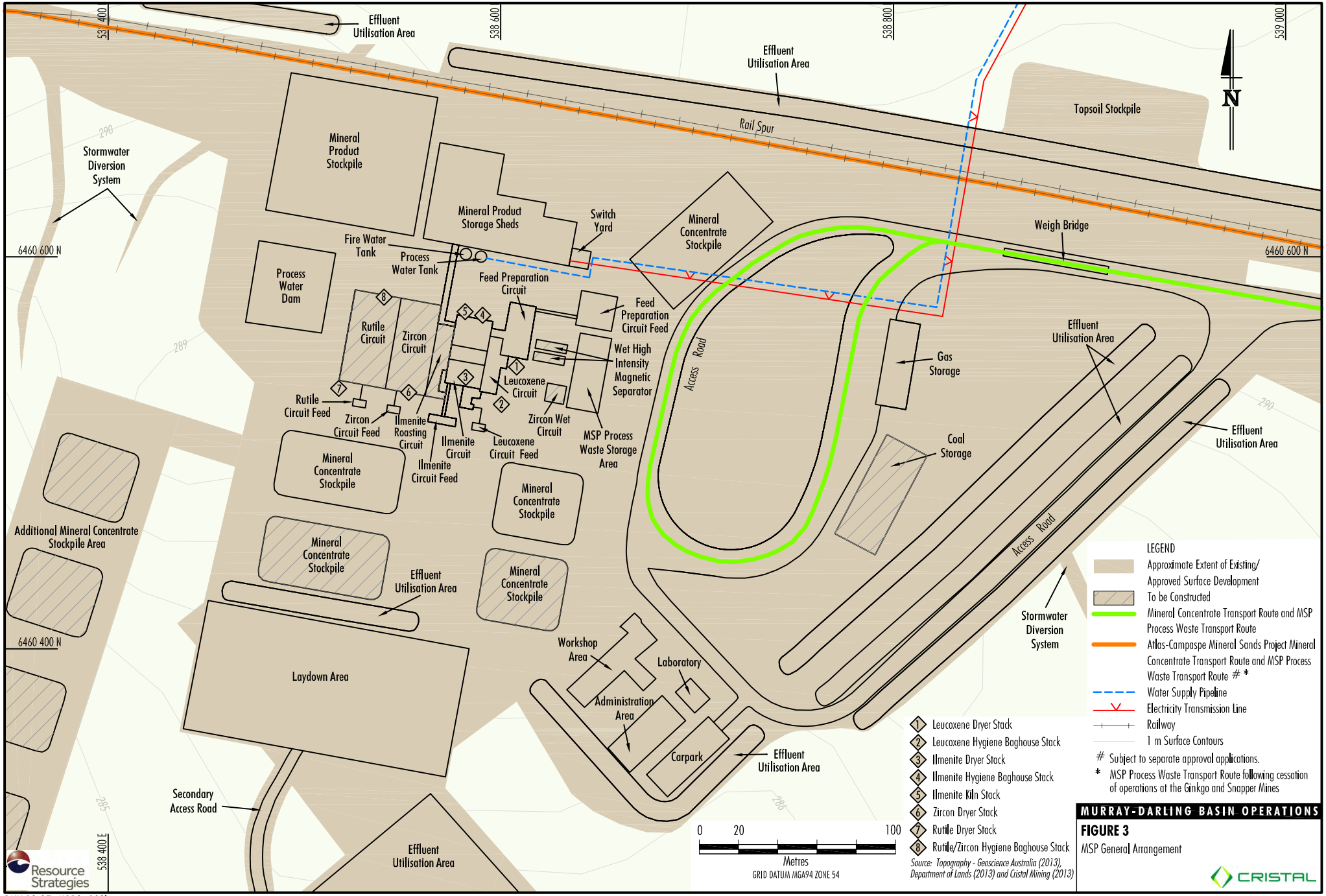
2.2.4 Mineral Concentrates/HMC Handling

Mineral concentrates/HMC are transported to the MSP via road from the Ginkgo and Snapper Mines (Section 2.2.3).

The haulage vehicles (i.e. double road trains or other RMS-approved vehicles) enter the MSP site via the MSP access road (Figure 3). A turn-around loop at the MSP (Figure 3) enables the haulage vehicles to turn-around, unload and exit using the same access road.

Mineral concentrates/HMC are emptied from the haulage vehicles directly onto mineral concentrate/HMC stockpiles (Figure 3).

Front end loaders are used to manage the mineral concentrate/HMC stockpiles and transfer mineral concentrates/HMC between stockpiles and the relevant MSP circuit feed (e.g. feed preparation circuit) hopper/WHIMS for processing.



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2.2.5 Mineral Concentrates/HMC Processing

Mineral concentrate/HMC processing at the MSP involves gravity, electrostatic and magnetic separation methods.

A description of the processing operations at the MSP is provided in the following sub-sections. The process flow sheet schematics for the MSP (without and with WHIMS) are shown on Figures 4 and 5.

WHIMS

The WHIMS circuit is a preliminary treatment stage which separates HMC into ilmenite-rich, leucoxene-rich and non-magnetic (containing rutile and zircon) mineral concentrates.

The WHIMS circuit relies on magnetic separation and requires no chemical reagents. The WHIMS circuit consists of primary and secondary magnetic separators to separate the magnetic and non-magnetic mineral concentrates and product dewatering cyclones.

As described in Section 2.2.3, HMC is currently approved to be processed in the WHIMS at either the MSP or at the Ginkgo and Snapper Mines. The WHIMS is currently located at the Gingko Mine.

If the WHIMS is relocated to the MSP, HMC will be transported from Ginkgo and Snapper Mines to the MSP for processing at the WHIMS. The ilmenite-rich, leucoxene-rich and non-magnetic mineral concentrates produced will be placed in separate stockpiles prior to being processed in the MSP circuits (see below).

The location of the WHIMS, if it is relocated to the MSP, is shown on Figure 3.

MSP Circuits

The existing/approved MSP consists of the following circuits:

- feed preparation circuit;
- leucoxene circuit;
- ilmenite circuit;
- ilmenite kiln/roaster circuit (not constructed to date);
- rutile circuit (not constructed to date); and
- zircon circuit (not constructed to date).

Feed Preparation Circuit

The feed preparation circuit processes the non-magnetic mineral concentrate to produce a non-magnetic concentrate product and a minor process waste component.

The feed preparation circuit uses gravity separation (spirals and wet tables) and requires no chemical reagents.

The non-magnetic concentrate product is currently stored in a mineral product stockpile or storage shed adjacent the rail spur prior to its rail transport from the MSP (Section 2.2.6).

Once the rutile and zircon circuits are constructed, a portion of the non-magnetic concentrate product will be fed to these circuits for further processing.

The existing/approved MSP process waste management measures are described in Section 2.2.8.

Leucoxene Circuit

The leucoxene circuit processes the leucoxene mineral concentrate to produce leucoxene mineral product, sulphate ilmenite mineral product and a minor process waste component.

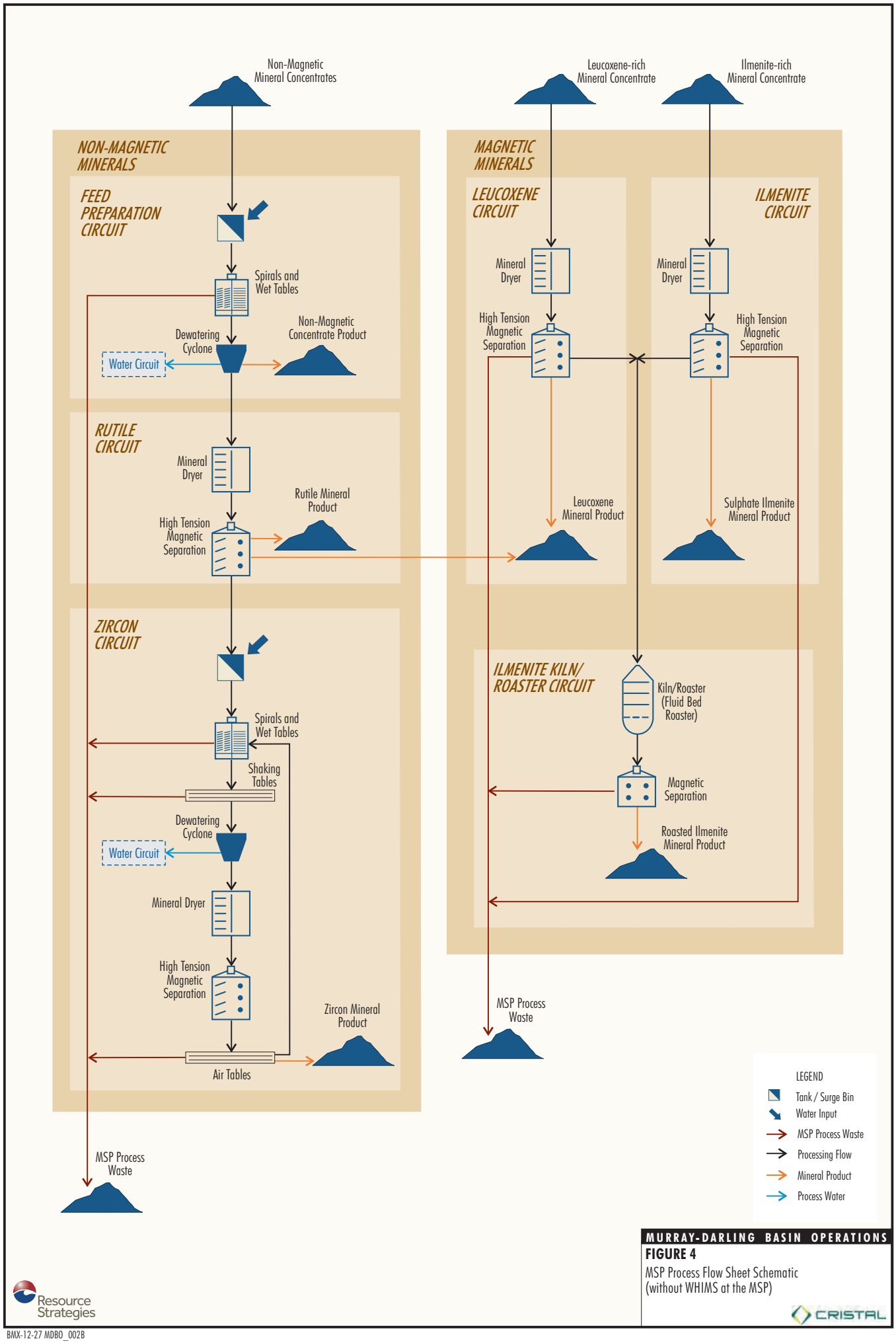
The leucoxene circuit uses magnetic separation and requires no chemical reagents. The leucoxene mineral concentrate is initially washed and then dried in a bed dryer before being transferred to a high tension magnetic separator.

Liquefied petroleum gas (LPG) is used as the fuel for the bed dryer.

The leucoxene and sulphate ilmenite mineral products are currently stored in separate mineral product stockpiles or storage sheds adjacent the rail spur prior to rail transport from the MSP (Section 2.2.6).

Once the ilmenite kiln/roaster circuit is constructed, the sulphate ilmenite mineral product will be fed to this circuit for further processing.

The existing/approved MSP process waste management measures are described in Section 2.2.8.



MURRAY-DARLING BASIN OPERATIONS

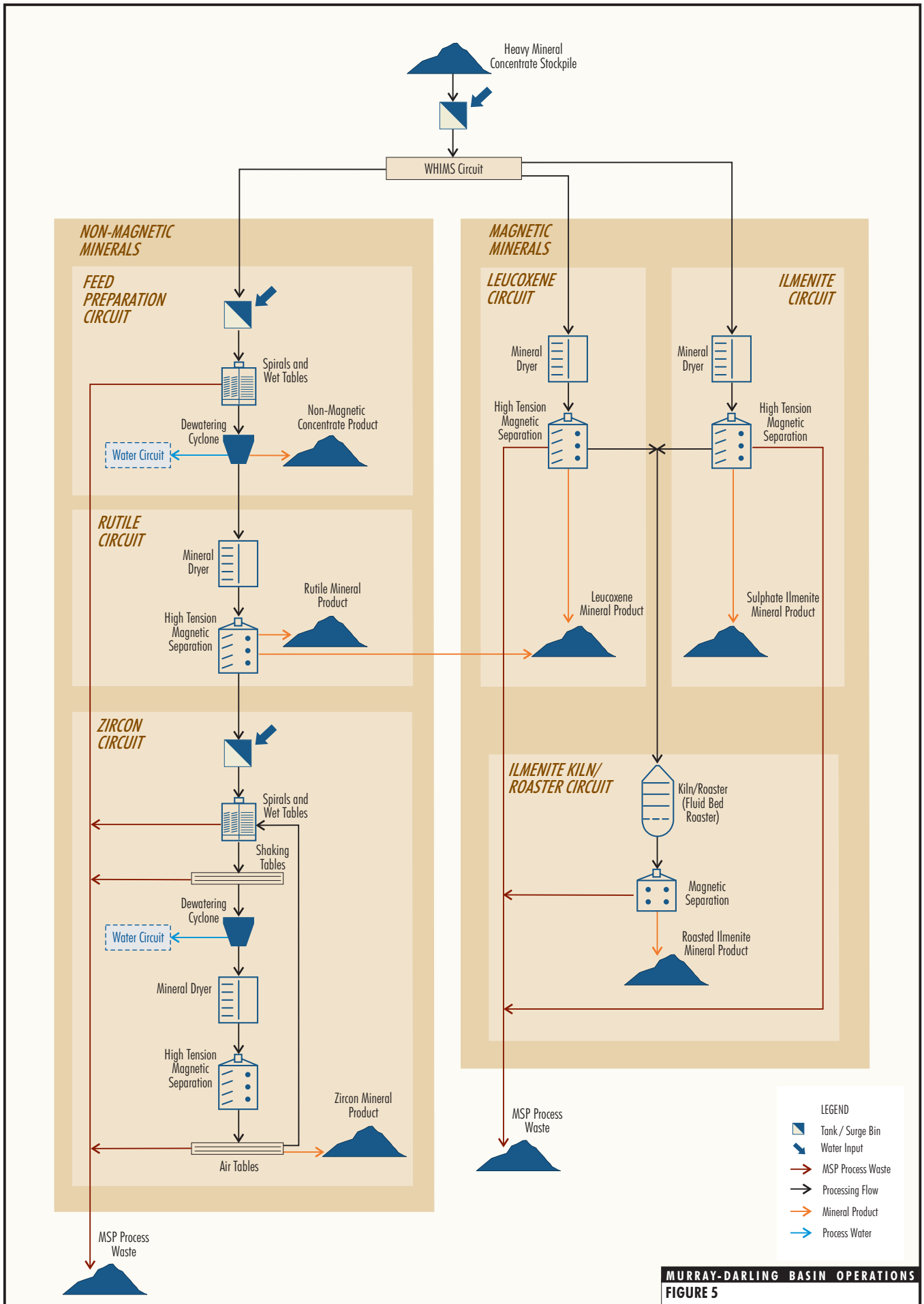
FIGURE 4

MSP Process Flow Sheet Schematic
(without WHIMS at the MSP)

Resource Strategies

CRISTAL

BMX-12-27 MDBO_002B



Resource Strategies

MURRAY-DARLING BASIN OPERATIONS

FIGURE 5

MSP Process Flow Sheet Schematic
(with WHIMS at the MSP)

CRISTAL

BMX-12-27 MDBO_004A

Ilmenite Circuit

The ilmenite circuit processes the ilmenite mineral concentrate to produce sulphate ilmenite mineral product and a minor process waste component.

The ilmenite circuit uses magnetic separation and requires no chemical reagents. The ilmenite mineral concentrate is initially washed and then dried in a bed dryer before being transferred to a high tension magnetic separator.

LPG is used as the fuel for the bed dryer.

The sulphate ilmenite mineral product is currently stored in a mineral product stockpile or storage shed adjacent the rail spur prior to rail transport from the MSP (Section 2.2.6).

Once the ilmenite kiln/roaster circuit is constructed, a portion of the sulphate ilmenite mineral product will be combined with the sulphate ilmenite mineral product from the leucoxene circuit to be fed to the ilmenite kiln/roaster.

The existing/approved MSP process waste management measures are described in Section 2.2.8.

Ilmenite Kiln/Roaster Circuit

The ilmenite kiln/roaster circuit has not yet been constructed.

Once the ilmenite kiln/roaster circuit has been constructed, it will process a combined sulphate ilmenite mineral product (from the ilmenite and leucoxene circuits) to produce a roasted ilmenite mineral product and a minor process waste component.

The ilmenite kiln/roaster circuit will use magnetic separation and will require no chemical reagents. The ilmenite kiln/roaster will heat the feed to increase the magnetic susceptibility of chromite bearing ilmenite allowing it to be separated magnetically from the roasted ilmenite mineral product in a magnetic separator circuit.

Brown coal briquettes are the approved fuel for the kiln/roaster.

The roasted ilmenite mineral product will be stored in a mineral product stockpile or storage shed adjacent the rail spur prior to rail transport from the MSP (Section 2.2.6).

The existing/approved MSP process waste management measures are described in Section 2.2.8.

Rutile and Zircon Circuits

The rutile and zircon circuits have not yet been constructed.

Once the rutile and zircon circuits have been constructed, they will process a portion of the non-magnetic concentrate product from the feed preparation circuit to produce rutile and zircon mineral products and two process waste streams.

The rutile and zircon circuits will use gravity, magnetic and electrostatic separation and will require no chemical reagents.

The non-magnetic concentrate product is dried in a bed dryer before being transferred to a multistage circuit comprising magnetic, high tension and electrostatic separators to separate the following streams:

- conductive fraction of the non-magnetic concentrate (i.e. rutile mineral product);
- non-conductive fraction of the non-magnetic concentrate (i.e. comprising mainly zircon); and
- leucoxene mineral product.

The rutile and leucoxene mineral products will be stored in separate mineral product stockpiles or storage sheds adjacent the rail spur prior to rail transport from the MSP (Section 2.2.6).

The non-conductive fraction of the non-magnetic concentrate (comprising mainly zircon) will be transferred to the zircon circuit for an additional stage of magnetic separation. It will be initially be passed through gravity separation spirals and shaking tables (the wet component of the zircon circuit) to remove a process waste stream.

The zircon wet circuit concentrate will then be dried and passed through high tension, electrostatic and magnetic separators combined with air tables (the dry component of the zircon circuit) to produce a zircon mineral product and a minor process waste stream.

Black coal is the approved fuel for the rutile and zircon bed dryers.

The rutile and zircon mineral products will be stored in separate mineral product stockpiles or storage sheds adjacent the rail spur prior to rail transport from the MSP (Section 2.2.6).

The existing/approved MSP process waste management measures are described in Section 2.2.8.

Mineral Product Production Rates

The approved mineral product production rates for the MSP are provided in Table 2.

Table 2
Approved Mineral Product Production Rates

Mineral Product	Production Rate (ktpa)
Leucoxene	185
Sulphate Ilmenite	124
Non-magnetic Concentrate	210
Roasted Ilmenite	225
Zircon	75
Rutile	100

ktpa = kilotonnes per annum.

2.2.6 Mineral Product Storage, Loading and Transport

Mineral product produced at the MSP is stored in mineral product stockpiles or storage sheds adjacent the rail spur (Figure 3) prior to rail transport from the MSP.

A front end loader is used to reclaim mineral product from the stockpiles and load directly into containers on train wagons. An integrated tool carrier is used to remove and replace covers on the containers.

Mineral product produced at the MSP is transported via rail from the MSP to South Australia via the Peterborough-Broken Hill Railway. Up to six train movements per week (i.e. three trains) consisting of approximately 50 wagons (transporting approximately 3,200 t of mineral product) per train depart from the MSP each week.

2.2.7 Mobile Fleet

The existing MSP mobile fleet includes front end loaders, an integrated tool carrier, water truck and light vehicles.

2.2.8 MSP Process Waste Management

Characterisation and Classification

Process waste generated at the MSP comprises the following:

- silica and quartz from the feed preparation circuit;
- silicate minerals and monazite from the leucoxene and ilmenite circuits;
- silicate minerals and monazite from the rutile and zircon circuits; and
- ash waste by-product and sulphur-based effluent from the combustion of coal.

All heavy mineral sands (including those from the Ginkgo and Snapper Mines) contain traces of naturally occurring radioactive elements (e.g. thorium). Monazite contains cerium, lanthanum and neodymium and is a source of the radioactive element thorium.

Monazite concentrates in the waste streams along with other minerals that have similar specific gravities, magnetic and conductivity properties.

Given the presence of monazite in the MSP process waste, its specific activity can be greater than 100 becquerels per gram. The MSP process waste is likely to be classified as:

- "Hazardous" in accordance with the *Waste Classification Guidelines Part 3: Waste Containing Radioactive Material* (NSW Department of Environment and Climate Change [DECC], 2008); and
- a "radioactive substance" under the NSW *Radiation Control Act, 1990*.

Quantities and Management Strategy

The MSP is currently approved to produce up to approximately 300,000 tpa of MSP process waste. MSP process waste production at the MSP to date has typically been approximately 120,000 tpa (i.e. much less than expected).

The management of MSP process waste at the MSP is conducted in accordance with the MSP Waste Management Plan.

The MSP Waste Management Plan outlines the following management measures:

- separate dust collection for sections of the MSP that involve streams containing elevated monazite contents;
- use of an industrial vacuum system to minimise potential dust sources;
- separately enclose equipment items that involve streams containing elevated monazite contents; and
- wetting (or "pugging") of any dust collected to eliminate the dust hazard at its source.

MSP waste streams containing monazite are directed to a process sump where it is wetted and blended with the other MSP waste streams (refer above).

Front end loaders are used to load the "pugged" MSP process waste on to haulage vehicles (i.e. double road trains or other RMS-approved vehicles) for transport via the mineral concentrate and MSP process waste transport route to the Gingko and Snapper Mines for disposal.

The MSP process waste is transported in accordance with the Transport of Hazardous Materials Plan and the *Code of Practice for the Safe Transport of Radioactive Material* (Australian Radiation Protection and Nuclear Safety Agency [ARPANSA], 2008).

A description of the management of MSP process waste at the Ginkgo and Snapper Mines is provided in Section 2.3.1.

2.2.9 Water Management

Site Water Management System

Site water management at the MSP is conducted in accordance with the MSP Water Management Plan.

Water resources at the MSP are managed in a manner that:

- conserves water resources throughout all areas of the MSP operation;
- maximises the re-use/recycling of water to decrease the demand on external water supplies;
- contains contaminated water on-site in constructed dams;
- maintain sufficient storage capacity in stormwater structures to contain the run-off from a 1 in 10 year, 1-hour storm event; and
- reduces the potential for pollution of water.

To meet these objectives, a site water management system has been developed at the MSP. Key components of the site water management system are described below.

Up-catchment Runoff Control

Both temporary and permanent up-catchment diversion drains/bunds and perimeter banks/channels are constructed to divert runoff from undisturbed areas around the MSP site.

Up-catchment diversions are designed to be stable (non-eroding) at the design flows. Stabilisation of the upslope diversion works is achieved by design of appropriate channel cross-sections and gradients and the use of channel lining with grass or rock fill.

The design criteria for up-catchment runoff control structures are outlined in the MSP Water Management Plan.

Sedimentation Control

Drainage from disturbed areas at the MSP is directed to the evaporation/sediment dams for containment.

The design criteria for evaporation/sediment dams are outlined in the MSP Water Management Plan.

Water collected in evaporation/sediment sumps is recycled in the site water management system or allowed to evaporate.

Process Water Dam

A 1,000 cubic metre process water dam is located on-site (Figure 3) to manage and buffer process water supply. The process water dam is primarily filled with treated effluent from the Wills Street Waste Water Treatment Plant (Figure 2).

Processing Water Treatment Plant

Water from the Wills Street Waste Water Treatment Plant is treated in an on-site processing water treatment plant at the MSP before being used for processing operations.

Recycled process water and water drained from the stockpiles is also treated in the on-site processing water treatment plant before being re-used.

Wastewater generated from the processing water treatment plant is transferred to the on-site sewage treatment plant for treatment.

Sewage Treatment Plant

Sewage and wastewater from on-site ablution facilities and the processing water treatment plant is treated in an on-site sewage treatment plant at the MSP. The sewage treatment plant is operated in accordance with the requirements of Environment Protection Licence (EPL) 12314.

The treated water from the sewage treatment plant is irrigated on effluent utilisation areas (Figure 3) in accordance with EPL 12314 and the MSP Effluent Management Plan.

Water Demand and Supply

The approved process water demand for the MSP is up to approximately 175 million litres per annum (ML/annum) at full development (assuming the WHIMS is located at the MSP). The WHIMS and the feed preparation and zircon circuits are the main users of water at the MSP.

The current process water demand at the MSP is approximately 24 ML/annum (i.e. well below the currently approved water demand) because the WHIMS and the zircon circuit have not been developed and less water has been required for the feed preparation circuit than expected.

Process water for the MSP is sourced from the Wills Street Waste Water Treatment Plant. The water is transferred to the MSP site via a pipeline (Figure 2). In the event that water is not available from the Wills Street Waste Water Treatment Plant, water from the BHCC mains water supply is used.

Potable water requirements for the MSP is provided by the BHCC mains water supply.

2.2.10 Infrastructure and Services

Administration and Workshop Buildings and Car Parking Facilities

The administration and the workshop buildings are pre-fabricated and of demountable design for removal following cessation of operations.

A car park for employees and visitors is provided adjacent to the buildings.

Site Access and Internal Access Roads

Access to the MSP is via the MSP access road off Pinnacles Road (Figure 2). A secondary access road off Pinnacles Road is located further to the south (Figure 2) and is used irregularly for oversized deliveries (e.g. during maintenance activities).

Other minor roads are associated with internal access roads around the MSP (Figure 3). The use of internal access roads is restricted to MSP personnel.

Dust from internal access roads and MSP access road is suppressed by routinely spraying water sourced from the MSP water management system.

Rail Spur

A 1.2 km rail spur is located on the northern side of the MSP site (Figure 3). The rail spur consists of a main line where mineral product is loaded on to the wagons (Section 2.2.6) and a secondary line where wagons can be parked.

Electrical Supply and Distribution

Electricity is supplied by the local network. An 11 kilovolt (kV) ETL connects the MSP to the local network (Figure 2).

Site Security

Access to the MSP is restricted to authorised personnel only to maintain public safety and site security.

All visitors are required to report to the administration/office buildings upon entry on-site.

2.2.11 Dangerous Goods Management

Dangerous goods used at the MSP include fuels (e.g. diesel, LPG and coal) and other workshop lubricants (e.g. oils, greases, degreaser and kerosene).

Only minor quantities of other consumables (e.g. very limited chemical requirements for water treatment) are required for the MSP.

Transport

Dangerous goods required for the MSP are transported in accordance with the appropriate regulations under the NSW *Dangerous Goods (Road and Rail Transport) Act, 2008.* These regulations apply the *Australian Code for the Transport of Dangerous Goods by Road and Rail* approved by the Australian Transport Council, as amended from time to time (National Transport Commission, 2007).

Storage

The existing/approved dangerous goods storages at the MSP include:

- diesel – 500 litres (L) and 110,000 L storages for on-site refuelling of MSP mobile fleet, mineral concentrate haulage vehicles and trains;
- coal – two 1,500 t storages for use in processing operations; and
- LPG – 189,000 L storage for use in processing operations.

Hydrocarbon storage facilities are operated in accordance with the requirements of Australian Standard (AS) 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids* and AS 1596:2008 *The Storage and Handling of Liquefied Petroleum Gas*.

The following measures will be implemented to reduce the risks associated with the transportation of coal and coal storage:

- coal dust suppression over the coal crusher;
- control of ignition sources surrounding the coal storage;
- administrative controls; and
- fire control equipment.

Waste hydrocarbons are collected, stored and removed by licensed contractors on a periodic basis.

The management and storage of chemicals (including separation according to chemical type) is conducted in accordance with the relevant Australian Standards and codes.

2.2.12 Waste Management

Waste management at the MSP is conducted in accordance with the MSP Waste Management Plan. The MSP Waste Management Plan outlines the following:

- classification of waste generated at the MSP;
- waste management strategy (e.g. avoid/reduce, re-use/recycle, treat and dispose);
- waste handling, collection and disposal measures; and
- spill management.

MSP process waste management is described in Section 2.2.8.

2.2.13 Workforce

The approved MSP operational workforce is approximately 85 personnel plus an additional 40 personnel associated with the haulage vehicle contractor.

2.2.14 Rehabilitation Strategy

Rehabilitation at the MSP is conducted in accordance with the MSP Operation Environmental Management Plan.

Rehabilitation Principles

The MSP Operation Environmental Management Plan outlines the following principles that will be adopted for the rehabilitation of the MSP:

- preservation of existing vegetation and landforms (where practicable);
- progressive rehabilitation (where practicable);
- development of passive drainage and stormwater diversion structures;
- use of appropriate cover crops to provide initial erosion protection on newly prepared (i.e. topsoiled) landforms prior to the establishment of native vegetation; and
- revegetation with endemic native vegetation consistent with an agreed final land use.

Rehabilitation and Final Land Use Concepts

Closure and rehabilitation activities will include the decommissioning of the MSP and the removal of infrastructure from site.

Site storages (process water dam) will also be decommissioned, reformed to an acceptable final landform and revegetated.

All infrastructure and hardstand areas will be removed, including the plant, buildings, workshops, conveyors, hoppers, elevators, tanks, storage bins and rail loading facilities.

Once all infrastructure is removed a land contamination assessment will be undertaken. Any contaminated soils will be removed for disposal at a licensed facility off-site.

Stockpiled topsoil will then be applied and stabilised and the endemic plant species will be used to revegetate.

Final site closure and rehabilitation requirements will be formulated in consultation with key government authorities, the landholder and other relevant stakeholders.

2.3 GINKGO AND SNAPPER MINES

This description of the existing/approved Gingko and Snapper Mines focuses on the existing/approved MSP process waste management measures because the Modification would only result in a change to the source of the existing/approved MSP process waste (i.e. MSP process waste from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates) disposed at the Ginkgo and Snapper Mines.

A complete description of the existing/approved Ginkgo and Snapper Mines is provided in *Gingko and Snapper Mines Modification Environmental Assessment* (Bemax Resources Limited [Bemax Resources], 2010).

2.3.1 MSP Process Waste Management

As described in Section 2.2.8, MSP process waste is transported from the MSP to the Ginkgo and Snapper Mines in accordance with the Transport of Hazardous Materials Plan and the *Code of Practice for the Safe Transport of Radioactive Material* (ARPANSA, 2008).

The MSP process waste is transported between the MSP and the Ginkgo and Snapper Mines via the mineral concentrate and MSP process waste transport route (Section 2.2.3).

Up to 300,000 tpa of MSP process waste is approved to be transported from the MSP to the Gingko and Snapper Mines. The amount of MSP process waste transported to date has been much lower than this as MSP process waste production at the MSP to date has been much less than expected (typically approximately 120,000 tpa) (Section 2.2.8).

The management of MSP process waste at the Ginkgo and Snapper Mines is outlined in the following:

- Ginkgo Mine Landfill Management Plan; and
- Snapper Mine Waste Management Plan.

At the Ginkgo or Snapper Mines, the MSP process waste is unloaded from the haulage vehicles and placed in short-term designated stockpiles prior to depositing on the sand residue beach and/or with overburden and covered with overburden.

The MSP process waste would be:

- placed above the groundwater table;
- placed no closer than 10 metres (m) from the natural ground surface; and
- covered under a minimum of 10 m of overburden and soil, such that the radiation level at the surface of the rehabilitated process waste emplacement cells would be equivalent to the natural background radiation level.

No MSP process wastes would be placed in off-path sand residue dams.

3 MURRAY-DARLING BASIN OPERATIONS MODIFICATION

The Modification would not require any significant alteration to the existing/approved MDBO. A description of the Modification is provided below.

3.1 BROKEN HILL MINERAL SEPARATION PLANT

A comparison of the proposed modified MSP with the existing/approved MSP is provided in Table 3.

3.1.1 General Arrangement

The Modification would not require any changes to the existing/approved MSP general arrangement (Section 2.2.1).

3.1.2 Operational Life and Hours of Operation

As mineral concentrates from the Atlas-Campaspe Mineral Sands Project are proposed to be processed at the MSP, the operational life of the MSP would increase to approximately 26 years (i.e. to 2032) to match the proposed life of the Atlas-Campaspe Mineral Sands Project.

The existing/approved hours of operation (Section 2.2.2) would remain unchanged for the Modification.

3.1.3 Mineral Concentrates/HMC Transport

Ginkgo and Snapper Mines

The Modification would not require any changes to the approved mineral concentrate/HMC transport from the Ginkgo and Snapper Mines (Section 2.2.3).

Table 3
Comparison of the Existing/Approved and Modified MSP

Project Component	Existing/Approved MSP	Modified MSP
Project Life	• Operational life of 19 years (i.e. to 2025).	Increased operational life to approximately 26 years (i.e. 2032) to account for the integration of the Atlas-Campaspe Mineral Sands Project.
Major Site Components	• Major site components include: – WHIMS[5] circuit; – feed preparation circuit; – leucoxene circuit; – ilmenite circuit; – ilmenite kiln/roaster circuit (not constructed to date); – rutile circuit (not constructed to date); – zircon circuit (not constructed to date); – mineral concentrate/HMC stockpiles; – mineral product stockpiles; – mineral product storage sheds; – gas storage; – coal container storage (not constructed to date); – MSP process waste storage area; – rail spur line; – access road; – secondary access road; – ETL; – water supply pipeline; – water management infrastructure; – processing water treatment plant; – sewage treatment plant; – effluent utilisation areas; – process water dam; – laydown area; and – administration, laboratory and workshop buildings.	No change.
Mineral Concentrate/HMC Processing Rate	• Processing of up to approximately 650,000 tpa of mineral concentrates/HMC from the Snapper and Ginkgo Mines.	Increased mineral concentrate/HMC processing rate to approximately 1,200,000 tpa to accommodate the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates.

[5] The WHIMS is currently approved to be located at either the MSP or at the Ginkgo and Snapper Mines. The WHIMS is currently located at the Ginkgo Mine.

Table 3 (Continued)
Comparison of the Existing/Approved and Modified MSP

Project Component	Existing/Approved MSP	Modified MSP
Mineral Separation	• Mineral separation at the MSP involves gravity, electrostatic and magnetic separation methods. The following MSP circuits are approved: – feed preparation circuit; – leucoxene circuit; – ilmenite circuit; – ilmenite kiln/roaster circuit (not constructed to date); – rutile circuit (not constructed to date); and – zircon circuit (not constructed to date).	No change.
Processing Fuel Types	• Existing/approved processing fuel types area as follows: – LPG – leucoxene and ilmenite dryers. – Brown Coal Briquettes – ilmenite kiln/roaster (not constructed to date). – Black Coal – rutile and zircon dryers (not constructed to date).	• The rutile and zircon dryer fuel type would change from black coal to LPG (i.e. black coal would no longer be used). • No change to the other processing fuel types.
Mineral Products	• The following mineral products are approved to be produced at the MSP: – leucoxene; – sulphate ilmenite; – roasted ilmenite; – non-magnetic concentrate; – rutile; and – zircon.	No change.
Mineral Product Storage	• Mineral products are stored in mineral product stockpiles or storage sheds.	No change.
MSP Process Waste Management	• MSP process waste is managed in accordance with the MSP Waste Management Plan.	No change.
Mobile Equipment	• Mobile equipment includes front end loaders, integrated tool carrier, water truck and light vehicles.	Additional mobile equipment (e.g. tip trucks and reach stacker) would be required to unload Atlas-Campaspe Mineral Sands Project mineral concentrates.
Mineral Concentrate/HMC Road Transport to the MSP	• Transport of up to approximately 735,000 tpa of mineral concentrates/HMC from the Ginkgo and Snapper Mines to the MSP.	No change.
Mineral Concentrate Rail Transport to the MSP	• No mineral concentrates are currently received by rail.	Transport of up to approximately 450,000 tpa of mineral concentrates from the Ivanhoe Rail Facility to the MSP.

Table 3 (Continued)
Comparison of the Existing/Approved and Modified MSP

Project Component	Existing/Approved MSP	Modified MSP
Mineral Product Transport	• Mineral products transported by rail to South Australia for shipping overseas.	No change.
	• A maximum of approximately six train movements per week (three trains) are required.	No change.
	• Each train consists of approximately 50 wagons transporting approximately 3,200 t of mineral concentrate product per train.	Product train size would increase to approximately 100 wagons transporting approximately 6,400 t of mineral product per train.
MSP Process Waste Transport	• Transport of up to 300,000 tpa of MSP process waste generated from the processing of Ginkgo and Snapper Mine mineral concentrates via road to the Ginkgo and Snapper Mines for disposal.	• Transport of up to approximately 300,000 tpa of MSP process waste generated from the processing of mineral concentrates from the Ginkgo and Snapper Mines and the Atlas-Campaspe Mineral Sands Project initially via road to the Ginkgo and Snapper Mines for disposal. • Transport of up to approximately 50,000 tpa MSP process waste generated from the processing of mineral concentrates from the Atlas-Campaspe Mineral Sands Project via rail to the Atlas-Campaspe Mine for disposal (once the approvals at the Ginkgo and Snapper Mines expire).
	• MSP process waste material transported in accordance with the *Code of Practice for the Safe Transport of Radioactive Materials* (ARPANSA, 2008).	No change.
Water Supply and Demand	• Water is supplied from the Wills Street Waste Water Treatment Plant or BHCC mains water supply. • Approved maximum water demand for the MSP at full development will be approximately 175 ML/annum.	No change.
Fuel Storage	• Diesel – 500 L and 110,000 L storages for on-site refuelling of MSP mobile fleet, mineral concentrate haulage vehicles and trains; • Coal – two 1,500 t storages for use in processing operations; and • LPG – 189,000 L storage for use in processing operations.	No change.
Workforce	• Operational workforce of up to approximately 85 personnel plus an additional 40 personnel associated with the haulage vehicle contractor.	No change.

Atlas-Campaspe Mineral Sands Project

Atlas-Campaspe Mineral Sands Project mineral concentrates would be railed in containers via the Orange – Broken Hill railway to the MSP for processing (subject to separate approval). Based on the planned maximum Atlas-Campaspe Mineral Sands Project production rate, up to 450,000 tpa of mineral concentrates would be railed to the MSP.

A maximum of three Atlas-Campaspe Mineral Sands Project trains per week would be required. No more than one train of mineral concentrates from the Atlas-Campaspe Mineral Sands Project would be railed to the MSP in any 24 hour period.

The Atlas-Campaspe Mineral Sands Project train would typically arrive at the MSP during the evening (i.e. 6.00 pm – 10.00 pm) and would be unloaded during the night (i.e. 10.00 pm – 7.00 am). The unloaded Atlas-Campaspe Mineral Sands Project train would depart the following morning (i.e. after 7.00 am).

3.1.4 Mineral Concentrates/HMC Handling

Ginkgo and Snapper Mines

The Modification would not require any changes to the approved mineral concentrate/HMC handling infrastructure at the MSP (Section 2.2.4).

Atlas-Campaspe Mineral Sands Project

As described in Section 3.1.3, Atlas-Campaspe Mineral Sands Project mineral concentrates would be railed in containers to the MSP for processing.

Once the Atlas-Campaspe Mineral Sands Project train arrives at the MSP, the covers of the containers would be removed by an integrated tool carrier. A reach stacker would then remove the container from the wagon and place it on a tip truck.

The tip truck would then transport the container to the existing/approved mineral concentrate stockpiles at the MSP where they would be emptied. The mineral concentrates would then be handled as described in Section 2.2.4.

The empty containers would then be transported back to the reach stacker and loaded back onto the Atlas-Campaspe Mineral Sands Project train.

3.1.5 Mineral Concentrates/HMC Processing

Processing Atlas-Campaspe Mineral Sands Project mineral concentrates at the MSP would increase the maximum mineral concentrate processing rate from approximately 650,000 tpa to approximately 1,200,000 tpa.

The Modification would not however require any significant alteration to the existing/approved mineral concentrates/HMC processing operations, existing/approved mineral separation methods or processing infrastructure at the MSP.

WHIMS

The Modification would not require any changes to the approved WHIMS operations (Section 2.2.5).

As described in Section 2.2.5, HMC is currently approved to be processed in the WHIMS at either MSP or the Ginkgo and Snapper Mines. The WHIMS is currently located at the Ginkgo Mine.

If the WHIMS is relocated at the MSP, it would only process Gingko and Snapper Mine HMC as the HMC generated at the Atlas-Campaspe Mineral Sands Project would be processed in a WHIMS located at the Atlas-Campaspe Mine (i.e. the WHIMS operation would remain unchanged despite the proposed increase in processing rate at the MSP).

MSP Circuits

Feed Preparation Circuit

As described in Section 2.2.5, the feed preparation circuit processes the non-magnetic mineral concentrate to produce a non-magnetic concentrate product and a minor process waste component.

The non-magnetic concentrate product maximum production rate would increase from approximately 210 tpa to approximately 450 tpa. The existing feed preparation circuit has in-built capacity to produce the proposed 450 tpa of non-magnetic concentrate product and therefore no upgrades are required.

The Modification would not result in any other changes to the existing/approved feed preparation circuit (Section 2.2.5).

Leucoxene Circuit

As described in Section 2.2.5, the leucoxene circuit processes the leucoxene mineral concentrate to produce leucoxene mineral product, sulphate ilmenite mineral product and a minor process waste component.

The leucoxene mineral product maximum production rate would increase from approximately 185 tpa to approximately 250 tpa. The existing leucoxene circuit has in-built capacity to produce the proposed 250 tpa of leucoxene mineral product and therefore no upgrades are required.

LPG would continue to be used as the fuel for the bed dryer. LPG consumption would increase from approximately 1,155 tpa to approximately 1,510 tpa.

The Modification would not result in any other changes to the existing/approved leucoxene circuit (Section 2.2.5).

Ilmenite Circuit

As described in Section 2.2.5, the ilmenite circuit processes the ilmenite mineral concentrate to produce sulphate ilmenite mineral product and a minor process waste component.

The sulphate ilmenite mineral product maximum production rate would increase from approximately 124 tpa to approximately 600 tpa. The existing ilmenite circuit has in-built capacity to produce the proposed 600 tpa of ilmenite mineral product and therefore no upgrades are required.

LPG would continue to be used as the fuel for the bed dryer. LPG consumption would increase from approximately 870 tpa to approximately 4,160 tpa.

The Modification would not result in any other changes to the existing/approved ilmenite circuit (Section 2.2.5).

Ilmenite Kiln/Roaster Circuit

The Modification would not result in any changes to the approved ilmenite kiln/roaster circuit (Section 2.2.5).

Rutile and Zircon Circuits

The Modification would not result in any changes to the approved rutile and zircon circuits (Section 2.2.5) with the exception of the fuel type for the rutile and zircon dryers. It is proposed to use LPG rather than black coal. Approximately 630 tpa of LPG would be required.

Mineral Product Production Rates

The approved and proposed mineral product production rates for the MSP are provided in Table 4.

3.1.6 Mineral Product Storage, Loading and Transport

The Modification would not require any changes to the existing/approved mineral product storage and loading (Section 2.2.6).

There would be no change to mineral product transport practices at the MSP described previously (Section 2.2.6) as a result of the Modification, with the exception of increased train size required to transport increased mineral product. Product train size would increase from approximately 50 wagons transporting approximately 3,200 tpa of mineral product to approximately 100 wagons transporting approximately 6,400 tpa of mineral product.

There would be no change to the train frequency described in Section 2.2.6.

Table 4
Approved and Proposed Mineral Product Production Rates

Mineral Product	Approved Production Rate (ktpa)	Proposed Production Rate (ktpa)
MSP (Existing)		
Leucoxene Mineral Product	185	250
Sulphate Ilmenite	124	600
Non-magnetic Concentrate	210	450
MSP (Full Development)		
Leucoxene Mineral Product	185	250
Sulphate Ilmenite	124	375
Roasted Ilmenite	225	225
Non-magnetic Concentrate	210	250
Zircon Mineral Product	75	75
Rutile Mineral Product	100	100

3.1.7 Mobile Fleet

Additional mobile fleet would be required to unload the mineral concentrates from the Atlas-Campaspe Mineral Sands Project train (Section 3.1.3). The additional mobile fleet would include a reach stacker and tip trucks.

Details of the additional mobile fleet are provided in the MSP Noise Assessment (Appendix B).

3.1.8 MSP Process Waste Management

MSP process waste would be generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates.

This additional MSP process waste would be combined with the existing/approved MSP process wastes produced at the MSP and be transported to the Ginkgo and Snapper Mines in accordance with existing/approved operations (Section 2.2.8) up until their cessation.

Once operations at the Ginkgo and Snapper Mines have ceased, the MSP process waste would be loaded into containers at the MSP for transport via the Atlas-Campaspe Minerals Sands Project mineral concentrate and MSP process waste transport route to the Atlas-Campaspe Mine (Figure 1).

Characterisation and Classification

The MSP process waste would continue to comprise silica, quartz, monazite, ash waste by-product and sulphur based effluent (Section 2.2.8).

Based on the results of a pilot plant study and metallurgical analysis conducted for the Atlas-Campaspe Minerals Sands Project, the MSP process waste generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates would likely be classified as (Radiation Advice & Solutions, 2012):

- "Hazardous" in accordance with the *Waste Classification Guidelines Part 3: Waste Containing Radioactive Material (*DECC, 2008).
- A "radioactive substance" under the *Radiation Control Act, 1990*.

The MSP process waste generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates is therefore likely to be classified the same as the existing/approved MSP process waste (Section 2.2.8).

Quantities and Management Strategy

Up to approximately 50,000 tpa of MSP process waste is expected to be generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates.

As the MSP process waste production rate at the MSP to date has been below (typically approximately 120,000 tpa) the approved MSP process waste production (i.e. 300,000 tpa), the Modification would not result in an increase in the approved MSP process waste production rate.

Prior to the cessation of operations at the Ginkgo and Snapper Mines, the additional MSP process waste would be combined with the existing/approved MSP process wastes and managed as per existing/approved MSP process waste (Section 2.2.8).

Once operations at the Ginkgo and Snapper Mines have ceased, the MSP process waste would be transported via the Atlas-Campaspe Minerals Sands Project mineral concentrate and MSP process waste transport route to the Atlas-Campaspe Mine (Figure 1).

Front end loaders would be used to load the "pugged" MSP process waste directly into containers on train wagons. An integrated tool carrier is used to remove and replace covers on the containers.

Up to 50,000 tpa of MSP process waste would be transported via rail and road to the Atlas-Campaspe Mineral Sands Project. The MSP process waste would be loaded on the empty Atlas-Campaspe Mineral Sands Project mineral concentrate trains (i.e. no additional rail movements would be required to transport the MSP process waste) for transport to the Ivanhoe Rail Facility where it would be loaded on to trucks for transport to the Atlas-Campaspe Mine (subject to separate approval).

The MSP process waste would be transported in accordance with the *Code of Practice for the Safe Transport of Radioactive Material* (ARPANSA, 2008).

A description of the proposed management of MSP process waste at the Ginkgo and Snapper Mines is provided in Section 3.2.1.

3.1.9 Water Management

Site Water Management System

The Modification would not result in changes to the existing/approved site water management system (Section 2.2.9).

Water Demand and Supply

The WHIMS and the feed preparation and zircon circuits are the main water users at the MSP.

As the processing rate for the WHIMS and zircon circuit would remain unchanged for the Modification, the water demand for these components would also remain unchanged.

The increase in the processing rate of the feed preparation circuit (i.e. approximate 115 percent) increase would result in a commensurate increase in water demand for this component.

As the water demand at the MSP to date (approximately 24 ML/annum) has been below the approved MSP water demand (i.e. approximately 175 ML/annum), the Modification would not result in an increase in the approved MSP water demand.

The MSP water supply would continue to be sourced from the Wills Street Waste Water Treatment Plant and the BHCC mains water supply (Section 2.2.9).

3.1.10 Infrastructure and Services

The Modification would not require any changes to the existing/approved infrastructure and services (Section 2.2.10).

3.1.11 Dangerous Goods Management

The Modification would not require any changes to the existing/approved dangerous goods storage at the MSP (Section 2.2.11).

The proposed increase in LPG consumption would require an additional delivery each week (i.e. an increase from one to two LPG deliveries per week).

Diesel would continue to be delivered to the MSP on a daily basis (i.e. no change to delivery frequency would be required).

There would be no change to the approved brown coal deliveries (i.e. approximately one per week) as no change to the ilmenite kiln/roaster circuit processing rate is proposed. Deliveries of black coal would no longer be required as black coal is no longer proposed to be used for the rutile and zircon dryer fuel.

The transport activities would be conducted in accordance with existing/approved management measures (Section 2.2.11).

3.1.12 Waste Management

The Modification would not require any changes to the existing/approved waste management at the MSP (Section 2.2.12).

3.1.13 Workforce

The Modification would not require any changes to the approved MSP workforce (Section 2.2.13).

3.1.14 Rehabilitation Strategy

The Modification would not require any changes to the existing/approved rehabilitation strategy (Section 2.2.14) as no change to the general arrangement of the MSP is proposed.

3.2 GINKGO AND SNAPPER MINES

A comparison of the proposed modified Ginkgo and Snapper Mines with the existing/approved Ginkgo and Snapper Mines is provided in Table 5.

The Modification would only result in a change to the source of the existing/approved MSP process waste (i.e. MSP process waste from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates) disposed at the Ginkgo and Snapper Mines (Table 5).

This description of the modified Gingko and Snapper Mines therefore focuses on the proposed MSP process waste management measures.

Table 5
Comparison of the Existing/Approved and Modified Gingko and Snapper Mines

MDBO Approval	Project Component	Existing/Approved	Modified
Gingko Mine Development Consent (DA 251-09-01)	Project Life	• Life of mine of approximately 14 years.	No change.
	Tenement	• Mining operations conducted within Mining Lease (ML) 1504.	No change.
	Mining	• Reserve of approximately 145 million tonnes (Mt) of ore to be mined over the life of the mine. • A double-pass mine path dredge mining operation producing approximately 13 Mtpa of ore and moving up to approximately 24 Mtpa of overburden.	No change.
	Mineral Concentration	• Concentration to be undertaken in a primary gravity concentration unit (comprising a screen, surge bin and wet concentrator). • The HMC produced is then treated at either of the Ginkgo Mine, the Snapper Mine or the MSP (dependent on the location of the WHIMS). • Approximately 3,700 kilotonnes (kt) of mineral concentrates to be produced over the life of the mine. • Maximum annual mineral concentrate production rate of approximately 576,000 tpa.	No change.
	Mineral Concentrate/HMC Transport to the MSP	• Double road trains (or other RMS approved vehicles) are used to transport mineral concentrate/HMC from the Ginkgo Mine to the MSP via the mineral concentrate and MSP process waste transport route. • Up to 735,000 tpa of mineral concentrates from the Ginkgo and Snapper Mines to be transported to the MSP.	No change.
	Overburden Management	• Replacement of overburden is undertaken by an overland conveyor system. Stripped overburden is transported via the overland conveyor system and replaced over sand residues that have been deposited behind the floating plant.	No change.
	Sand Residue and Coarse Reject Management	• Sand residues and coarse rejects from the primary gravity concentration unit are placed in the sand residue dam or in the active mining area (behind the advancing ore extraction area).	No change.

Table 5 (Continued)
Comparison of the Existing/Approved and Modified Gingko and Snapper Mines

MDBO Approval	Project Component	Existing/Approved	Modified
Gingko Mine Development Consent (DA 251-09-01) (Continued)	MSP Process Waste Management	• MSP process waste from the processing of Ginkgo and Snapper Mines mineral concentrates are transported to the Ginkgo and Snapper Mines for disposal.	MSP process waste from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates in addition to Ginkgo and Snapper Mines mineral concentrates would be transported to the Ginkgo and Snapper Mines for disposal. No change to the existing/approved classification of MSP process waste disposed at the Gingko Mine.
		• The MSP process waste would be: – placed above the groundwater table; – placed no closer than 10 m from the natural ground surface; and – covered under a minimum of 10 m of overburden and soil, such that the radiation level at the surface of the rehabilitated process waste emplacement cells would be equivalent to the natural background radiation level.	No change.
	Water Supply	• Water requirements would be supplied primarily by a borefield comprising six bores located adjacent to the initial sand residue dam and initial overburden emplacement. • The maximum water supply requirement from the borefield would be 128 litres per second (L/s), much of which is returned to the watertable after use. • Water would be recycled on-site (where practicable) to minimise the quantity of water extracted from the borefield.	No change.
	Mine Site Electricity Distribution	• A main substation and 66 kV to 22 kV transformer is located at the Ginkgo Mine. Power is reticulated around the site at 22 kV. Each operating area would then have a relocatable step-down substation located adjacent to the active mining area.	No change.
	Access	• Access to the Ginkgo Mine is via the 64 km HAR to the Silver City Highway.	No change.
	Employment	• Operational workforce of approximately 270 personnel (including 85 Cristal Mining employees and 185 contractors).	No change.
	Hours of Operation	• 24 hours per day, seven days per week.	No change.
	Rehabilitation Works	• Progressive rehabilitation undertaken as mining advances. Rehabilitation trials and investigations undertaken to assess the effectiveness of rehabilitation techniques, cover depths and the performance of different plant species over the life of the Ginkgo Mine.	No change.
	Biodiversity Offset Area	• Approximately 521 hectares (ha) has been established to offset native vegetation communities cleared at Ginkgo Mine.	No change.

Table 5 (Continued)
Comparison of the Existing/Approved and Modified Gingko and Snapper Mines

MDBO Approval	Project Component	Existing/Approved	Modified
Snapper Mine Project Approval (06_0168)	Project Life	• Life of mine of approximately 15 years.	No change.
	Tenement	• Mining operations conducted within ML 1621.	No change.
	Mining	• Reserve of approximately 122 Mt of ore to be mined over the life of the mine. • Mining up to approximately 9.1 Mtpa of ore. • Single-pass dredge mining for the initial six years (or approximately 4 km along the mine path) followed by double-pass mining for the remainder of the life of mine. • Secondary (dry) mining using conventional mobile equipment in various locations along the mine path where ore is located above the groundwater table such that dredge mining is not feasible.	No change.
	Mineral Concentration	• Concentration to be undertaken in a primary gravity concentration unit (comprising a screen, surge bin and wet concentrator). • The HMC produced is then treated at either of the Ginkgo Mine, the Snapper Mine or the MSP (dependent on the location of the WHIMS). • Approximately 5,200 kt of mineral concentrates to be produced over the life of the mine. • Maximum annual mineral concentrate production rate of approximately 621,000 tpa.	No change.
	Mineral Concentrate/HMC Transport to the MSP	• Double road trains (or other RMS approved vehicles) are used to transport mineral concentrate/HMC from the Ginkgo Mine to the MSP via the mineral concentrate and MSP process waste transport route. • Up to 735,000 tpa of mineral concentrates from the Ginkgo and Snapper Mines to be transported to the MSP.	No change.
	Overburden Management	• Overburden was initially deposited in an off-path overburden emplacement area. Overburden is now transported via an overland conveyor system and/or dry mine fleet to the rear of the mine path where it is placed over deposited sand residues.	No change.
	Sand Residue and Coarse Reject Management	• Sand residues and coarse rejects from the primary gravity concentration unit were initially placed in an initial sand residue dam. Sand residues are now placed directly to the rear of the mine path.	No change.

Table 5 (Continued)
Comparison of the Existing/Approved and Modified Gingko and Snapper Mines

MDBO Approval	Project Component	Existing/Approved	Modified
Snapper Mine Project Approval (06_0168) (Continued)	MSP Process Waste Management	• MSP process waste from the processing of Ginkgo and Snapper Mines mineral concentrates are transported to the Ginkgo and Snapper Mines for disposal.	MSP process waste from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates in addition to Ginkgo and Snapper Mines mineral concentrates would be transported to the Ginkgo and Snapper Mines for disposal. No change to the existing/approved classification of MSP process waste disposed at the Snapper Mine.
		• The MSP process waste would be: – placed above the groundwater table; – placed no closer than 10 m from the natural ground surface; and – covered under a minimum of 10 m of overburden and soil, such that the radiation level at the surface of the rehabilitated process waste emplacement cells would be equivalent to the natural background radiation level.	No change.
	Water Supply	• Water requirements are supplied primarily by a borefield extracting water from the deep, high yielding, saline Lower Olney Formation aquifer. • The maximum water supply requirement from the borefield would be 270 L/s, much of which is returned to the watertable after use. • Water would be recycled on-site (where practicable) to minimise the quantity of water extracted from the borefield.	No change.
	Mine Site Electricity Distribution	• A 66 kV ETL extends the existing ETL from the Ginkgo Mine to the Snapper Mine.	No change.
	Access	• Snapper Mine traffic to share the existing 64 km HAR from the Ginkgo Mine to the Silver City Highway.	No change.
	Employment	• Operational workforce of approximately 110 employees.	No change.
	Hours of Operation	• 24 hours per day, seven days per week.	No change.
	Rehabilitation Works	• Progressive rehabilitation to be undertaken as mining advances. Rehabilitation trials and investigations to be undertaken to assess the effectiveness of rehabilitation techniques, cover depths and the performance of different plant species over the life of the Snapper Mine.	No change.
	Biodiversity Offset Area	• The offset area comprises an enhancement area of approximately 5,470 ha.	No change.

3.2.1 MSP Process Waste Management

As described in Section 3.1.8, MSP process waste generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates would be combined with the existing/approved MSP process wastes produced at the MSP and be transported to the Ginkgo and Snapper Mines in accordance with existing/approved operations (Section 2.2.8) up until their cessation.

The Modification would not result in a change to the existing/approved classification of MSP process waste transported to the Ginkgo and Snapper Mines (Section 3.1.8).

The approved MSP process waste disposal rate (i.e. 300,000 tpa) would remain unchanged for the Modification as the MSP process waste production rate at the MSP to date has been below (typically approximately 120,000 tpa) the approved MSP process waste production (i.e. 300,000 tpa).

The Modification would result in no changes to the existing/approved MSP process waste management measures at the Ginkgo and Snapper Mines (Section 2.3.1).

4 ENVIRONMENTAL ASSESSMENT – BROKEN HILL MINERAL SEPARATION PLANT

4.1 IDENTIFICATION OF KEY ISSUES

The following existing/approved development components of the MSP would be unchanged by the Modification (Section 3.1):

- general arrangement;
- mineral processing operations (except for processing rate);
- water supply and demand;
- site water management system;
- MSP process waste management measures; and
- workforce.

The key potential impacts of the Modification are related to the increase in the mineral concentrate/HMC processing rate at the MSP and the associated potential air quality, noise, MSP process waste, greenhouse gas, transport and regional economic impacts and changes to the existing/approved risks and hazards.

A discussion of the potential air quality, noise, MSP process waste, greenhouse gas, transport and regional economic impacts are provided in Sections 4.2 to 4.7, respectively. Potential changes to hazards and risk are discussed in Section 4.8.

As no change to the existing/approved general arrangement is proposed for the Modification, no additional surface development would be required. Therefore, there would be no material alteration to the existing/approved impacts of the MSP on land resources, flora, fauna, Aboriginal cultural heritage, non-Aboriginal cultural heritage, visual amenity and the rehabilitation strategy.

The Modification would not result in any material alteration to the existing/approved water resource impacts given there is no proposed change to the existing/approved site water management system and water supply and demand.

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

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

4.2 AIR QUALITY

4.2.1 Background

Previous Assessments

The potential air quality impacts of the MSP were assessed by Pacific Air and Environment (PAE) (PAE, 2001). The assessment considered the potential air quality emissions likely to be generated by the MSP at potentially affected receivers against applicable assessment criteria. No potentially affected receivers were predicted to exceed the applicable assessment criteria.

PAE (2005) assessed the potential air quality impacts associated with alterations to the MSP required as a result of the detailed design process and feasibility studies. The assessment also concluded that no potentially affected receivers were predicted to exceed the applicable assessment criteria (PAE, 2005).

Air Quality Monitoring

The MSP Air Quality Management Plan details relevant air quality criteria, MSP air quality emission sources, monitoring programme, mitigation procedures, complaints protocol and a contingency plan.

Air quality monitoring conducted in accordance with the MSP Air Quality Management Plan at the MSP includes dust deposition and dust concentration (as particulate matter with an equivalent aerodynamic diameter of 10 micrometres or less [PM_{10}]) at locations surrounding the MSP (Figure 6) since 2005 and 2006, respectively. In-stack total suspended particulates (TSP) and nitrogen dioxide (NO_2) concentrations are also monitored at the existing MSP stacks (Figure 3).

Dust deposition is measured at four locations (Figure 6). The annual average dust deposition results at all of these locations have been within the EPA criterion (i.e. 4 grams per square metre per month [g/m^2/month]) since 2009 (Appendix A).

PM_{10} concentrations are measured by high volume air sampler at one location (Figure 6). All results demonstrate compliance with the EPA annual average PM_{10} criterion (i.e. 30 micrograms per cubic metre [$\mu g/m^3$]) since 2009 (Appendix A).

The EPA 24-hour PM_{10} criterion (i.e. 50 $\mu g/m^3$) has been complied with since 2010 (Appendix A).

The monitored TSP and NO_2 concentrations in the leucoxene dryer stack have complied with the EPL 12314 criteria (i.e. 100 milligrams per cubic metre [mg/m^3] and 350 grams per cubic metre) on all occasions since 2006. The monitored TSP concentrations in the leucoxene baghouse hygiene stack have complied with the EPL 12314 criterion (100 mg/m^3) on all occasions since 2006 (Appendix A).

Air Quality Management Measures

Existing/approved air quality management measures implemented at the MSP include:

- Minimisation of disturbance areas.
- Active disturbance areas (e.g. areas around mineral concentrate stockpiles) are watered.
- MSP circuits are enclosed.
- Mineral concentrate/product conveyors are covered.
- Mineral product stored in mineral product sheds where possible.
- Baghouses are installed on the dryer stacks.
- A wet scrubber will be installed on the ilmenite kiln stack.
- Stacks are designed to comply with the *Protection of the Environment Operations (Clean Air) Regulation, 2010*.
- Devices (i.e. alarms) are fitted to the dryer and ilmenite kiln stacks to warn operators of any malfunctions have occurred in the emission controls.
- Process equipment is maintained to manufacturer's specifications to minimise the potential for leaks and fugitive emissions.
- Mineral concentrates/HMC and mineral product stockpiles managed in accordance with the MSP Stockpile Management, Quality and Product Control Standard Operating Procedure.
- A mobile industrial vacuum is used to collect mineral concentrates/HMC and mineral product that has migrated from designated storage areas every six months.
- Vegetation wind breaks around the MSP have been established.
- Topsoil stockpiles which are not planned to be used for over six months are revegetated.

4.2.2 Environmental Review

An Air Quality Assessment for the MSP component of the Modification was undertaken by Pacific Environment Limited (2013) and is presented in Appendix A. The assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW Department of Environment and Conservation, 2005).

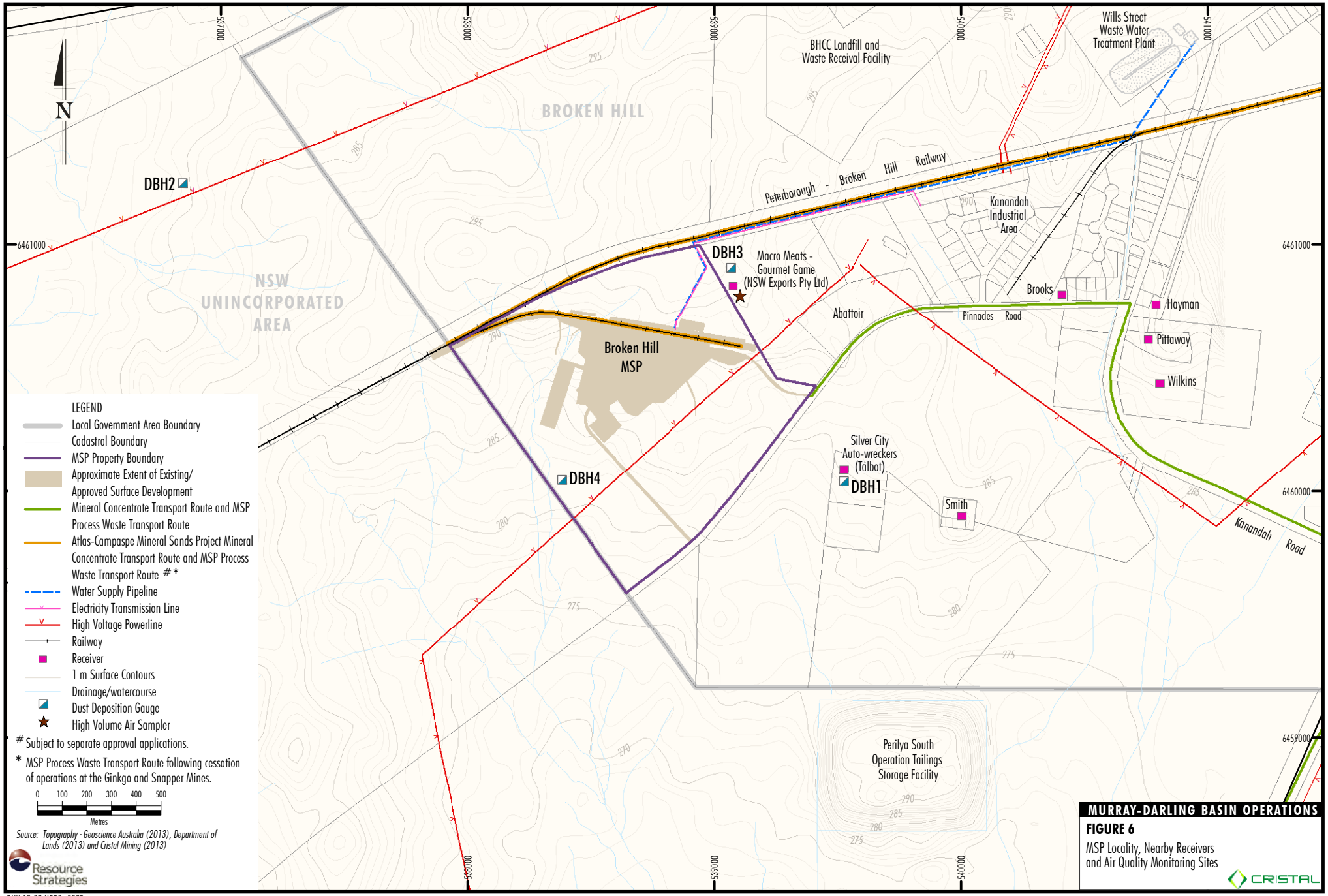
Potential Impacts

Assessment Methodology

Potential air quality impacts at the MSP were modelled for the MSP at full development (i.e. all MSP circuits operational) and maximum processing rate to assess the potential impact at the nearest residential receivers (Figure 6).

An emission inventory was prepared for the MSP including mineral concentrate/HMC haulage, unloading and loading mineral concentrates/HMC, managing mineral concentrate/HMC stockpiles, stack emissions and wind-blown emissions (e.g. from mineral concentrate stockpiles). The major emission sources were associated with the following activities (Appendix A):

- managing mineral concentrate/HMC stockpiles;
- loading mineral product on trains; and
- mineral concentrate/HMC haulage on access road.



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The estimated wind blown emissions from stockpiles included in the emission inventory are considered conservative given the high density and coarse nature of the mineral concentrates/HMC and mineral product (Appendix A).

Cumulative impacts associated with the approved Broken Hill Solar Plant, existing Perilya South Operation and the existing Rasp Mine have been considered in the assessment (Appendix A).

The AERMOD modelling system was used by Pacific Environment Limited (2013) to assess potential air quality impacts associated with the Modification.

A full description of the dispersion model methodology, predicted in-stack concentration calculation methodology and the emissions inventory is provided in Appendix A.

Predicted In-Stack Concentrations

The predicted in-stack particulate matter and NO_x concentrations and relevant criteria are summarised in Table 6. All predicted particulate matter and NO_x concentrations comply with the relevant criteria (Table 6).

Ground Level Concentrations

Air quality modelling results for the Modification indicate (Appendix A):

- The annual average dust deposition assessment criteria of 2 g/m²/month (project only) and the 4 g/m²/month (cumulative) would not be exceeded at any receiver.
- The annual average TSP assessment criterion of 90 µg/m³ would not be exceeded at any receiver, when considering potential project only and cumulative impacts.
- The annual average PM_{10} assessment criterion of 30 µg/m³ would not be exceeded at any receiver, when considering potential project only and cumulative impacts.
- The 24-hour average PM_{10} criterion of 50 µg/m³ would not be exceeded any receiver due to potential project only impacts.
- The potential for additional cumulative exceedances of the 24-hour PM_{10} assessment criterion (i.e. 50 µg/m³) at the nearest receiver as a result of the modified MSP is very small as the maximum predicted project only 24-hour PM_{10} concentrations are well below the relevant criterion.
- The annual average NO_2 assessment criterion of 62 µg/m³ would not be exceeded at any receiver, when considering potential project only and cumulative impacts.
- The 1-hour average NO_2 criterion of 246 µg/m³ would not be exceeded any receiver due to potential impacts from the project only and cumulative impacts.

Chromium (IV) Emissions

PAE (2001) assessed the potential impacts associated with hexavalent chromium (Cr [VI]) emissions and concluded that the maximum Cr (VI) concentrations would be well below the relevant criteria. As there is no change proposed to the ilmenite kiln stack, these findings are still considered relevant (Appendix A).

Table 6
Predicted In-stack Concentrations

Stack	NO_x (mg/m^3)		Particulate Matter (mg/m^3)	
	Estimated In-stack Concentration	Criteria	Estimated In-stack Concentration	Criteria
Leucoxene Hygiene Baghouse	-	-	30	100[1]
Leucoxene Dryer	107	350[1]	76	100[1]
Ilmenite Hygiene Baghouse	-	-	27	100[1]
Ilmenite Dryer	86	350[1]	49	100[1]
Ilmenite Kiln	350	500[2]	50	50[2]
Zircon/Rutile Hygiene Baghouse	-	-	5	50[2]
Zircon Dryer	40	350[2]	46	50[2]
Rutile Dryer	15	350[2]	17	50[2]

Source: After Appendix A.

1 EPL 12314.

2 *Protection of the Environment Operations (Clean Air) Regulation, 2010.*

Management Measures

The MSP Air Quality Management Plan would continue to be implemented for the MSP incorporating the Modification. This would include the continued implementation of the air quality management measures described in Section 4.2.1.

The MSP Air Quality Management Plan would be reviewed and, if necessary, revised for the Modification.

Ilmenite Kiln/Roaster Emissions

In accordance with Condition E2 of EPL 12314, prior to constructing the ilmenite kiln/roaster circuit, Cristal Mining will apply for a licence variation that includes an air quality assessment that demonstrates the ilmenite kiln/roaster circuit will meet the relevant in-stack and ground level concentration air quality criteria.

Mineral Concentrate/HMC and Mineral Product Migration

Cristal Mining would implement one or a combination of the following additional measures to minimise the potential for mineral concentrate/HMC and mineral product to migrate within and off the MSP site:

- Installation of containment structures around mineral concentrate/HMC and mineral product stockpiles.
- Installation of wind break fences around relevant areas of MSP site boundary.
- Increase the frequency of the use of the mobile industrial vacuum used to collect mineral concentrates/HMC and mineral product around the MSP site.

The above measures do not include stockpile watering because mineral concentrate/HMC moisture content is required to be minimised prior to drying during processing in the MSP. The use of sprinklers to minimise the potential for mineral concentrate/HMC migration would be counter to this objective.

When selecting the preferred management measure(s), Cristal Mining would consider the likely effectiveness of containing mineral concentrate/HMC and mineral product on-site, operational feasibility and the construction and operational costs of each.

The management options are discussed further below.

Potential containment structure options (e.g. concrete bunds, temporary bunds, synthetic fabric storage sheds, steel storage sheds) located immediately around or surrounding the mineral concentrate/HMC and mineral product stockpiles would minimise the ability of these materials to migrate (i.e. wind blown) beyond these designated stockpile areas and therefore the potential for these materials to migrate off-site.

Wind break fences (e.g. commercially available synthetic or steel/aluminium wind break fences, woven mesh fencing) around the MSP site boundary to contain the extent of migrating (i.e. wind blown) mineral concentrate/HMC and mineral product within the MSP site could be installed on the basis that the relatively coarse particle size of the mineral concentrate/HMC and mineral product would restrict the majority of the material to migration along the surface (i.e. not suspended and dispersed) (Appendix A). If wind break fences are selected, they would be approximately 1 m high and constructed on the northern side of the MSP as a priority as the dominant strong winds (i.e. winds that would be capable of moving the relatively coarse and dense mineral concentrate/HMC and mineral product particles) are from the south-southwest to south-southeast (i.e. migration is predominately towards the north).

A mobile industrial vacuum has been used at the MSP to collect mineral concentrate/HMC and mineral product that has migrated from designated stockpile areas (Section 4.2.1). Increasing the frequency would minimise the source of mineral concentrate/HMC and mineral product that could migrate.

Alternatives to the above measures that are identified during considerations may also be identified.

Upon selection of a preferred management measure, Cristal Mining would consult with the EPA regarding the specific design and monitoring proposals prior to installation.

4.3 NOISE

4.3.1 Background

Previous Assessment

The potential noise impacts of the MSP were assessed by PAE in 2001 (PAE, 2001).

The assessment considered the potential noise impacts associated with the MSP at nearby residential and industrial receiver locations. No exceedances of relevant noise criteria were predicted at any receiver location.

Noise Limits

Operations at the MSP are currently required to comply with the noise limits in Development Consent (DA 345-11-01) and EPL 12314.

Condition 3.6(a), Schedule 2 of Development Consent (DA 345-11-01) and Condition L5.1 of EPL 12314 both specify that noise from the MSP premises must not exceed 35 A-weighted decibels (dBA) equivalent continuous noise level ($L_{Aeq[15minute]}$) during the day, evening or night, with compliance with these noise limits determined by noise monitoring at receiver location R2 (i.e. Silver City Auto-wreckers [Talbot]) (Figure 7).

Management and Monitoring

Noise management and monitoring at the MSP is conducted in accordance with the existing MSP Noise Management Plan.

Cristal Mining currently implements the following noise mitigation measures at the MSP:

- The processing circuits are enclosed within a building.
- External conveyors and conveyor drives are enclosed.
- Scheduling of operations to avoid potential maximum noise generating activities occurring during the night (i.e. loading of product trains, which requires two front end loaders and an integrated tool carrier does not occur during the night-time period).
- Road trains transporting mineral concentrate do not idle when not in use.
- All equipment is regularly maintained and serviced.

A combination of attended and unattended monitoring is conducted in accordance with the MSP Noise Management Plan to determine compliance with the noise limits specified in the Development Consent (DA 345-11-01) and EPL 12314.

Complaints

No noise related complaints have been received since the MSP operations commenced in 2005.

4.3.2 Environmental Review

A Noise Assessment for the MSP component of the Modification was undertaken by RenzoTonin (2013) and is presented in Appendix B. The assessment was conducted in accordance with the *NSW Industrial Noise Policy* (INP) (EPA, 2000).

Assessment Methodology

The noise assessment considered the potential change in noise emissions from the MSP due to the increase in handling, processing and transport of mineral concentrate/HMC and mineral product associated with the Atlas-Campaspe Mineral Sands Project.

Potential noise impacts associated with the MSP were modelled by RenzoTonin (2013) for the MSP at full development (i.e. all MSP circuits operational) and maximum processing rate to assess potential impacts at the nearest receivers.

Sound Power Level Testing

On 25 September 2013, RenzoTonin conducted sound power level (SWL) monitoring for key existing mobile and fixed equipment currently operational at the MSP.

The results of this on-site SWL monitoring were incorporated into the noise modelling where relevant (Appendix B).

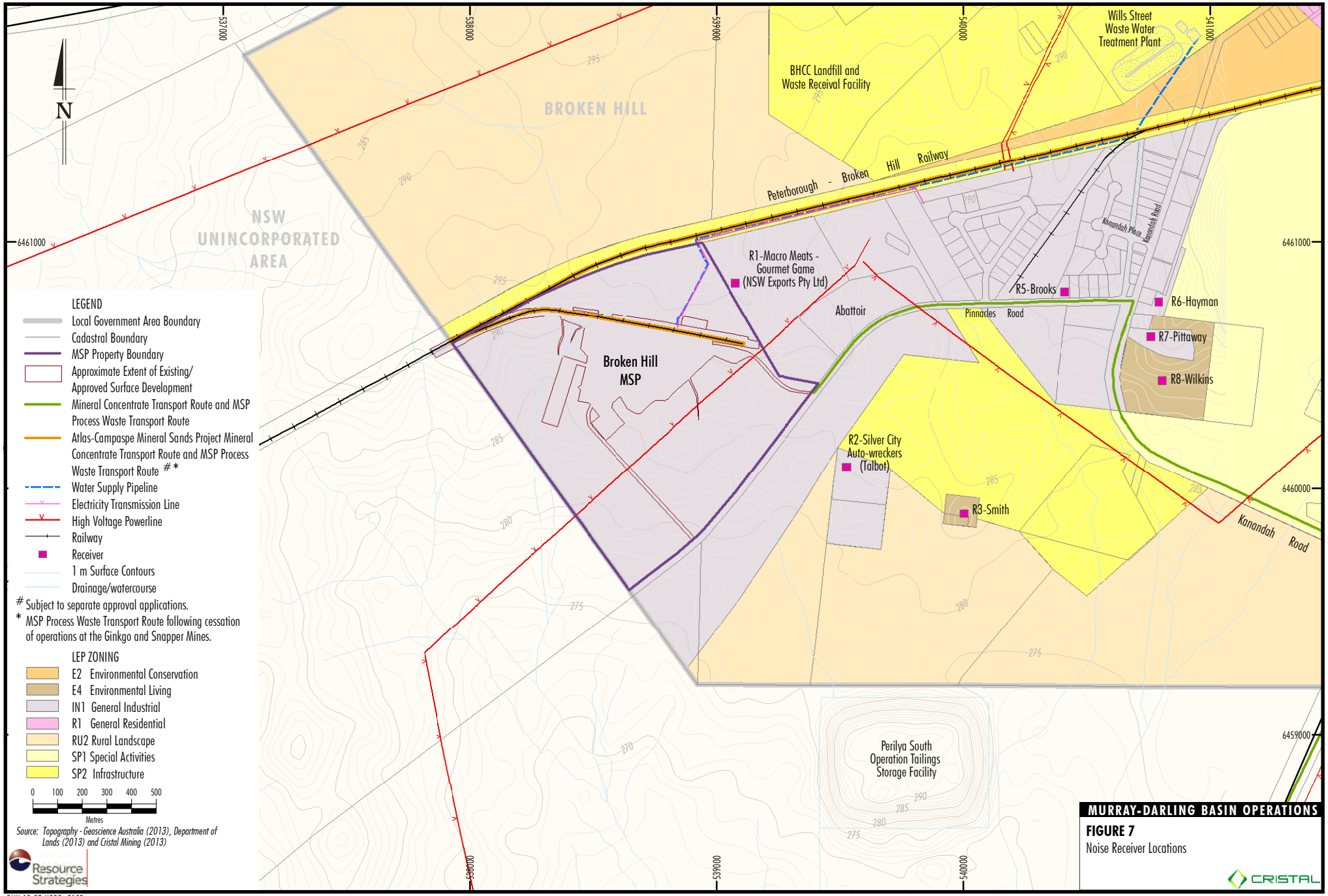
Operational Scenarios

Two operational scenarios were modelled by RenzoTonin (2013) to represent the modified MSP operations during the daytime/evening period (i.e. 7.00 am to 10.00 pm) and night-time period (i.e. 10.00 pm to 7.00 am), respectively.

The key differences between these operational scenarios are as follows (Appendix B):

- The loading of mineral product to trains using front end loaders would occur during the daytime/evening (consistent with current operations).
- The unloading of trains transporting mineral concentrate from the Atlas-Campaspe Mineral Sands Project would occur during the night-time.

Both scenarios included the operation of all MSP circuits, which would continue to operate 24 hours per day, 7 days per week for the Modification.



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Meteorology

One year of meteorological data from the Broken Hill Airport Automatic Weather Station was assessed to determine prevailing meteorological conditions for noise modelling, in accordance with the INP (Appendix B).

Consistent with previous assessment (PAE, 2001), no prevailing wind conditions were identified by RenzoTonin (2013) for any receiver location.

Unlike PAE (2001), noise enhancing temperature inversions were identified as being a feature of the area, and in accordance with the INP, G Class temperature inversions with strength 8 degrees Celsius per 100 m were assessed for the night-time period (Appendix B). Noise enhancing temperature inversions were not identified as assessable conditions by PAE (2001).

Reasonable and Feasible Mitigation Measures

The existing mitigation measures (Section 4.3.1) would continue for the Modification.

In addition, the following noise mitigation measures would be implemented for the Modification (Appendix B):

- The front end loader operating during the night-time would be retrofitted with a noise suppression kit (e.g. engine compartment lining and/or exhaust silencer) once the MSP begins to receive trains from the Atlas-Campaspe Mineral Sands Project.
- Cladding/enclosures would be installed around existing external auxiliary equipment to the processing circuits (i.e. five external fans, one external pump and one external screening table).
- If the approved zircon, rutile and ilmenite kiln/roaster processing circuits are constructed at the MSP, these circuits would be fully enclosed within a building, and external auxiliary equipment (e.g. conveyors and fans) would also be enclosed.
- Scheduling of operations to avoid the potential maximum noise generating activities during the night (i.e. the loading of product trains would not occur during the night).

Cristal Mining considers these noise mitigation measures to be reasonable and feasible for the Modification. Accordingly, these noise mitigation measures have been considered in the operational noise modelling (Appendix B).

Additional mitigation measures were also considered, however, these additional measures were not considered to be reasonable/feasible for the MSP.

The effect of constructing of bunds/acoustic barriers is considered by RenzoTonin (2013) to be limited during temperature inversions, and therefore, the additional capital costs associated with their construction is not considered to be reasonable.

Cristal Mining also considered alternatives to train unloading during the night-time. However, due to the constraint of the single rail spur at the MSP, it is not feasible for both the unloading of trains from Atlas-Campaspe and the loading of mineral product trains to occur during the daytime/evening only.

Alternative train unloading practices (e.g. conveyors) are not considered to be reasonable, due to the significant capital costs, and given the associated infrastructure (e.g. conveyor drives) would also generate noise emissions.

Project Specific Noise Limits

A summary of relevant Project Specific Noise Limits (PSNLs) for the Modification is provided in Table 7.

Residential Receivers

Receivers R3 (Smith) and R8 (Wilkins) are located within the zone *E4 Environmental Living* (Figure 7), as defined in the *Broken Hill Local Environment Plan 2013* (the Broken Hill LEP). Home occupations are permitted in the zone *E4 Environmental Living*, and accordingly, R3 and R8 have been considered as residential receivers.

Industrial Receivers

Receivers R1 (Macro Meats – Gourmet Game [NSW Exports Pty Ltd]), R2 (Silver City Auto-wreckers [Talbot]), R5 (Brooks), R6 (Hayman) and R7 (Pittaway) are located within the BHCC's industrial zone *IN1 General Industrial* (Figure 7), as defined in the Broken Hill LEP.

It is noted that an objective of the *IN1 General Industrial* zone is to support and protect industrial land for industrial uses.

Table 7
Project Specific Noise Levels

Receiver Location	Receiver Type	Intrusiveness Criteria (dBA $L_{Aeq,15minute}$)			Amenity Criteria (dBA $L_{Aeq,period}$)		
		Day	Evening	Night	Day	Evening	Night
R1 – Macro Meats – Gourmet Game (NSW Exports Pty Ltd)	Industrial	-	-	-	70[1]		
R2 – Silver City Auto-wreckers (Talbot)	Industrial	-	-	-	70[1]		
R3 – Smith	Residential	35	35	35	50	45	40
R5 – Brooks	Industrial	-	-	-	70[1]		
R6 – Hayman	Industrial	-	-	-	70[1]		
R7 - Pittaway	Industrial	-	-	-	70[1]		
R8 – Wilkins	Residential	35	35	35	50	45	40

(1) When in use.

Source: After Appendix B.

Refer to Figure 7 for receiver locations.

In regard to receivers located within an industrial zone, the INP states:

> *Industrial — an area defined as an industrial zone on an LEP. For isolated residences within an industrial zone the industrial amenity criteria would usually apply.*

Further, in regard to receivers located within an industrial zone, the INP Application Notes state:

> *The INP does not require that intrusive noise be assessed at industrial or commercial premises. For industrial/commercial receivers, only the amenity criteria apply. Amenity noise levels should be assessed at the most affected point on or within the property boundary. This approach also applies to other non-residential receivers, such as educational facilities, hospitals and places of worship.*

Accordingly, the relevant noise criteria for receivers located within the zone *IN1 General Industrial* is the amenity criteria for industrial premises (Table 7) (Appendix B).

Potential Impacts

Intrusive Noise

The noise modelling results for the modified MSP indicate (Appendix B):

- There would be no exceedance of the PSNL of 35 dBA $L_{Aeq,15minute}$ at any residential receiver location during the day or evening, or during the night under calm meteorological conditions.
- There would be a moderate (i.e. 4 dBA) exceedance of the PSNL of 35 dBA $L_{Aeq,15minute}$ at receiver location R3 (Smith) during the most adverse weather conditions (i.e. G Class temperature inversions).
- There would be no exceedances of the relevant amenity criteria at any receiver location.

A summary of potential exceedances of PSNLs is provided in Table 8.

Table 8
Summary of Potential Operational Noise Exceedances of PSNLs

Period	Noise Management Zone		Noise Affectation Zone
	Marginal 1 to 2 dBA Exceedance of PSNL	Moderate 3 to 5 dBA Exceedance of PSNL	> 5 dBA Exceedance of PSNL
Day	-	-	-
Evening	-	-	-
Night	-	R3 (Smith)	-

Source: After Appendix B.

Refer to Figure 7 for receiver locations.

Sleep Disturbance

An assessment of potential sleep disturbance impacts is presented in Appendix B.
A sleep disturbance criterion of 45 dBA $L_{A1,1minute}$ has been adopted by the EPA. The sleep disturbance criteria are not considered to be ideal, because the research into disturbance of sleep due to extraneous noise sources remains inconclusive (Appendix B). Other research by the EPA indicates that sleep awakening reactions are likely due external noise levels below 65 dBA $L_{A1,1minute}$ (Appendix B).

No exceedances of 65 dBA $L_{A1,1minute}$ were predicted at any residential receiver (Appendix B). However, it was predicted there would be a moderate (i.e. 3 dBA) exceedance of the sleep disturbance noise criteria of 45 dBA $L_{Aeq,1minute}$ at one receiver location (R3 [Smith]) during adverse weather conditions.

This receiver (R3 [Smith]) is predicted to be in the Noise Management Zone for the modified MSP (Table 8). The mitigation measures implemented for this receiver to manage potential intrusive noise impacts would also reduce potential sleep disturbance impacts.

Cumulative Impacts

Potential cumulative noise impacts associated with other existing operations (Sectio 4.9) have been considered, and no exceedance of the relevant amenity criteria is expected at any receiver location (Appendix B).

Management Measures

Noise mitigation and management measures for the existing MSP are described in the MSP Noise Management Plan.

The MSP Noise Management Plan would be reviewed and updated for the Modification to include:

- A description of activities relevant to potential noise impacts associated with the Modification.
- A summary of predicted noise levels associated with Modification.
- A review of noise mitigation measures.
- Revised attended noise monitoring locations (e.g. R3) to reflect the land zoning defined in the *Broken Hill Local Environment Plan 2013* and predicted noise levels.

Noise Management Zone

One privately-owned receiver (R3 [Smith]) is predicted to be within the Noise Management Zone for the modified MSP (Table 8).

In addition to the noise mitigation measures included in the predictive modelling, noise management procedures for receivers predicted to be within the Noise Management Zone would include:

- Prompt response to community concerns or complaints.
- Attended noise monitoring at these receiver locations.
- Refinement of on-site noise mitigation measures and operating procedures as required (and where possible).
- Implementation of reasonable and feasible acoustical mitigation at receivers (which may include measures such as enhanced glazing, insulation and/or air conditions), in consultation with the relevant landowner, where noise monitoring shows noise levels which are 3 to 5 dBA above project-specific noise levels.

4.4 MSP PROCESS WASTE MANAGEMENT

4.4.1 Background

Previous Assessments

A Process Waste Materials Assessment (Bemax Resources, 2006) was prepared to assess the potential environmental impacts and describe management measures associated with the management of MSP process waste.

The Process Waste Materials Assessment included a Process Waste Materials Risk Assessment which concluded that all identified potential hazards and risks associated with the management of MSP process waste were rated as a low level risk (Bemax Resources, 2006).

MSP Process Waste Management

The management of MSP process waste at the MSP is conducted in accordance with the MSP Waste Management Plan and the Transport of Hazardous Materials Plan.

A description of the existing/approved MSP process waste management is provided in Section 2.2.8.

4.4.2 Environmental Review

Potential Impacts

MSP process waste would be generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates.

This additional MSP process waste would be combined with the existing/approved MSP process wastes produced at the MSP and be transported to the Ginkgo and Snapper Mines in accordance with existing/approved operations (Section 2.2.8) up until cessation of those operations.

Once operations at the Ginkgo and Snapper Mines have ceased, the MSP process waste would be loaded into containers at the MSP for transport via the Atlas-Campaspe Minerals Sands Project mineral concentrate and MSP process waste transport route to the Atlas-Campaspe Mine (Figure 1).

The potential impacts associated with the management of MSP process waste at the MSP and the Ginkgo and Snapper Mines and the MSP and the Atlas-Campaspe Mine are discussed below.

Management of MSP Process Waste at the MSP and the Ginkgo and Snapper Mines

The Modification would not result in a change to the approved transport rate and classification of MSP process waste transported to the Ginkgo and Snapper Mines (Section 3.1.8).

The existing/approved MSP process waste management strategy (Section 2.2.8) would therefore continue to be implemented while the MSP process waste is transported to the Ginkgo and Snapper Mines for disposal.

Given the above, it is considered that the conclusions of the Process Waste Materials Assessment (Bemax Resources, 2006) (i.e. all identified potential hazards and risks associated with the management of MSP process waste were rated as a low level risk) are still relevant to the Modification.

A description of the proposed management of MSP process waste at the Ginkgo and Snapper Mines is provided in Section 3.2.1.

Management of MSP Process Waste at the MSP and the Atlas-Campaspe Mine

A description of the proposed management strategy for MSP process waste at the MSP and the Atlas-Campaspe Mine is provided in Section 3.1.8.

A Mineral Concentrate and Process Waste Materials Assessment (Radiation Advice & Solutions, 2012) was prepared for the Atlas-Campaspe Mineral Sands Project. The Mineral Concentrate and Process Waste Materials Assessment considered the potential impacts associated with the management of MSP process waste.

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

Management Measures

The MSP Waste Management Plan and the Transport of Hazardous Materials Plan would continue to be implemented for the MSP incorporating the Modification. This would include the continued implementation of the management strategy described in Section 2.2.8.

In addition, the MSP Waste Management Plan and the Transport of Hazardous Materials Plan would be reviewed and, if necessary, revised for the Modification.

4.5 GREENHOUSE GAS EMISSIONS

4.5.1 Background

The Commonwealth *National Greenhouse and Energy Reporting Act, 2007* (NGER Act) established a national framework for corporations to report greenhouse gas emissions and energy consumption. Registration and reporting is mandatory for corporations that have energy production, energy use or greenhouse gas emissions that exceed specified thresholds. Cristal Mining is registered under the NGER Act and reports greenhouse gas emissions from its operations, including the MSP.

Previous Assessments

The potential greenhouse gas impacts of the MSP were assessed by PAE in 2001 (PAE, 2001). The assessment considered the construction and operational greenhouse gas emissions due to diesel, LPG and end use of electricity. The assessment reported that 1.13 Mt of carbon dioxide equivalents (CO_2-e) would be produced over the life of the MSP (PAE, 2001).

The *Broken Hill Mineral Separation Plant February 2007 Modification Statement of Environmental Effects* (Bemax Resources, 2007) assessed the incremental greenhouse gas emissions associated with the February 2007 Modification. Approximately 1.71 Mt CO_2-e of additional greenhouse gas emissions were estimated to occur (i.e. a total of approximately 2.84 Mt CO_2-e would be produced over the MSP lifetime) (Bemax Resources, 2007).

4.5.2 Environmental Review

Potential Impacts

Changes to MSP greenhouse gas emissions associated with the Modification would be associated with the following:

- increased operational life from 19 to 26 years;
- increased LPG and diesel consumption;
- increased electricity consumption;
- additional rail transport requirements; and
- no black coal consumption.

The incremental MSP greenhouse gas emissions associated with the Modification were estimated using emission factors from the Commonwealth Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education *National Greenhouse Accounts Factors* (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013).

Table 9 provides a summary of the estimated incremental emissions associated with the Modification.

The incremental greenhouse gas emissions associated with the Modification were estimated to be (Table 9):

- Scope 1 – 2.51 Mt CO_2-e;
- Scope 2 – 0.04 Mt CO_2-e; and
- Scope 3 – 0.45 Mt CO_2-e.

The incremental coal emissions (Table 9) account for the reduction in black coal usage due to the proposed change in fuel type for the rutile and zircon circuits from black coal to LPG.

4.6 TRANSPORT

4.6.1 Background

Road Transport

Previous Assessments

The potential road transport impacts of the MSP were originally assessed by Traffix and Resource Strategies in 2001 (Traffix and Resource Strategies, 2001). Traffix and Resource Strategies (2001) concluded that the existing road and intersections have sufficient capacity to cater for predicted MSP traffic flows with no detrimental impact to the existing levels of service.

Traffix (2007) prepared a cumulative road transport assessment that included consideration of the MDBO and other non-Cristal Mining road traffic movements. Traffix (2007) concluded that there was satisfactory capacity on the local road network and that no additional significant road safety issues were anticipated with the operations of the existing MDBO.

Existing Road Transport Management

Road transport for the MDBO is currently managed in accordance with the following:

- Ginkgo and Snapper Mines and MSP Transport Management Plan;
- Transport of Hazardous Materials Plan; and
- Ginkgo and Snapper Mines and MSP Traffic Code of Conduct.

Table 9
Summary of Estimated Incremental CO_2-e Emissions

Project Component	Emissions (kt CO_2-e)			
	Direct Emissions	Indirect Emissions		Full Fuel Cycle
	Scope 1	Scope 2	Scope 3	
Operations – Diesel	7	-	1	8
Operations – LPG	75	-	6	81
Operations – Coal	2,422	-	295	2,717
Operations – Electricity	-	42	9	51
MSP Process Waste Transport (Road and Rail)	6	-	-	6
Rail Transport of Mineral Product from the MSP to Port Adelaide	-	-	136	136
Total	**2,510**	**42**	**447**	**2,999**

Rail Transport

As described in Section 2.2.6, mineral product produced at the MSP is transported via rail from the MSP to South Australia via the Peterborough-Broken Hill Railway. Up to six train movements per week (i.e. three trains) consisting of approximately 50 wagons (or approximately 3,200 t of mineral product) per train depart from the MSP each week.

In addition, two train movements per week (i.e. one train) will typically be required for delivery of coal to the MSP.

4.6.2 Environmental Review

Road Transport

Potential Impacts

MSP road traffic is associated with the following:

- mineral concentrate/HMC transport;
- MSP process waste transport;
- deliveries of consumables (e.g. LPG and diesel); and
- workforce movements.

The Modification would not result in changes to the frequency of approved mineral concentrate/HMC transport movements (Section 3.1.3) or approved MSP process waste transport movements (Section 3.1.8). In addition, as the approved workforce would not change as a result of the Modification (Section 3.1.13), the frequency of approved workforce-related road traffic movements would also remain unchanged.

As described in Section 3.1.11, the proposed increase in LPG consumption would require an additional delivery each week (i.e. an increase from one to two LPG deliveries per week) and there would be no change to diesel delivery frequency.

Traffix (2007) concluded that there was satisfactory capacity on the local road network and that no additional significant road safety issues were anticipated with the operations of the existing Cristal Mining operations. As the increases in traffic resulting from the Modification are predicted to be negligible (i.e. an additional LPG delivery per week), it is considered that the Modification is unlikely to result in any capacity constraints or safety concerns on the surrounding road network.

An increase in potential cumulative road transport impacts may occur once the Broken Hill Solar Plant commences. Given the predicted Broken Hill Solar Plant road transport impacts are not expected to be significant (Sinclair Knight Merz, 2011) and the predicted increase in the traffic associated with the Modification is negligible, potential cumulative impacts are not expected to be significant.

Management Measures

The management measures in the Ginkgo and Snapper Mines and MSP Transport Management Plan, Transport of Hazardous Materials Plan and the Traffic Code of Conduct would continue to be implemented for the MSP incorporating the Modification.

In addition, the Ginkgo and Snapper Mines and MSP Transport Management Plan, Transport of Hazardous Materials Plan and the Traffic Code of Conduct would be reviewed and, if necessary, revised for the Modification.

Rail Transport

MSP rail traffic is associated with mineral product transport and coal deliveries (Section 4.6.1).

As described in Section 3.1.6, the frequency of mineral product trains would remain unchanged for the Modification. The coal delivery trains would also remain unchanged for the Modification (Section 3.1.11).

The Atlas-Campaspe Mineral Sands Project would include up to three mineral concentrate/MSP process waste trains per week to the MSP (Sections 3.1.3 and 3.1.8). The potential impacts associated with these rail movements are assessed in the *Atlas-Campaspe Mineral Sands Project Environmental Impact Statement* (Cristal Mining, 2013). As outlined in Section 3.1.7 of the *Atlas-Campaspe Mineral Sands Project Environmental Impact Statement* (Cristal Mining, 2013), the ARTC confirmed that:

> *… there is sufficient capacity to accommodate the requested train paths on the ARTC network.*
>
> *….*
>
> *The proposed rail traffic will not have a material effect upon any other services that operate on the ARTC network.*

Given the above, the Modification is not expected to have a significant impact on the rail network.

4.7 REGIONAL ECONOMY

4.7.1 Background

An economic assessment was undertaken for the MSP by Gillespie Economics (2001), which included a regional economic assessment. Gillespie Economics (2001) concluded that the MSP will stimulate demand in the Broken Hill economy lending to increased business turnover in a range of sectors and increased employment opportunities.

4.7.2 Environmental Review

Potential positive impacts on the regional economy would be related to the following components of the Modification:

- an extension of the MSP operational life from 19 years to 26 years;
- an increase in annual operating costs associated with the increase in processing rate; and
- an increase in total mineral product production. and, therefore, an increase in regional output and value-added.

The Modification would increase and extend the duration of the approved positive regional economic impacts (e.g. increased direct and indirect regional output, value added and household income) by seven years.

The Modification would also result in retention of approximately 85 approved personnel for an additional seven years.

4.8 HAZARD AND RISK

4.8.1 Background

A Preliminary Hazard Analysis (PHA) (Resource Strategies, 2001) for the MSP was prepared in accordance with the general principles of risk evaluation and assessment provided in the *Multi Level Risk Assessment* Guidelines (NSW Department of Urban Affairs and Planning, 1999).

Potential hazards associated with the public, property and environment were identified and the consequences and likelihood of hazardous events were assessed qualitatively. The main potential risk areas identified in the PHA included:

- transportation and storage of LPG (e.g. explosion, fires);
- transportation and storage of diesel (e.g. leaks/spills, fires); and
- mineral concentrate/HMC and MSP process waste transport (e.g. vehicle accidents, leaks/spills).

Following the implementation of the proposed hazard mitigation measures, no risks posing significant off-site impacts were identified (Resource Strategies, 2001).

The PHA was revisited in 2005 and 2007and the following additional potential risks were identified (Bemax Resources, 2005 and 2007):

- increase in the frequency of mineral concentrate/HMC and MSP process waste transport;
- increase in diesel storage at the MSP; and
- risk of fire (from spontaneous combustion) during the transportation and storage of coal.

A Process Waste Materials Risk Assessment was included in the Process Waste Materials Assessment (Bemax Resources, 2006) and it concluded that all identified risks were rated as a low level risk.

The increase in storage of diesel at the MSP was considered not to pose a significant risk of off-site impacts (Bemax Resources, 2005).

The risks of off-site impacts associated with the transport and storage of coal were considered to be negligible (Bemax Resources, 2005 and 2007).

A Hazard and Operability Study (Pinnacle Risk Management, 2012) was prepared for the MSP accordance with *Hazardous Industry Planning Advisory Paper Nº 8 – HAZOP Guidelines* (NSW Department of Planning, 2008) prior to the construction of the ilmenite circuit. Cristal Mining is implementing the recommendations of the Hazard and Operability Study.

A Fire Safety Study (Norman Disney & Young, 2012) was prepared for the MSP in accordance with *Hazardous Industry Planning Advisory Paper No. 2 – Fire Safety Guidelines* (Department of Planning, 2011) prior to the construction of the ilmenite circuit. The Fire Safety Study concluded that with the implementation of the proposed management measures, risks associated with to an acceptable level (Norman Disney & Young, 2012).

4.8.2 Environmental Review

Potential Hazards and Risks

The Modification would result in the following changes to potential hazards and risks at the MSP:

- increased frequency of LPG transport to the MSP; and
- transport of mineral concentrates and MSP process waste between the Atlas-Campaspe Mineral Sands Project and the MSP.

There would be no change to the approved frequency of transport of mineral concentrates/HMC or MSP process waste between the MSP and the Ginkgo and Snapper Mines as a result of the Modification.

The changes to potential hazards and risks are discussed below.

LPG

Risks associated with the transportation and storage of LPG were assessed in the PHA as low (Resource Strategies, 2001). The amount of LPG stored at existing/approved MSP is less than assessed in the PHA.

As the existing LPG storage at the MSP (Figure 3) and LPG storage mitigation measures (Section 2.2.11) would not change as a result of the Modification, the risk associated with the storage of LPG at the MSP for the Modification is considered to remain low.

The frequency of LPG deliveries would increase from one delivery per week to two deliveries per week due to the proposed increase in LPG consumption for the Modification (Section 3.1.11). The existing LPG transport mitigation measures (Section 2.2.11) would continue to be implemented for the Modification. Given the infrequent nature of the LPG deliveries and the continuation of the existing LPG transport mitigation measures, it is considered that the risk associated with this activity would remain low.

Transport of Atlas-Campaspe Mineral Sands Project Mineral Concentrates and MSP Process Waste

A Mineral Concentrate and Process Waste Materials Assessment (Radiation Advice & Solutions, 2012) was prepared for the Atlas-Campaspe Mineral Sands Project. The Mineral Concentrate and Process Waste Materials Assessment considered the potential impacts associated with the management of MSP process waste.

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

Mitigation Measures

The following hazard mitigation and/or preventative measures would be applied to the MSP to reduce the likelihood of potentially hazardous incidents:

- Structures – Civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, the necessary licences and permitting for engineering structures would be obtained.
- Fuel Storage – The storages for diesel and LPG at the MSP site would be designed, constructed and operated in accordance with the requirements of applicable Australian Standards (e.g. AS 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids* and AS 1596:2008 *The Storage and Handling of Liquefied Petroleum Gas*).

  In addition, the bunded LPG storage facility would be fitted with both manual and remote shut-off valves and would be bunded, some 600 m from the nearest residence.
- Water Management – Structures such as stormwater diversion drains and sediment dams would be constructed to separate upslope and operational areas and to collect MSP site runoff. These structures would also enable the containment of potential spills or fire suppression water runoff within operational areas.
- Maintenance – Ongoing and timely maintenance of all mobile and fixed plant and equipment would be undertaken in accordance with a maintenance schedule.
- Staff Training – Operators and drivers would be trained and (where applicable) licensed for their positions.
- MSP Emergency Response Plan – This plan would provide emergency response objectives, site roles and responsibilities and a series of detailed response procedures for a range of potential emergencies.
- MSP Safety Management System – Specifies all safety-related procedures, responsibilities, policies and adherence mechanisms.

- Site Emergency Response Team – Selected Cristal Mining employees and/or contractors would be trained to respond to emergencies and spills within the MSP site. The emergency response team would be supported by Broken Hill emergency service authorities, as required.

A Fire Safety Study and Hazard and Operability Study would be prepared prior to the construction of the ilmenite kiln/roaster circuit and the rutile and zircon circuits.

The MSP Emergency Response Plan and the MSP Safety Management System would be reviewed and, if necessary, revised for the Modification.

4.9 CONSIDERATION OF CUMULATIVE IMPACTS WITH OTHER NEARBY OPERATIONS

The following existing/approved developments are located in the MSP area:

- Perilya South Operations;
- Rasp Mine; and
- Broken Hill Solar Plant.

These existing/approved developments are discussed below.

4.9.1 Perilya South Operation

The Perilya South Operation is a lead-zinc underground mine that mines ore at a rate of up to 5 Mtpa. The Perilya South Operation is located approximately 1.5 km to the south-east of the MSP.

The potential cumulative impacts of the existing Perilya South Operations have been considered in the environmental studies where potentially relevant in this EA (i.e. air quality and noise).

4.9.2 Rasp Mine

The Rasp Mine is located approximately 4 km to the north-east of the MSP and was granted Project Approval (07-0018) by the Minister for Planning in January 2011.

The Rasp Mine is an underground lead-zinc-silver mine that includes:

- establishing an underground mine to extract 8.45 Mt of lead-zinc-silver ore;
- processing 750,000 tpa of ore at the surface for up to 12 years;
- constructing and/or extending associated infrastructure, plant, equipment and activities; and
- transporting concentrate by rail to a smelter and/or port.

The potential cumulative impacts of the existing Rasp Mine have been considered in the environmental studies where potentially relevant in this EA (i.e. air quality and noise).

4.9.3 Broken Hill Solar Plant

The Broken Hill Solar Plant was granted Project Approval (MP10_0202) by the Planning Assessment Commission in March 2013 and includes:

- a photovoltaic array incorporating rows of solar panels mounted on a fixed steel frame and a series of central inverters and transformers;
- aboveground and underground electrical conduits and cabling to connect the arrays to the inverters and transformers;
- marshalling switchgear to collect the power from the photovoltaic arrays;
- a diversion of the existing aboveground transmission line and placing it underground;
- construction of an aboveground transmission line to connect the solar plant to the existing Broken Hill sub station;
- internal access tracks, upgrades to existing roads, fencing and landscaping;
- site office, operations and maintenance office buildings; and
- temporary construction facilities such as a site compound and equipment laydown area.

The Broken Hill Solar Plant is located approximately 800 m to the west of the MSP and is not operational at this stage.

The potential cumulative impacts of the existing Rasp Mine have been considered in the environmental studies where potentially relevant in this EA (i.e. air quality and noise).

5 ENVIRONMENTAL ASSESSMENT – GINKGO AND SNAPPER MINES

5.1 IDENTIFICATION OF KEY ISSUES

The following existing/approved development components of the Ginkgo and Snapper Mines would be unchanged by the Modification (Section 3.2):

- project life;
- general arrangement;
- maximum production rates (mineral ore and mineral concentrate);
- overburden and sand residue management;
- mine fleet;
- mineral concentrate/HMC transport rate to the MSP;
- MSP process waste transport rate from the MSP;
- water supply;
- mine site electricity distribution;
- mine site access;
- hours of operation;
- workforce; and
- rehabilitation.

The key potential impacts of the Modification are related to the disposal of MSP process waste generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates. A discussion of these potential impacts is provided in Section 5.2.2.

As no change to the existing/approved general arrangement is proposed for the Modification, no additional surface development would be required. Therefore, there would be no material alteration to the existing/approved impacts of the Gingko and Snapper Mines on land resources, flora, fauna, Aboriginal cultural heritage, non-Aboriginal cultural heritage, visual amenity or the rehabilitation strategy.

The existing/approved Ginkgo and Snapper Mines general arrangement, mining methods, mine fleet and production rates would remain unchanged for the Modification and therefore the existing/approved noise, air quality and greenhouse gas impacts would not materially change.

The Modification would not result in any material alteration to the existing/approved water resource impacts given there is no proposed change to the existing/approved site water management system and water supply and demand.

As no change to the approved Gingko and Snapper Mines workforce is proposed for the Modification, there would be no material alteration to the existing approved community infrastructure impacts.

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

5.2 MSP PROCESS WASTE MANAGEMENT

5.2.1 Background

The management of MSP process waste at the Ginkgo and Snapper Mines is outlined in the Gingko Mine Landfill Management Plan and Snapper Mine Waste Management Plan.

A description of the existing/approved MSP process waste management is provided in Section 2.2.8.

5.2.2 Environmental Review

Potential Impacts

As described in Section 3.1.8, MSP process waste generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates would be combined with the existing/approved MSP process wastes produced at the MSP and be transported to the Ginkgo and Snapper Mines in accordance with existing/approved operations (Section 2.2.8) up until cessation of those operations.

The Modification would not result in a change to the approved transport rate and classification of MSP process waste transported to the Ginkgo and Snapper Mines (Section 3.2.1).

The existing/approved MSP process waste management strategy (Section 2.3.1) is therefore considered appropriate for the modified Ginkgo and Snapper Mines.

The expected quantity of Atlas-Campaspe Mineral Sands Project MSP process waste that would be placed at the Ginkgo and Snapper Mines (i.e. up to 50,000 tpa) is minor relative to the quantities of sand residues placed in the Ginkgo (i.e. up to approximately 8.5 Mtpa) and Snapper (12.4 Mtpa) mine paths. The Atlas-Campaspe Mineral Sands Project MSP process waste would therefore not materially change the final landform at the Ginkgo and Snapper Mines.

Management Measures

The Ginkgo Mine Landfill Management Plan and Snapper Mine Waste Management Plan would continue to be implemented for the Modification. This would include the continued implementation of the management strategy described in Section 2.3.1.

In addition, the Ginkgo Mine Landfill Management Plan and Snapper Mine Waste Management Plan would be reviewed and, if necessary, revised for the Modification.

5.3 CONSIDERATION OF CUMULATIVE IMPACTS WITH OTHER NEARBY OPERATIONS

No other existing/approved operations are located in the vicinity of the Gingko and Snapper Mines.

6 STATUTORY CONTEXT

6.1 LEGISLATIVE FRAMEWORK

6.1.1 Environmental Planning and Assessment Act, 1979

The existing/approved MDBO is subject to the following approvals under the EP&A Act:

- MSP Development Consent (DA 345-11-01) – approved under Part 4 of the EP&A Act in May 2002;
- Ginkgo Mine Development Consent (DA 251-09-01) – approved under Part 4 of the EP&A Act in January 2002; and
- Snapper Mine Project Approval (PA 06_0168) – approved under Part 3A of the EP&A Act in August 2007.

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

The MSP Development Consent (DA 345-11-01) and Ginkgo Mine Development Consent (DA 251-09-01) fall within the criteria for clause 8J(8)(c) of the EP&A Regulation and, therefore, can be modified under section 75W of Part 3A of the EP&A Act.

The Snapper Mine is a 'transitional Part 3A project' under clause 2 of Schedule 6A of the EP&A Act and therefore section 75W of the EP&A Act continues to apply to modifications to the Snapper Mine Project Approval (PA 06_0168), notwithstanding its repeal.

As outlined in Section 1.3, Cristal Mining consulted with the DP&I in August 2013 with regards to seeking the necessary approvals for the Modification and based on this consultation, this EA has been prepared under section 75W of the EP&A Act.

Section 75W of the EP&A Act relevantly provides:

> **75W Modification of Minister's approval**
>
> *(1) In this section:*
>
> ***Minister's approval** means an approval to carry out a project under this Part, and includes an approval of a concept plan.*
>
> ***Modification of approval** means changing the terms of a Minister's approval, including:*
>
> *(a) revoking or varying a condition of the approval or imposing an additional condition of the approval, and*
>
> *(b) changing the terms of any determination made by the Minister under Division 3 in connection with the approval.*
>
> *(2) The proponent may request the Minister to modify the Minister's approval for a project. The Minister's approval for a modification is not required if the project as modified will be consistent with the existing approval under this Part.*
>
> *(3) The request for the Minister's approval is to be lodged with the Director-General. The Director-General may notify the proponent of environmental assessment requirements with respect to the proposed modification that the proponent must comply with before the matter will be considered by the Minister.*

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

(4) The Minister may modify the approval (with or without conditions) or disapprove of the modification…

6.1.2 Environmental Planning Instruments

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

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

The *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) regularises the various environmental planning instruments that previously controlled mining activities. The Mining SEPP applies to the Ginkgo and Snapper Mines but is not considered relevant to the MSP, which does not include mining activities.

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

Clause 7

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

(b) mining carried out:

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

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

The Ginkgo Mine includes mining operations wholly within existing Cristal Mining controlled mining leases and on land where development for the purposes of agriculture is permissible. Therefore the Modification activities are permissible with development consent.

The Snapper Mine is wholly on land where development for the purposes of agriculture is permissible. Therefore the Modification activities are permissible with development consent.

Clause 12

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

(a) consider:

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

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

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

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

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

The Modification would not change the existing/approved land uses or development areas, and is considered to be compatible with existing and future land uses in the vicinity of the Ginkgo and Snapper Mines.

Clause 14

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

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

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

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

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

As no change to the existing/approved Gingko and Snapper Mine general arrangements is proposed for the Modification, no additional surface development would be required. Therefore, there would be no material alteration to the existing/approved impacts of the Gingko and Snapper Mines on flora and fauna.

The existing/approved Ginkgo and Snapper Mines general arrangement, mining methods, mine fleet and production rates would remain unchanged for the Modification and therefore the existing/approved greenhouse gas impacts would not materially change.

The Modification would not result in any material alteration to the existing/approved water resource impacts given there is no proposed change to the existing/approved site water management system and water supply and demand.

Clause 15

Clause 15 of the Mining SEPP requires that:

(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider the efficiency or otherwise of the development in terms of resource recovery.

(2) Before granting consent for the development, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at optimising the efficiency of resource recovery and the reuse or recycling of material.

(3) The consent authority may refuse to grant consent to development if it is not satisfied that the development will be carried out in such a way as to optimise the efficiency of recovery of minerals, petroleum or extractive materials and to minimise the creation of waste in association with the extraction, recovery or processing of minerals, petroleum or extractive materials.

The Modification would not change the currently approved development areas or mining methods at the Ginkgo and Snapper Mines.

Clause 16

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

(a) require that some or all of the transport of materials in connection with the development is not to be by public road,

(b) limit or preclude truck movements, in connection with the development, that occur on roads in residential areas or on roads near to schools,

(c) require the preparation and implementation, in relation to the development, of a code of conduct relating to the transport of materials on public roads.

The Modification would not result in any changes to the existing/approved transport routes associated with the Ginkgo and Snapper Mines.

Clause 17

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

In particular, the consent authority must consider whether conditions of the consent should:

(a) require the preparation of a plan that identifies the proposed end use and landform of the land once rehabilitated, or

(b) require waste generated by the development or the rehabilitation to be dealt with appropriately, or

(c) require any soil contaminated as a result of the development to be remediated in accordance with relevant guidelines (including guidelines under section 145C of the Act and the Contaminated Land Management Act 1997), or

(d) require steps to be taken to ensure that the state of the land, while being rehabilitated and at the completion of the rehabilitation, does not jeopardize public safety.

The rehabilitation of the Ginkgo and Snapper Mines would be conducted in accordance with the existing/approved rehabilitation practices outlined in Sections 2.2.14 and 3.1.14.

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

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

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

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

…

The risks and hazards and relevant mitigation measures associated with the Modification are outlined in Section 4.8.2.

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

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

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

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

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

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

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

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

As the Modification requires no change to the existing/approved surface development area, no change of use is proposed and no preliminary land contamination investigation is required.

Broken Hill Local Environmental Plan 2013

The MSP is located wholly within the Broken Hill LGA (Figure 1). The following sub-sections identify the provisions in the Broken Hill LEP which may have relevance to the Modification:

Part 2.3, clause 2 of the Broken Hill LEP provides:

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

The MSP is located within Zone IN1 (General Industrial) within the Broken Hill LGA. The objectives of the zone include:

- *To provide a wide range of industrial and warehouse land uses.*
- *To encourage employment opportunities.*
- *To minimise any adverse effect of industry on other land uses.*
- *To support and protect industrial land for industrial uses.*

Under the Broken Hill LEP the MSP is permissible on lands zoned as IN1 (General Industrial).

Part 5.9 of the Broken Hill LEP refers to the protection of preservation of trees and vegetation and requires authority to be obtained and conferred in either the Development Consent or by a permit granted by BHCC for the removal of vegetation.

Part 5.10 refers to the conservation of heritage and includes the requirement that a Development Consent be obtained before impacting on any items of cultural heritage significance.

As no change to the existing/approved MDBO general arrangements is proposed for the Modification, no additional surface development would be required. Therefore, there would be no material alteration to the existing/approved impacts of the Gingko and Snapper Mines on cultural heritage items.

Wentworth Local Environmental Plan 2011

The Ginkgo and Snapper Mines are located wholly within the WSC LGA (Figure 1). The following sub-sections identify the provisions in the *Wentworth Local Environmental Plan 2011* (Wentworth LEP) which may have relevance to the Modification.

Part 2.3, clause 2 of the Wentworth LEP provides:

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

The Ginkgo and Snapper Mines are located within Zone RU1 (Primary Production) within the Wentworth LGA. The objectives of this zone include:

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

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

The operation of Part 2.3, clause 2 and the objectives of Zone RU1 are negated by the Mining SEPP (Section A4.2).

Part 5.9 of the Wentworth LEP refers to the protection of preservation of trees and vegetation and requires authority to be obtained and conferred in either the Development Consent or by a permit granted by WSC for the removal of vegetation.

Part 5.10 refers to conservation of heritage and includes the requirement that a Development Consent be obtained before impacting on any items of cultural heritage significance.

Part 7.4 refers to the protection and conservation of terrestrial biodiversity and includes the requirement that a Development Consent be obtained for a development that is likely to have an adverse impact on terrestrial biodiversity within the Wentworth LGA.

As no change to the existing/approved MDBO general arrangements is proposed for the Modification, no additional surface development would be required. Therefore, there would be no material alteration to the existing/approved impacts of the Gingko and Snapper Mines on flora, fauna and cultural heritage items.

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Appendix A

MSP Air Quality Assessment

Pacific Environment Limited

Consulting • Technologies • Monitoring • Toxicology

FINAL REPORT

MURRAY-DARLING BASIN OPERATIONS MODIFICATION – BROKEN HILL MINERAL SEPARATION PLANT AIR QUALITY ASSESSMENT

Cristal Mining Australia Limited

Job No: **6964**

5 November 2013

PROJECT TITLE:	Murray-Darling Basin Operations Modification – Broken Hill Mineral Separation Plant Air Quality Assessment
JOB NUMBER:	6964
PREPARED FOR:	Cristal Mining Australia Limited
PREPARED BY:	R. Kellaghan
APPROVED FOR RELEASE BY:	D. Roddis
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APPENDIX

1 INTRODUCTION

Pacific Environment was engaged by Cristal Mining Australia Limited (Cristal Mining) to conduct an assessment examining the potential air quality impacts associated with a proposed modification to Cristal Mining's mineral sand mining and processing operations located in the Murray Darling Basin in western New South Wales (NSW), which are collectively known as the Murray Darling Basin Operations (MDBO).

1.1 Existing/approved and proposed MDBO

Cristal Mining's existing/approved MDBO include (refer **Figure 1-1**):

- **Broken Hill Mineral Separation Plant** (MSP) – is a mineral concentrate processing plant located on the south-western outskirts of Broken Hill and is approved to process mineral concentrates from Cristal Mining's existing Ginkgo and Snapper Mines.
- **Ginkgo Mine** – is a mineral sands mining operation located approximately 85 kilometres (km) north of Wentworth and approximately 170 km south of Broken Hill in western NSW.
- **Snapper Mine** – is a mineral sands mining operation located approximately 10 km to the west of the Ginkgo Mine.

Cristal Mining has lodged a separate application to develop the Atlas-Campaspe Mineral Sands Project which consists of a mineral sands mining operation and associated rail load out facility. The proposed Atlas-Campaspe Mineral Sands Project would be an additional component of the existing MDBO and would mainly integrate through the transporting of mineral concentrates produced at the Atlas-Campaspe Mineral Sands Project via rail to the MSP for processing.

1.2 Proposed MDBO modification

The MDBO Modification (the Modification) is required in order to allow for the integration of the proposed Atlas-Campaspe Mineral Sands Project (subject to separate approval) with the existing MDBO and would involve the following key components:

- MSP Processing Rate Increase – increase in the currently approved mineral concentrate receival and processing rate at the MSP to account for the proposed development of the Atlas-Campaspe Mineral Sands Project.
- MSP Process Waste Disposal – disposal of MSP process waste generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates at the Ginkgo and Snapper Mines.

1.3 Scope of the air quality assessment

The key potential air quality impacts of the Modification are associated with the MSP and as such, this Air Quality Assessment focuses on the potential air quality impacts at the MSP. This Air Quality Assessment has been prepared in accordance with the NSW Environment Protection Authority's (EPA) "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (the Approved Methods) (**EPA, 2005**).

Potential air quality impacts at the Ginkgo and Snapper Mines associated with the Modification are addressed in Section 5 of the Environmental Assessment (EA).

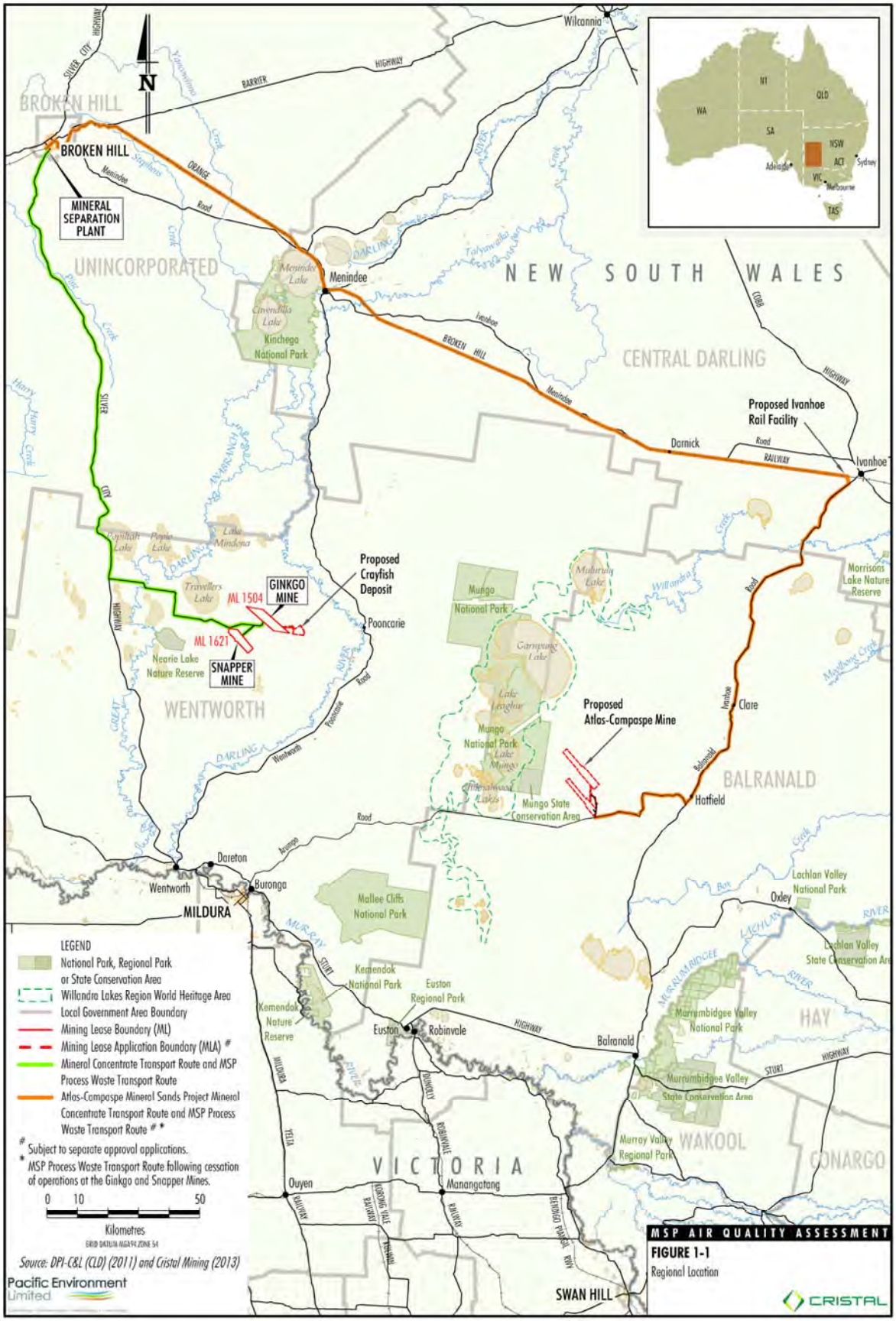

Figure 1-1: Regional Location

2 DESCRIPTION OF THE MSP

2.1 Overview

Development Consent (DA 345-11-01) for the MSP was issued under Part 4 of the *Environmental Planning and Assessment Act*, *1979* in 2002. The MSP is currently approved to:

- have an operational life of approximately 19 years (i.e. to 2025);
- receive up to approximately 735,000 tonnes per annum (tpa) of mineral concentrates (combined) via road haulage from the Ginkgo and Snapper Mines;
- process up to 650,000 tpa of mineral concentrates (combined) from the Ginkgo and Snapper Mines;
- transport up to 300,000 tpa (combined) MSP process waste to the Ginkgo and Snapper Mines for disposal; and
- rail to market up to 3,200 tonnes (t) of mineral products per train (i.e. leucoxene, non-magnetic concentrates, rutile, zircon, unroasted and roasted ilmenite) from the MSP to South Australia, with a maximum of six train movements per week (i.e. three trains).

Cristal Mining holds Environment Protection Licence (EPL) No. 12314 issued under the *Protection of Environment Operations Act, 1997* for the MSP.

The existing/approved MSP layout (at full development) is shown in **Figure 2-1**.

2.2 Existing/approved stack parameters

At full development the MSP will require eight stacks (refer to **Figure 2-1** and **Table 2.1**). Four stacks (i.e. leucoxene hygiene baghouse, leucoxene dryer, ilmenite hygiene baghouse and ilmenite dryer stacks) are currently operating at the MSP. The three stacks associated with the zircon and rutile circuits and the ilmenite kiln stack have not yet been constructed. The existing/approved design parameters (i.e. stack height, stack diameter and discharge velocity) of these stacks are presented in **Table 2.1**.

Table 2.1: Existing/Approved Stack Design Parameters

Stack	Development Consent Reference[4]	Stack Height (m)	Stack Diameter (m)	Discharge Velocity (m/s)
Existing MSP				
Leucoxene Hygiene Baghouse[1]	6	40.0	0.49	15
Leucoxene Dryer[1]	10	40.2	0.50	16
Ilmenite Hygiene Baghouse[2]	7	40.4	0.75	15
Ilmenite Dryer[2]	12	40.4	0.90	15
Approved MSP				
Ilmenite Kiln[3]	13	41.2	0.55	15
Rutile/Zircon Hygiene Baghouse[3]	8	40.2	1.00	15
Zircon Dryer[3]	9	40.2	0.35	15
Rutile Dryer[3]	11	40.2	0.55	15

[1] Commissioned in 2006.

[2] Commissioned in 2013.

[3] To be developed in the future – currently approved stack design parameters.

[4] Refer to Condition 3.2(a), Schedule 2 of Development Consent (DA 345-11-01).

Notes: m = metres

m/s = metres per second

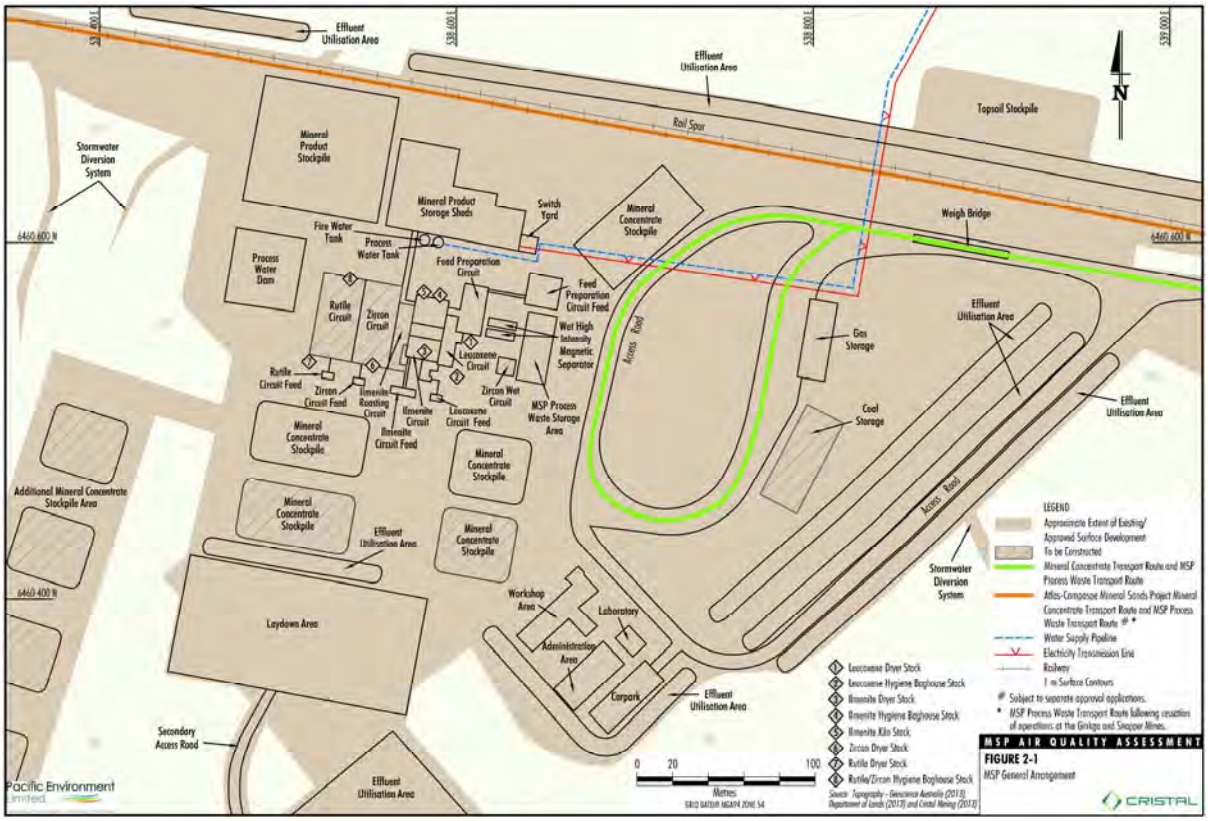

Figure 2-1: MSP General Arrangement

Condition 3.2(a), Schedule 2 of Development Consent (DA 345-11-01) provides design parameters for the MSP stack discharges, as outlined below (emphasis added).

> ***3.2 Plant and Equipment – Design Parameters***
>
> *(a) [4]The design parameters for the discharge points specified in the table below must meet the requirements specified in the table.*

DECC Identification Number	*Minimum Stack Height*	*Minimum Discharge Velocity (m/s)*	*Minimum Stack Diameter (m)*
6	*40.0*	*15*	*0.49*
7	*40.2*	*15*	*1.20*
8	*40.2*	*15*	*1.00*
9	*40.2*	*15*	*0.35*
10	*40.2*	*15*	*0.50*
11	*40.2*	*15*	*0.55*
12	*40.2*	*15*	*0.60*
13	*41.2*	*15*	*0.55*

The as-constructed design parameters for the leucoxene hygiene baghouse and dryer stacks presented in **Table 2.1** are consistent with the currently approved design.

As part of the detailed design process for the ilmenite circuit, the hygiene baghouse and dryer stack design parameters were reviewed. The stack design parameters selected as a result of the detailed process were not consistent with the stack design parameters listed in Condition 3.2(a), Schedule 2 of Development Consent (DA 345-11-01).

Condition 3.2(b), Schedule 2 of Development Consent (DA 345-11-01) however goes on to state:

> ***Note**: Where necessary, the holder of the DECC license will apply to the DECC to vary the stack design parameters included in U1.1. The DECC will consider any variation of the design parameters on application by the holder of the DECC license. Any application made by the license holder must demonstrate that air quality impact assessment which includes revised design parameters is undertaken and shows compliance with the Clean Air (Plant and Equipment) Regulation 1997.*

An Air Quality Assessment (**PAE Holmes, 2012**) that demonstrated that the proposed ilmenite hygiene baghouse and dryer stack design parameters would comply with the *Protection of the Environment Operations (Clean Air) Regulation, 2010* (the POEO Clean Air Regulation) was prepared and submitted to the EPA in November 2012. The EPA approved the proposed ilmenite hygiene baghouse and dryer stack design changes (**Table 2.1**) in December 2012.

As the three stacks associated with the zircon and rutile circuits and the ilmenite kiln stack have not yet been constructed, the currently approved design parameters of these stacks are presented in **Table 2.1**.

3 OVERVIEW OF THE MODIFICATION

The Modification would include:

- increased operational life to approximately 26 years (i.e. to 2032);
- receipt of mineral concentrates via rail from the Atlas-Campaspe Mineral Sands Project;
- increased production up to 1,200 kilotonnes per annum (ktpa) to accommodate up the processing of mineral concentrates from the proposed Atlas-Campaspe Mineral Sands Project;
- increase in number of wagons transporting mineral products by rail to account for 6,400 t of mineral concentrate per train;
- disposal of MSP process waste generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates at the Ginkgo and Snapper Mines; and
- associated changes to the mobile equipment operating at the MSP.

A summary of the approved and proposed MSP production is shown in **Table 3.1**.

Table 3.1: Approved and proposed MSP production

Component	Approved (ktpa)	Proposed (ktpa)
Maximum Mineral Concentrate Processing at MSP	650	1,200
Maximum Leucoxene Product Production	185	250
Maximum Roasted Ilmenite Product Production	225	225
Maximum Sulphate Ilmenite Product Production	124	375 - 600
Maximum Non-magnetic Product Production	210	250 - 450
Maximum Rutile Product Production	100	100
Maximum Zircon Product Production	75	75

The existing/approved stack design parameters (**Section 2.2**) and MSP layout (at full development) (**Figure 2-1**) would remain unchanged for the Modification.

A detailed description of the Modification is provided in Section 3 of the EA.

4 LOCAL SETTING

The MSP is located in the south-western outskirts of Broken Hill, approximately 3 km from the town. The surrounding land is primarily zoned as industrial. The nearest receiver to the proposed MSP is located approximately 50 m east of the site and is the Macro Meats – Gourmet Game caretaker's residence. The MSP locality and nearest sensitive receivers are shown in **Figure 4-1**.

The natural topography within the region is flat (**Figure 4-1**) and would have little influence on prevailing meteorology, for example in steering winds, generating turbulence and large scale eddies, and in generating drainage flows at night.

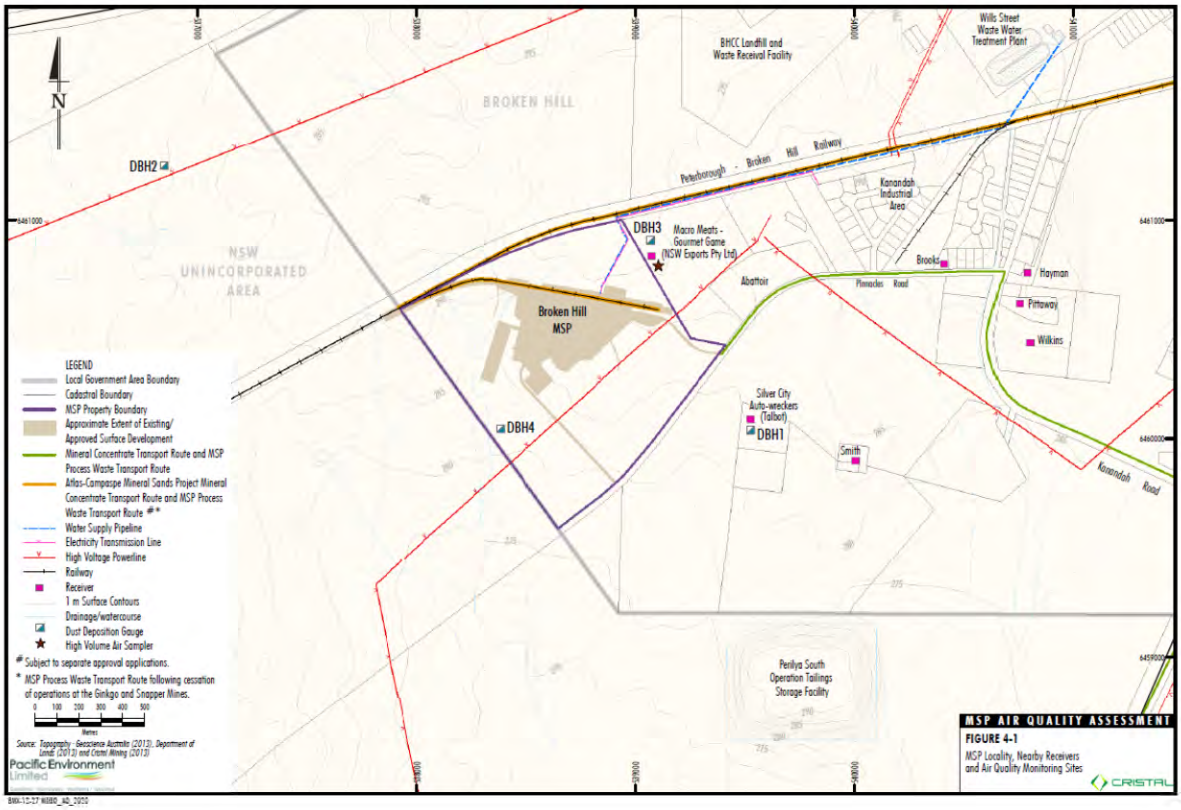

Figure 4-1: MSP Locality, Nearby Receivers and Air Quality Monitoring Sites

5 AIR QUALITY CRITERIA

5.1 Introduction

The primary emissions from the operation of the MSP (at full development) would be associated with:

- Combustion emissions from the combustion of liquefied petroleum gas (LPG) in the leucoxene, ilmenite, rutile and zircon dryers.
- Combustion emissions associated with the combustion of brown coal in the ilmenite kiln.
- Particulate matter (PM[a]) from product handling in the dryers and baghouse stacks.
- Fugitive dust emissions[b] associated with mineral concentrate delivery, handling, storage and dispatch.

Combustion emissions would include oxides of nitrogen (NO_x), carbon monoxide (CO) and sulfur dioxide (SO_2). Emissions of SO_2 would be minimal from the combustion of LPG but would need to be considered for the combustion of coal in the ilmenite kiln (refer **Section 8.4.2**). Emissions of CO are typically not high enough to exceed EPA air quality goals. The focus of the current assessment is on the key emissions of nitrogen dioxide (NO_2) and PM.

The following sections provide information on the air quality criteria used to assess the impact of dust and particulate emissions. To assist in interpreting the significance of predicted concentration and deposition levels some background discussion is also provided.

5.2 Particulate matter and its health significance

Particulate matter has the capacity to affect health and to cause nuisance effects, and is categorised by size and/or by chemical composition. The potential for harmful effects depends on both. The particulate size ranges are commonly described as:

- TSP – refers to all suspended particles in the air. In practice, the upper size range is typically 30 µm to 50 µm.
- PM_{10} – refers to all particles with equivalent aerodynamic diameters of less than 10 µm, that is, all particles that behave aerodynamically in the same way as spherical particles with diameters less than 10 µm and with a unit density. PM_{10} are a sub-component of TSP.
- $PM_{2.5}$ – refers to all particles with equivalent aerodynamic diameters of less than 2.5 µm diameter (a subset of PM_{10}). These are often referred to as the fine particles and are a sub-component of PM_{10}.
- $PM_{2.5-10}$ – defined as the difference between PM_{10} and $PM_{2.5}$ mass concentrations. These are often referred to as coarse particles.

Evidence suggests that health effects from exposure to airborne particulate matter are predominantly related to the respiratory and cardiovascular systems. The human respiratory system has in-built defensive systems that prevent larger particles from reaching the more sensitive parts of the respiratory system. Particles larger than 10 µm, while not able to affect health, can soil materials and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particles suspended in the air, this is referred to as TSP. In practice particles larger than 30 to 50 µm settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 µm.

---

[a] Particulate matter with an equivalent aerodynamic diameter of 2.5 micrometres (µm) or less ($PM_{2.5}$) and particulate matter with an equivalent aerodynamic diameter of 10 µm or less (PM_{10})

[b] Total suspended particulate matter (TSP), PM_{10} and deposited dust.

Both natural and anthropogenic processes contribute to the atmospheric load of particulate matter. Coarse particles ($PM_{2.5-10}$) are derived primarily from mechanical processes resulting in the suspension of dust, soil, or other crustal [c] materials from roads, farming, mining, dust storms, and so forth. Coarse particles also include sea salts, pollen, mould, spores, and other plant parts.

Fine particles or $PM_{2.5}$ are derived primarily from combustion processes, such as vehicle emissions, wood burning, coal burning for power generation, and natural processes such as bush fires. Fine particles also consist of transformation products, including sulphate and nitrate particles, and secondary organic aerosol from volatile organic compound emissions. $PM_{2.5}$ may penetrate beyond the larynx and into the thoracic respiratory tract and evidence suggests that particles in this size range are more harmful than the coarser component of PM_{10}.

The size of particles determine their behaviour in the respiratory system, including how far the particles are able to penetrate, where they deposit, and how effective the body's clearance mechanisms are in removing them. This is demonstrated in **Figure 5-1**, which shows the relative deposition by particle size within various regions of the respiratory tract. Additionally, particle size is an important parameter in determining the residence time and spatial distribution of particles in ambient air; key considerations in assessing exposure.

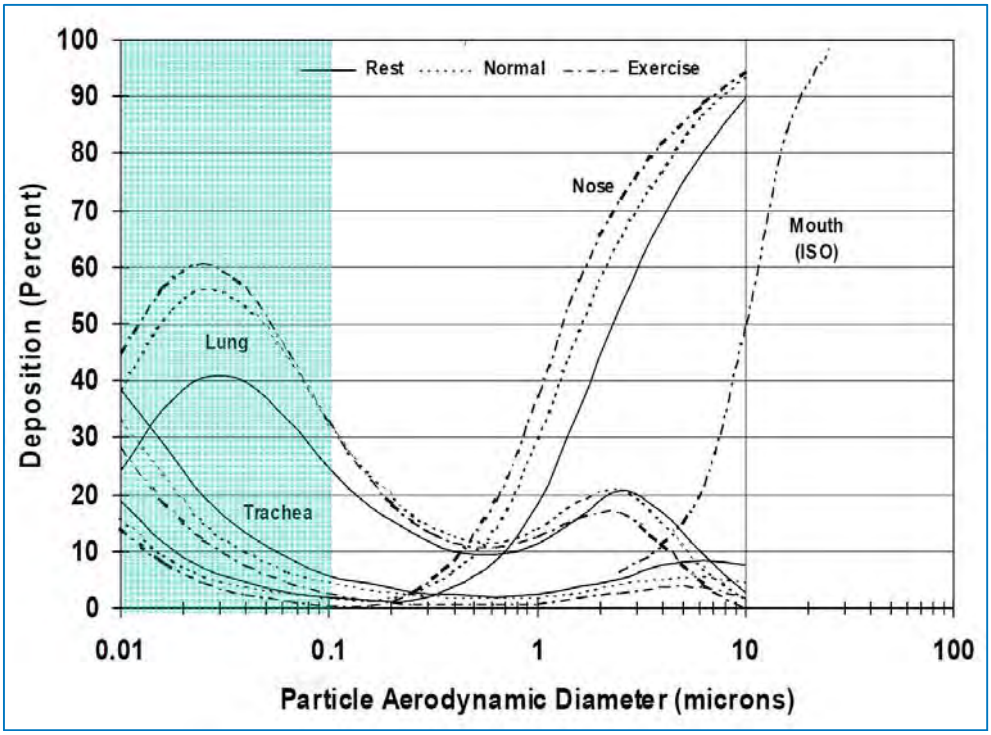

Figure 5-1: Particle Deposition within the Respiratory Track (after Chow, 1995)

The health-based assessment criteria used by the United States Environment Protection Agency (US EPA) have, to a large extent, been developed by reference to epidemiological studies undertaken in urban areas with large populations where the primary pollutants are the products of combustion (**US EPA**, **1998**; **National Environment Protection Council** [**NEPC**], **1998a**; **1998b**). This means that, in contrast to dust of crustal origin, the particulate matter from urban areas would be composed of smaller particles and would generally contain acidic and carcinogenic substances that are associated with combustion.

[c] Crustal dust refers to dust generated from materials derived from the earth's crust.

5.3 Oxides of nitrogen

NO_x are produced when fossil fuels are combusted. NO_x emitted by fossil fuel combustion are comprised mainly of nitric oxide (NO) and NO_2. NO is much less harmful to humans than NO_2 and is not generally considered a pollutant at the concentrations normally found in urban environments.

NO_2 is the regulated oxide of nitrogen in NSW and effects of exposure to NO_2 include irritation of the lungs and lower resistance to respiratory infections such as influenza. The effects of short term exposure are still unclear, but continued or frequent exposure to concentrations that are typically much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children. Concern with NO is related to its transformation to NO_2 and its role in the formation of photochemical smog.

Typically, close to the combustion sources, NO_2 makes up 5 to 20 percent (%) by weight of the total oxides of nitrogen. At the point of emission, NO_x would consist of approximately 90 to 95% of NO and 5 to 10% of NO_2, the regulated oxide. The dominant short term conversion is NO to NO_2 through oxidation with atmospheric ozone (O_3) as the plume travels from source.

$$NO + O_3 \equiv NO_2 + O_2$$

Therefore, to predict the ground level concentration (GLC) of NO_2 it is necessary to account for the transformation of NO_x to NO_2.

5.4 Air quality criteria

The Approved Methods specifies air quality assessment criteria relevant for assessing impacts from air pollution (**NSW Department of Environment and Conservation [DEC], 2005**). The air quality goals relate to the total pollutant burden in the air and consideration of background levels needs to be made when using these goals to assess potential impacts. These criteria are health-based (i.e. they are set at levels to protect against health effects).

These criteria are consistent with the National Environment Protection Measure for Ambient Air Quality (referred to as the Ambient Air-NEPM) (**NEPC, 1998a**). **Table 5.1** summarises the ambient air quality criteria for concentrations of particulate matter and combustion emissions relevant to this study.

Table 5.1: Ambient Air Quality Criteria

Pollutant	Standard	Averaging Period	Source
TSP	90 µg/m³	Annual mean	National Health and Medical Research Council
PM_{10}	50 µg/m³	24-Hour	DEC (2005) (assessment criteria)
	30 µg/m³	Annual	DEC (2005) (assessment criteria)
	50 µg/m³	24-Hour	NEPM (allows five exceedances per year)
$PM_{2.5}$	25 µg/m³	24-Hour	NEPM Advisory Reporting Standard
	8 µg/m³	Annual	NEPM Advisory Reporting Standard
NO_2	246 µg/m³	1-Hour	DEC (2005) (assessment criteria)
	62 µg/m³	Annual	DEC (2005) (assessment criteria)
SO_2	712 µg/m³	10-Minutes	DEC (2005) (assessment criteria)
	570 µg/m³	1-Hour	DEC (2005) (assessment criteria)
	228 µg/m³	24-Hour	DEC (2005) (assessment criteria)
	60 µg/m³	Annual	DEC (2005) (assessment criteria)

Notes: µg/m³ – micrograms per cubic metre.

In May 2003, the NEPC released a variation to the Ambient Air-NEPM (**NEPC, 2003**) to include advisory reporting standards for particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$). The purpose of the variation was to gather sufficient data nationally to facilitate the review of the Ambient Air-NEPM, which is currently underway. The variation includes a protocol setting out monitoring and reporting requirements for $PM_{2.5}$ particles. It is noted that the Ambient Air-NEPM $PM_{2.5}$ advisory reporting standards are not impact assessment criteria.

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including vegetation. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will fallout relatively close to source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment, and are assessed for nuisance or amenity impacts.

Table 5.2 shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust fallout levels are set to protect against nuisance impacts (**DEC, 2005**).

Table 5.2: Dust (Insoluble Solids) Fallout Criteria

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

Notes: g/m²/month – grams per square metre per month.

5.5 In-stack concentration limits

EPL No. 12314 includes in-stack concentration criteria for the four existing stacks and these are provided in **Table 5.3.**

Table 5.3: EPL No. 12314 In-stack Concentration Limits

Pollutant	Limit (mg/m³)
Leucoxene and Ilmenite Hygiene Baghouse Stacks	
Solid Particles (TSP)	100
Leucoxene and Ilmenite Dryer Stacks	
Solid Particles (TSP)	100
NO_x	350

Notes: mg/m³ – milligrams per cubic metre.

The in-stack concentration limits for the four existing stacks are based on the POEO Clean Air Regulation limits for Group 5 for solid particles and Group 6 for NO_2 (refer **Table 5.4**).

Table 5.4: POEO Clean Air Regulation In-stack Concentration Limits

Pollutant	Limit (mg/m³)		Source
	Group 5	Group 6	
Solid Particles (TSP)	100	50	POEO Clean Air Regulation – Schedule 4 "Any Activity or Plant"
NO_2	2,000	350	POEO Clean Air Regulation – Schedule 4 "Any Activity or Plant"

6 EXISTING ENVIRONMENT

6.1 Meteorology

The Bureau of Meteorology (BoM) collects climatic information at the Broken Hill Airport Automatic Weather Station (AWS), located approximately 6 km east of the MSP. Based on an analysis of four recent years of data collected at the AWS, 2011 was selected as the year for modelling. The rationale for choosing 2011 was data availability, in particular cloud cover data which is required for modelling. The modelling year was also demonstrated to be generally representative of prevailing meteorology, as demonstrated by the windroses in **Figure 6-1** and the comparative statistics are for each year are shown in **Table 6.1**.

Table 6.1: Comparative Statistics for Meteorological Data

Period	% Calms	Average Wind Speed (m/s)	% Data Recovery *
2009	1.0%	5.0	62.3%
2010	2.2%	4.5	99.5%
2011	3.2%	4.6	100.0%
2012	2.0%	4.4	74.2%

Annual and seasonal windroses for 2011 are shown in **Figure 6-2**. The dominant annual winds are from the south-southwest to south-southeast with a significant portion also from the northeast and east-northeast. The percentage calms (defined as wind speeds less than 0.5 m/s) are around 3%.

A plot of the annual monthly variation in temperature and rainfall for 2011 is shown in **Figure 6-3** and **Figure 6-4**.

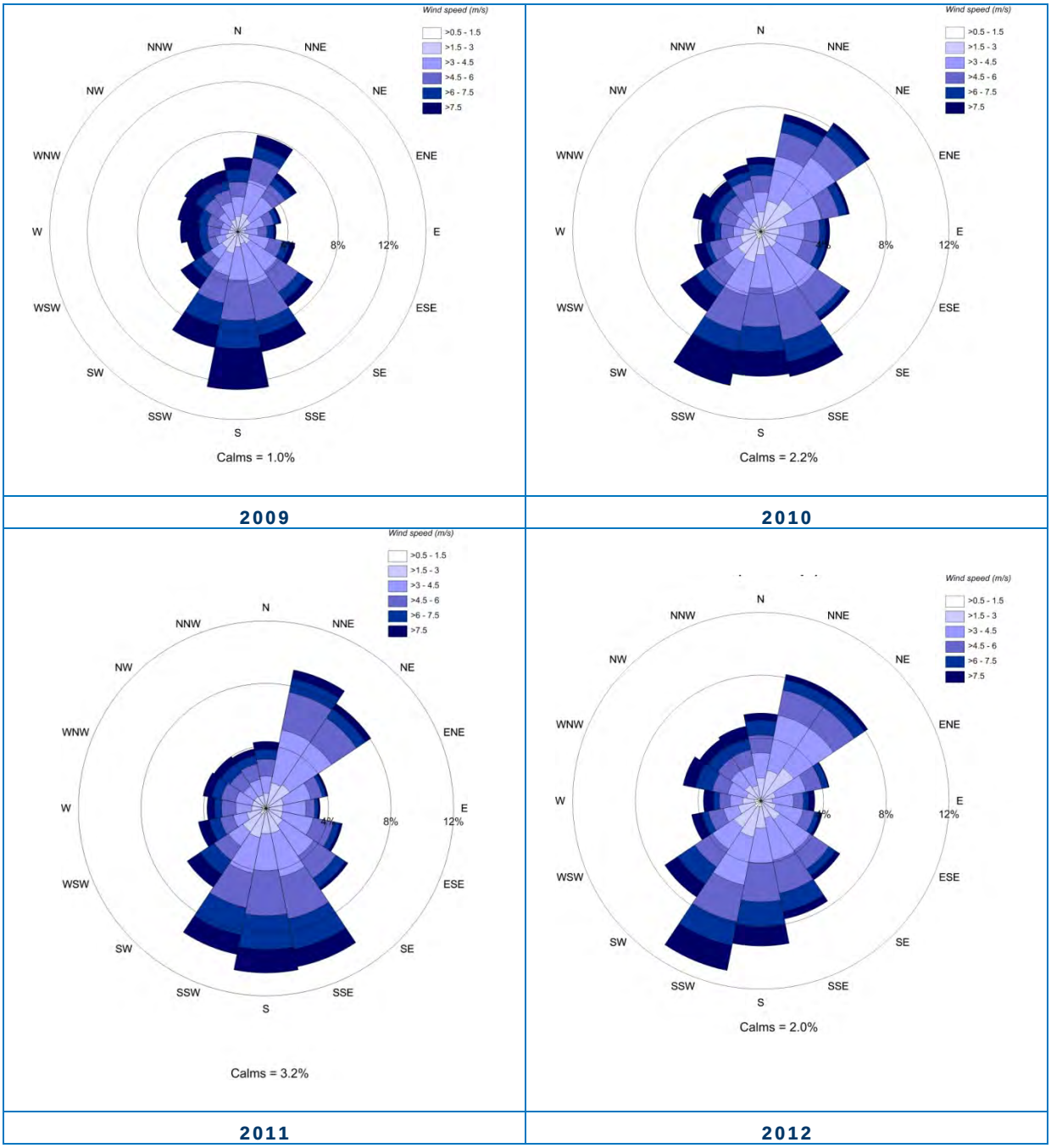

Figure 6-1: Annual Windroses for Broken Hill

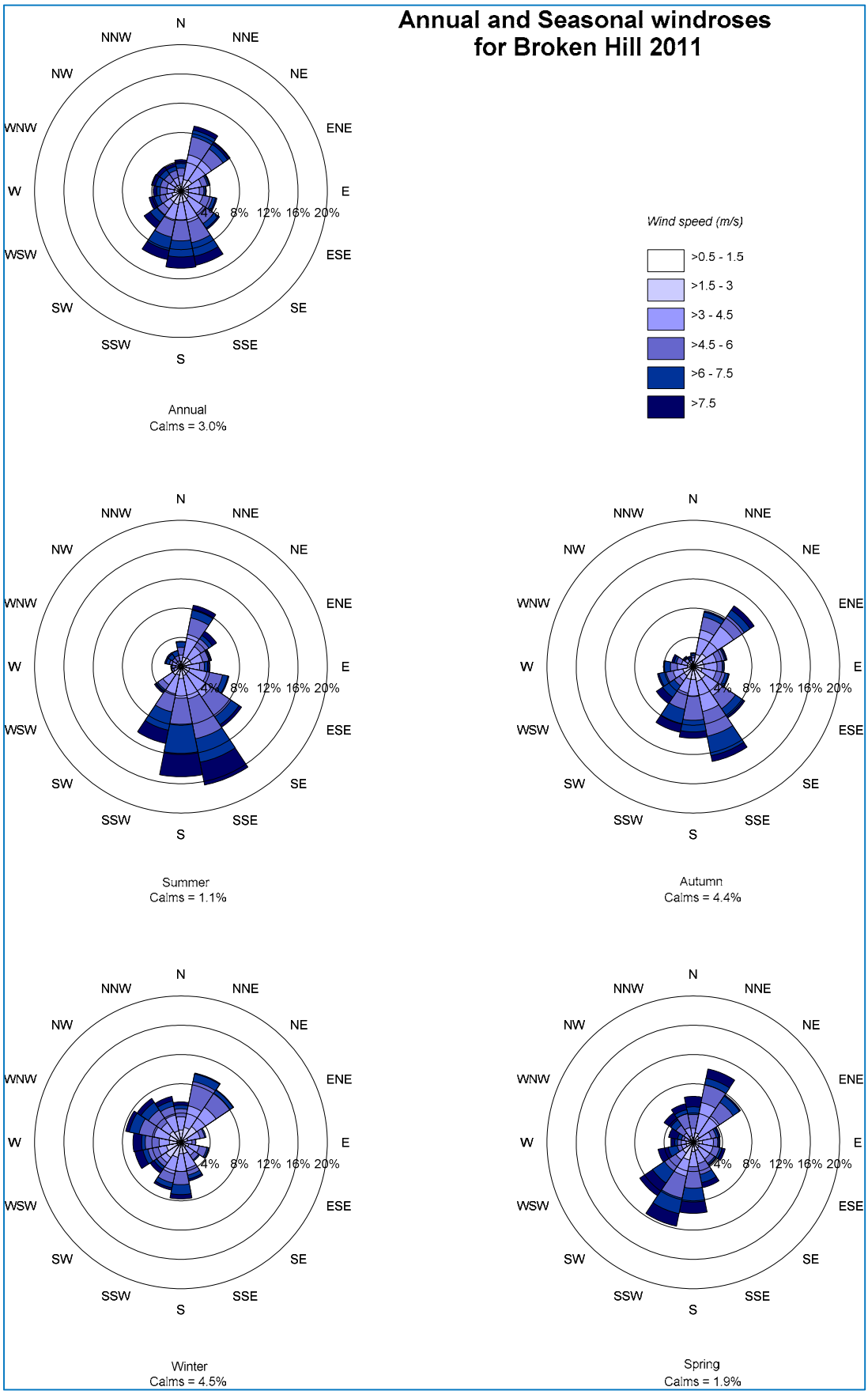

Figure 6-2: 2011 Annual and Seasonal Windroses for Broken Hill 2011

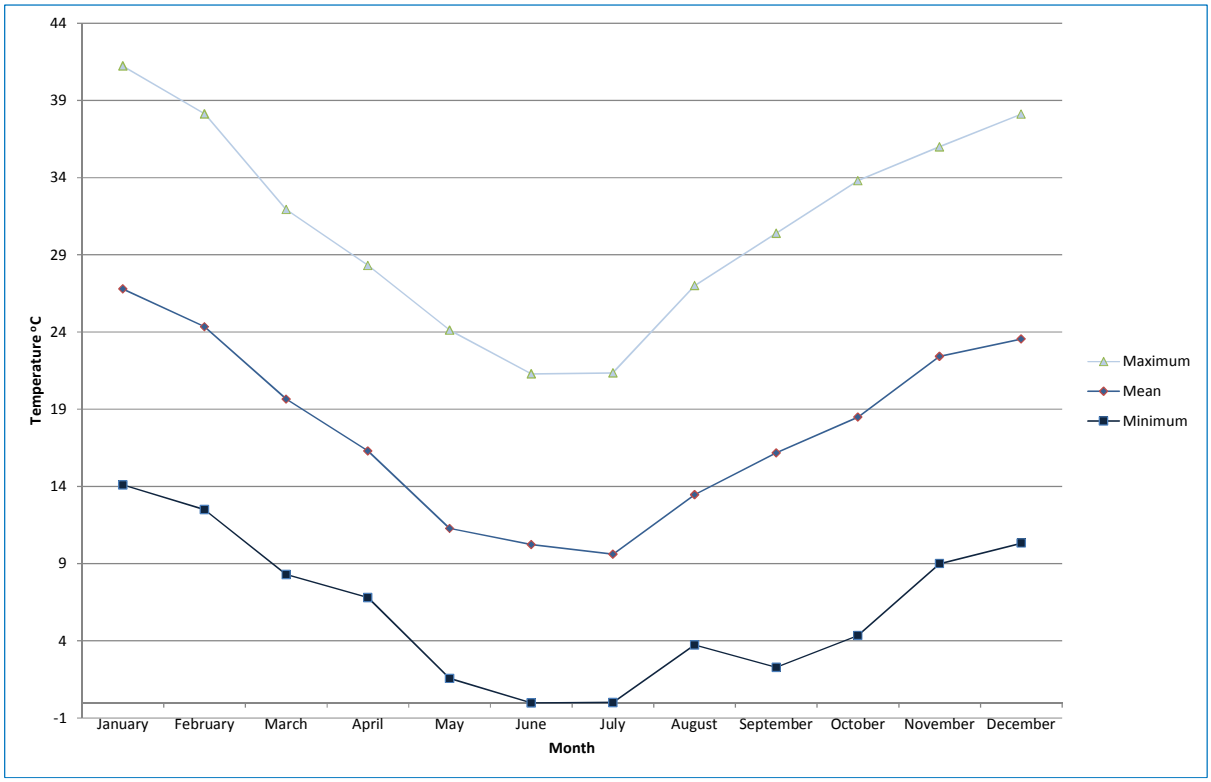

Figure 6-3: 2011 Monthly Temperature

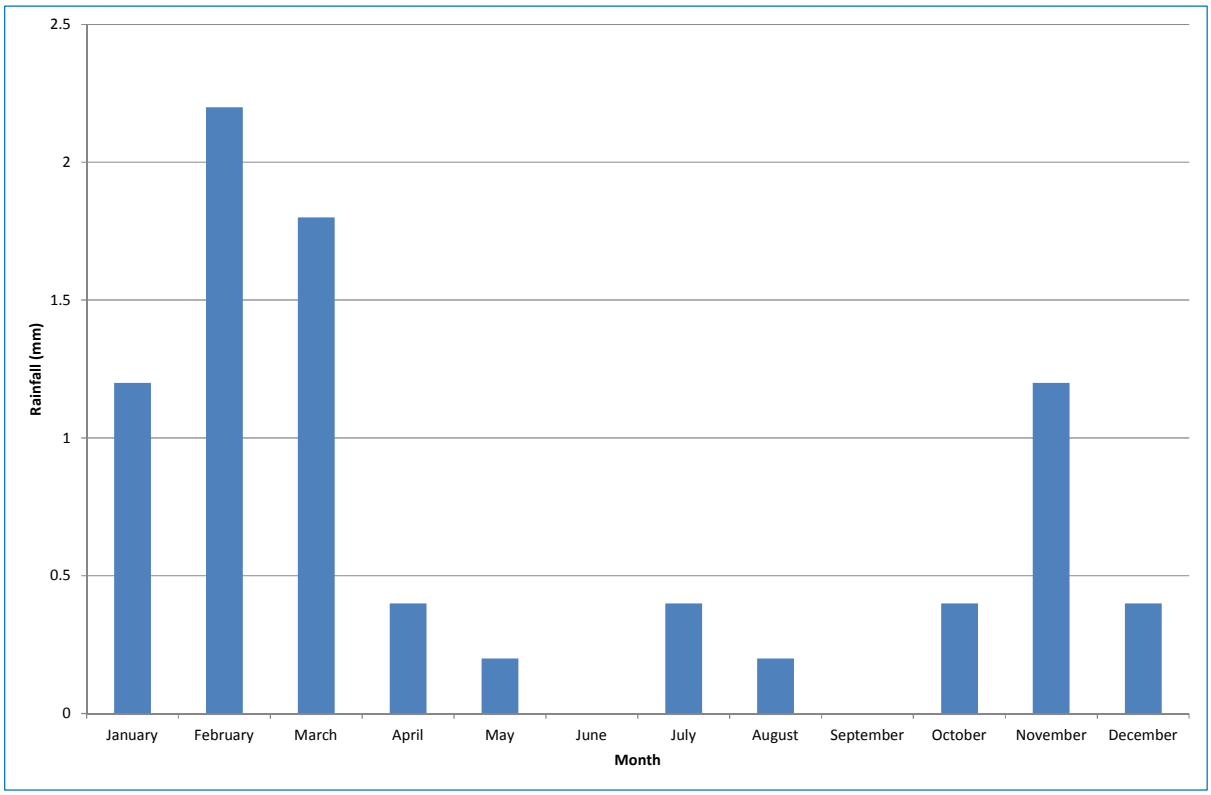

Figure 6-4: 2011 Monthly Rainfall

6.2 Existing air quality

Air quality standards and goals refer to total pollutant levels, which include the contribution from specific projects and existing sources. To fully assess impacts against the relevant air quality standards and goals it is necessary to have data on existing pollutant levels in the area in which the MSP is likely to contribute. It is important to note that the existing air quality conditions (that is, background conditions) will be influenced by existing operations at the MSP. The MSP air quality monitoring network currently consists of one High Volume Air Sampler (HVAS) and four dust deposition gauges (**Figure 4-1**).

6.2.1 Dust deposition

Cristal Mining has operated four dust gauges in the vicinity of the MSP (**Figure 4-1**) since 2005. The annual average dust deposition data are shown in **Table 6.2**. Dust deposition levels were elevated in 2008 and 2009 but have been below the EPA criteria of 4 g/m^2/month in recent years.

Table 6.2: Annual Average Dust Deposition

Year	Silver City Auto-wreckers (Talbot) - DBH01 (g/m^2/month)	DBH02 (g/m^2/month)	Macro Meats – Gourmet Game - DBH03 (g/m^2/month)	MSP - DBH04 (g/m^2/month)
2005	1.1	1.2	2.9	0.9
2006	1.2	1.1	3.0	1.4
2007	1.6	1.9	3.1	1.9
2008	3.6	6.3	4.7	4.2
2009	3.1	1.8	5.9	2.6
2010	0.9	1.3	1.8	1.8
2011	0.7	1.5	2.2	1.4
2012	0.9	3.6	1.6	1.8

6.2.1.1 PM_{10}

Cristal Mining has operated a HVAS in the vicinity of the MSP (**Figure 4-1**) since May 2006, which measures 24 hour average PM_{10} concentrations of PM_{10} on a one day in six run cycle (**Figure 6-5**). The annual average PM_{10} concentrations are shown in **Table 6.3**. Data for 2006 are not shown as the data are incomplete.

Annual average PM_{10} concentrations were below the impact assessment criterion of 30 µg/m^3, at all receivers with the exception of 2009. Annual average PM_{10} concentrations during 2009 are likely to be a result of the generally drier conditions experienced across NSW during 2009, and reflected in much of the PM_{10} monitoring across the state. 2009 was the warmest year on record for the state of NSW and annual average rainfall for the state was low at 484 millimetres (mm). This is lower than that recorded in 2008 (519 mm), 2007 (543 mm), although higher than in 2006 (349 mm) and on a par with 2005 (494 mm). 2010 had the highest rainfall recorded in the state for 50 years at 803 mm (http://www.bom.gov.au/climate/current/index.shtml). Given the dry, desert climate of Broken Hill, it is anticipated that the annual average PM_{10} concentrations are governed predominantly by natural (as opposed to man-made) sources. These will include the dust storms that regularly impact the region.

Table 6.3: Annual Average PM_{10} Concentrations (µg/m³)

Year	Concentration – µg/m³
2007	22.3
2008	26.3
2009	32.3
2010	9.6
2011	12.1
2012	11.6

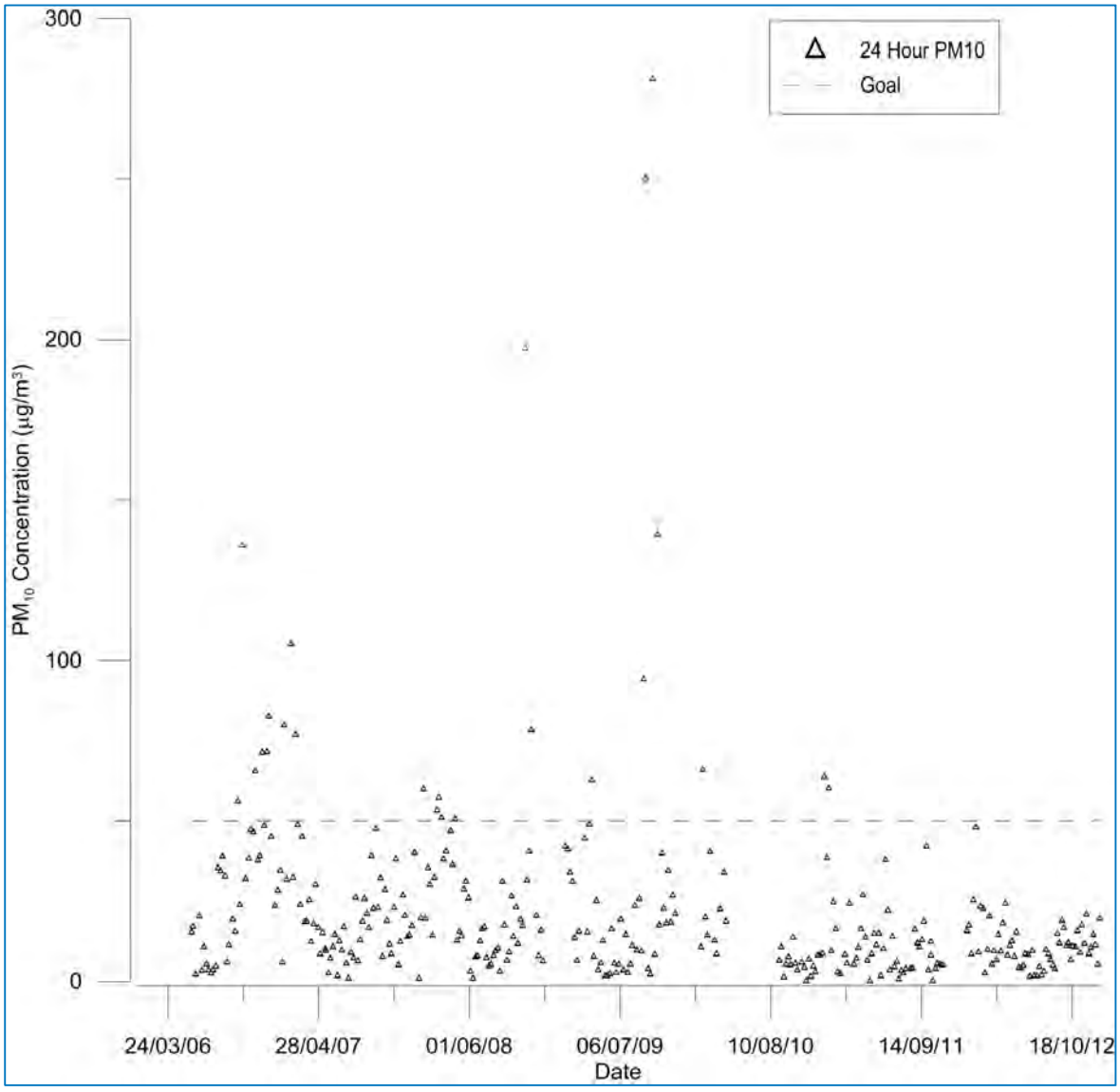

Figure 6-5: 24-Hour PM_{10} Concentrations

6.2.2 TSP

There are no available TSP concentrations data in the vicinity of the MSP, however TSP is measured by Broken Hill Operations Pty Ltd in the vicinity of the Rasp Mine in Broken Hill. Annual average TSP concentrations of 48 µg/m³ and 65 µg/m³ were recorded for 2008 and 2009, respectively (**Environ, 2010**). This monitoring location is close the mining activities and would be a conservatively high indication of background TSP in the vicinity of the MSP.

6.2.3 $PM_{2.5}$, NO_2 and SO_2

There are no available $PM_{2.5}$, NO_2 or SO_2 concentrations data in the vicinity of the MSP.

6.3 Existing air quality for assessment purposes

The monitoring data collected at the MSP air quality monitoring network would include contributions from existing operations, as well as all other sources for the area. In summary, the following background air quality levels are conservatively assumed for all existing sources.

- Annual average PM_{10} concentration of 12 µg/m^3.
- Annual average TSP concentration of 50 to 60 µg/m^3.
- Annual average dust deposition of 1-2 g/m^2/month.

7 MODELLING APPROACH

The assessment follows a conventional approach commonly used for air quality assessment in Australia and outlined in the Approved Methods (**EPA, 2005**).

7.1 Modelling system

AERMOD was chosen as the most suitable model due to the source types, location of nearest receiver and nature of local topography. AERMOD is the US EPA's recommended steady-state plume dispersion model for regulatory purposes. AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it provides more realistic results. Ausplume, a steady state Gaussian plume dispersion model developed by the Victorian EPA and frequently used in Australia for simple near-field applications is based on ISC, which has now been replaced by AERMOD.

A significant feature of AERMOD is the Pasquil-Gifford stability based dispersion is replaced with a turbulence-based approach that uses the Monin-Obukhov length scale to account for the effects of atmospheric turbulence based dispersion.

The AERMOD system includes AERMET, used for the preparation of meteorological input files and AERMAP, used for the preparation of terrain data.

Terrain data was sourced from NASA's Shuttle Radar Topography Mission Data (3 arc second [~90m] resolution) and processed within AERMAP to create the necessary input files.

AERMET requires surface and upper air meteorological data as input. Surface data, including cloud cover was sourced from the Broken Hill Airport AWS. The closest available upper air data sounding data were recorded at Cobar, NSW. Appropriate values for three surface characteristics are required for AERMET as follows:

- Surface roughness, which is the height at which the mean horizontal wind speed approaches zero, based on a logarithmic profile.
- Albedo, which is an indicator of reflectivity of the surface.
- Bowen ratio, which is an indicator of surface moisture.

Values of surface roughness, bowen ratio and albedo were determined based on a review of aerial photography for a radius of 3 km centred on the MSP. Default values for dry desert scrubland where chosen for each sector due to the uniformity across this area.

7.2 Building wake effects

Wind flow is often disrupted in the immediate vicinity of buildings. Plumes emitted nearby are assumed to be unaffected by building wakes if they manage to reach building height plus 1.5 times the lesser of building height or projected building width. If this is not the case, pollutants can be brought to ground within a highly turbulent, generally recirculating cavity region in the immediate lee of the building and/or be subject to plume downwash and enhanced dispersion in a turbulent region which extends further downwind behind the building (**Environmental Protection Authority of Victoria, 1999**).

A simplified building geometry was incorporated for simulation of building wake effects, modelled using BPIP-PRIME model, as shown in **Figure 7-1**. BPIP-PRIME uses heights and corner locations of buildings in the vicinity of the plume to simulate the effective height and width of the structures. The downwash algorithm calculates effective building dimensions relative to the plume, resolved down to ten degree intervals. AERMOD then calculates the impact of these buildings on plume dispersion and consequently on GLCs.

Figure 7-1: Visualisation of the Incorporation of MSP Building Dimensions within the Model

8 EMISSIONS TO AIR

8.1 Existing stack monitoring results

Cristal Mining is required to undertake annual stack testing for their existing stacks in accordance with EPL No. 12314. A summary of the previous 6 years of stack testing data is provided in **Table 8.1**. The monitoring data demonstrates that the stacks servicing the existing leucoxene circuit comply with the EPL limits and the POEO Clean Air Regulation standards of concentration (refer **Section 5.5**).

Table 8.1: Stack Testing Results

Test Year	Leucoxene Dryer		Leucoxene Baghouse
	Total Particles (mg/Nm^3)	NO_2 (mg/Nm^3)	Total Particles (mg/Nm^3)
2006	2.1	11	0.9
2007	2.7	32	0.1
2008	1.2	29	3.4
2009	1.1	48	0.8
2010	2	37	9.4
2011	<1	14	9.0
2012	3.1	0.027	33

Note: Nm^3 = normal metres cubed (adjusted to standard temperature and pressure)

8.2 Stack design parameters

As described in **Section 2**, a total of eight stacks will be required at the MSP at full development. A summary of the proposed mineral concentrate production rates and fuel consumption rates for the Modification are provided in **Table 8.2** and the stack design parameters for each of the stacks are provided in **Table 8.3**.

The stack flow rates (refer **Table 8.3**) have been determined from the stack diameter and minimum exit velocity, with the exception of the existing leucoxene hygiene baghouse and dryer stacks where measured flow data for the previous 5 years has been used (expressed as actual (A) m^3).

Stack temperatures (refer **Table 8.3**) for all stacks are based on the stack measurements taken at the leucoxene hygiene baghouse and dryer stacks. In-stack concentrations are presented based on normal (N) conditions (Nm^3) (adjusted for temperature) to allow comparison with the appropriate limits.

8.3 Product loss emissions

Particulate matter emissions from product handling (hygiene stacks) and product drying and roasting (dryer and kiln stacks) have been estimated based on an assumed product loss rate of 1% and 2% respectively. In the case of the dryer stacks, particulate matter emissions from combustion have also been estimated and modelled, although these are a small component of the total particulate matter based on the use of LPG fuel (refer **Section 8.4**).

A control efficiency of 99.93% has been assumed for the baghouses servicing the hygiene, dryer and kiln stacks. The control efficiency has been determined from site specific measurements taken at the existing leucoxene hygiene baghouse stack in 2011, assuming existing production rates and a 1% percentage product handling loss (refer **Table 8.4**). The percentage control achieved from the dryer stacks, based on 2011 leucoxene hygiene baghouse stack testing results was higher than 99.93%, however a control efficiency of 99.93% was conservatively applied to both hygiene and dryer stacks.

As the particulate matter emissions are passed through a hygiene baghouse, it has been assumed that all particulate matter emissions from the stacks will be PM_{10}. A summary of the particulate matter emission estimates for the hygiene, dryer and kiln stacks is provided in **Table 8.5** and **Table 8.6**.

Table 8.2: Proposed Production Rates and Fuel Consumption Rates

Product	Development Consent Reference	Production Rate (tpa)	Total Throughput Required to Reach Production Rate (tpa)	Hourly Throughput Required to Reach Production Rate (t/hr)	Fuel Type	Total Fuel Usage Required to Reach Production Rate (tpa)
Leucoxene Hygiene Baghouse	6	250,000	300,000	36	-	-
Leucoxene Dryer	10				LPG	1,512
Ilmenite Hygiene Baghouse	7	600,000	655,000	78	-	-
Ilmenite Dryer	12				LPG	4,158
Ilmenite Kiln	13	225,000	280,000	33	Brown Coal	187,767
Rutile/Zircon Hygiene Baghouse	8	200,000	230,000	27	-	-
Zircon Dryer	9	75,000	107,000	13	LPG	328
Rutile Dryer	11	100,000	100,000	12	LPG	302

Note: t/hr = tonnes per hour

Table 8.3: Stack Design Parameters

Stack	Development Consent Reference	Stack Height (m)	Stack Diameter (m)	Discharge Velocity (m/s)	Flow Rate (Am^3/s)	Stack Temperature (K)
Leucoxene Hygiene Baghouse	6	40.0	0.49	15	2.7	317
Leucoxene Dryer	10	40.2	0.50	16	2.5	340
Ilmenite Hygiene Baghouse	7	40.4	0.75	17.8	7.9	317
Ilmenite Dryer	12	40.4	0.90	16.3	10.3	340
Ilmenite Kiln	13	41.2	0.55	15	3.6	400
Rutile/Zircon Hygiene Baghouse	8	40.2	1.00	15	11.8	317
Zircon Dryer	9	40.2	0.35	15	1.4	340
Rutile Dryer	11	40.2	0.55	15	3.6	340

Notes: Am^3 = Actual metres cubed
K = Kelvin

Table 8.4: Control Efficiency Calculation

Stack	Development Consent Reference	Production Rate (tpa)	Particulate Matter Emission Rate (t/hr)	Particulate Matter Emission Rate (g/s)	Flow Rate (Nm^3/s)	Derived Particulate Matter In-Stack Concentration (mg/Nm^3)	2011 Stack Testing (mg/Nm^3)	% Control
Leucoxene Hygiene Baghouse	6	15.0	0.2	41.7	2.3	15,463	9	99.94%

Notes: Nm^3/s = normal metres cubed (adjusted to standard temperature and pressure)
g/s = grams per second

Table 8.5: Summary of Particulate Emissions – Product Handling Hygiene Stacks

Stack	Development Consent Reference	Production Rate (tpa)	Hourly Throughput Required to Reach Production Rate (t/hr)	Particulate Matter Emissions (t/hr)	Particulate Matter Emissions (with Baghouse Control) (t/hr)	Particulate Matter Emission Rate (g/s)	Flow Rate (Am^3/s)	Derived Particulate Matter In-Stack Concentration (mg/Nm^3)
Leucoxene Hygiene Baghouse	6	250,000	36	0.36	0.0003	0.07	2.7	30
Ilmenite Hygiene Baghouse	7	600,000	78	0.78	0.0005	0.15	7.9	27
Rutile/Zircon Hygiene Baghouse	8	200,000	27	0.27	0.0002	0.05	11.8	5

Table 8.6: Summary of Particulate Emissions – Product Loss Dryers and Kiln

Stack	Development Consent Reference	Hourly Throughput Required to Reach Production Rate (t/hr)	Particulate Matter Emissions (t/hr)	Particulate Matter Emissions (with Baghouse Control) (t/hr)	Particulate Matter Emissions (g/s)	Flow Rate (Am^3/s)	Derived Particulate Matter In-Stack Concentration (mg/Nm^3)
Leucoxene Dryer	10	36	0.7	0.0005	0.14	2.5	70
Ilmenite Dryer	12	78	1.6	0.001	0.3	10.3	44
Ilmenite Kiln	13	33	0.7	0.0005	0.13	3.6	36
Zircon Dryer	9	13	0.3	0.0002	0.05	1.4	44
Rutile Dryer	11	12	0.2	0.0002	0.05	3.6	16

8.4 Combustion emissions

8.4.1 Dryer stacks

Emissions of NO_x and PM_{10} have been estimated for the dryers, based on the proposed fuel use and emissions factors from the *National Pollution Inventory Emission Estimation Techniques (EET) Manual for Combustion in Boilers* (**Department of the Environment, Water, Heritage and the Arts** [**DEWHA], 2010**) and *National Pollutant Inventory Emission Estimation Technique Manual for Fossil Fuel Electric Power Generation* (**Department of Sustainability, Environment, Water, Population and Communities [DSEWPC], 2012**).

A summary of the combustion emission estimates for the dryer stacks are provided in **Table 8.7**.

8.4.2 Ilmenite kiln stack

In accordance with Condition 3.2, Schedule 2 of Development Consent (DA 345 11 01), the ilmenite kiln stack when constructed will be designed such that the emissions from the MSP will comply with POEO Clean Air Regulation (refer **Section 5.5).** It has therefore been assumed for this assessment that the ilmenite kiln stack will be designed and/or an appropriate fuel type chosen to achieve POEO Clean Air Regulation NO_x and TSP concentrations (refer **Section 5.5**). The emissions estimates are summarised in **Table 8.8**. As there are no applicable POEO Clean Air Regulation in-stack concentration criteria for SO_2, it has been assumed for the assessment that the ilmenite kiln stack will also be designed and/or an appropriate fuel type chosen to achieve compliance with EPA GLCs. This approach is considered appropriate as there are no other significant sources of SO_2 emissions at the MSP that would need to be incorporated in SO_2 modelling for the MSP. No SO_2 concentration modelling has therefore been undertaken for this assessment.

A separate application to vary EPL No. 12314 will be required once detailed design of the ilmenite kiln has been conducted to demonstrate compliance with the relevant EPA criteria.

8.5 Hexavalent chromium emissions

Magnesium and iron chromite spinals occur in the mineral concentrate feed, a study was performed on behalf of Cristal Mining by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (**Pacific Air Environment, 2001**) to determine if hexavalent chromium (Cr) emissions would be released from the ilmenite kiln. The study determined that in the likely temperature range of roasting (600-800 degrees Celsius [ºC]) the maximum level of Cr (VI) emission was no greater than 0.1 parts per billion and significantly lower under predominant conditions for roasting.

8.6 NO_x chemistry

Emissions of NO_x will consist of both NO and NO_2. NO_2 is the regulated oxide of nitrogen and assessed for compliance (refer to **Section 5.5**). While NO_x to NO_2 transformation rates will vary, for example, with amount of available sunshine, atmospheric O_3 concentration and with distance from source, a conservative assumption of 100% conversion is assumed for this assessment.

Table 8.7: Summary of Combustion Emissions Data – Dryers

Stack	Development Consent Reference	Total Fuel Usage Required to Reach Production Rate (tpa)	Approved Fuel Type	Emission Factor (LPG Boiler Propane) (kg/t)		Emission Rate (kg/yr)		Emission Rate (g/s)		Flow Rate (Am^3/s)	Derived In-Stack Concentration (mg/Nm^3)	
				NO_x	PM_{10}	NO_x	PM_{10}	NO_x	PM_{10}		NO_x	PM_{10}
Leucoxene Dryer	10	1,512	LPG	4.46	0.26	6,744	393	0.21	0.01	2.5	107	6
Ilmenite Dryer	12	4,158	LPG	4.46	0.26	18,545	1,081	0.59	0.03	10.3	86	5
Zircon Dryer	9	328	LPG	4.46	0.26	1,463	85	0.05	0.003	1.4	40	2
Rutile Dryer	11	302	LPG	4.46	0.26	1,347	79	0.04	0.002	3.6	15	1

Note: kg/yr = kilograms per year

Table 8.8: Summary of Combustion Emissions Data –Ilmenite Kiln

Stack	Development Consent Reference	Assumed Flow Rate (Am^3/s)	Assumed In-Stack Concentration (mg/m^3)		Estimated Emission Rate (g/s)	
			NO_x	PM_{10}	NO_x	PM_{10}
Ilmenite Kiln	13	3.6	500	14	1.8	0.18

8.7 Fugitive sources

Fugitive dust emissions have also been considered and estimates of emissions for the key dust generating activities have been made. Emission factors developed both locally, and by the US EPA, have been applied to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most reliable, contemporary methods for determining dust generation rates.

The fugitive emission sources considered in the assessment are:

- Wheel generated dust from mineral concentrate delivery/MSP process waste removal via the unsealed access road.
- Wheel generated dust from the internal tip truck movements.
- Unloading of mineral concentrate to stockpile areas.
- Loading of feed circuits with mineral concentrate by Front end loader (FEL).
- FEL on stockpiles.
- Loading trucks with MSP process waste.
- Loading trains by FEL.
- Wind erosion from stockpiles.

Calculations are provided in **Appendix A**, which provides information on the equations used, the basic assumptions about material properties (e.g. moisture content, silt content, etc.), information on the way in which equipment would be used to undertake activities and the quantities of materials that would be handled in each operation. A summary of the annual emissions for approved operations is provided in **Table 8.9**.

Table 8.9: Summary of PM_{10} Emissions from Fugitive Sources

ACTIVITY	PM_{10} Emissions for Proposed Operations (kg/yr)
Hauling - Access Road	2,282
Hauling - Internal tip truck	583
Unloading at Mineral Concentrate Stockpiles	147
Loading - Leucoxene Feed	37
Loading - Ilmenite Feed	116
Loading - Rutile/zircon feed	28
Loading - Trucks with Rejects	24
FEL - Loading Trains	3,812
FEL - at Mineral Concentrate Storage Pile	3,812
FEL - at Mineral Concentrate Storage Pile	3,812
Unloading - Coal Storage	181
Stockpiles - Mineral Concentrate Stockpile 1	45
Stockpiles - Mineral Concentrate Stockpile 2	32
Stockpiles - Mineral Concentrate Stockpile 3	46
Stockpiles - Mineral Concentrate Stockpile 4	33
Stockpiles - Additional Mineral Concentrate Stockpile	613
Stockpiles - Product stockpile	116
Stockpiles - Reject stockpile	14

It is noted that the emission estimates presented for wind erosion from stockpiles are based on conservative assumptions. The emission estimates are based on US EPA emission factors, which are derived from various data collected during the late 1970s and early 1980s using high volume air samplers positioned upwind and downwind of exposed areas and sand stockpiles. The use of US EPA emission factors for mineral concentrate stockpiles will result in conservative overestimates, primarily based on the particle size distribution and density of mineral concentrate.

Particle size distribution testing for a bulk sample of non-magnetic concentrate indicates that a very small fraction (approximately 2%) is less than 10 µm in diameter while the particle density was measured to be 4176 kilograms per cubic metre (kg/m^3) (**Tunra Bulk Solids Handling Research Associates, 2004**). The density of the material for which the emissions factors were derived is expected to be lower than mineral concentrate material, while the particle size distribution of exposed soil material and sand would have a higher percentage of smaller (sub 10 µm) particles. The emission factors are therefore expected to overestimate wind erosion emissions from the stockpiles (i.e. provide a conservative estimate of wind erosion emissions).

Furthermore, the transport of soil particles by the wind can be broadly characterised as follows (**Kok *et al.* (2012)**:

- Long term suspension (<20 µm)
- Short term suspension (20-70 µm)
- Saltation (70-500 µm)
- Creep (>500 µm)

This is further illustrated in **Figure 8-1** which shows the various modes for wind erosion. Approximately 90% of the bulk sample of non-magnetic concentrate tested is greater than 80 µm in diameter, suggesting that the dominant mode for wind erosion would be saltation, a process whereby particles hop along the surface. Only a small percentage (approximately 2%) would be subject to suspension and dispersion off-site.

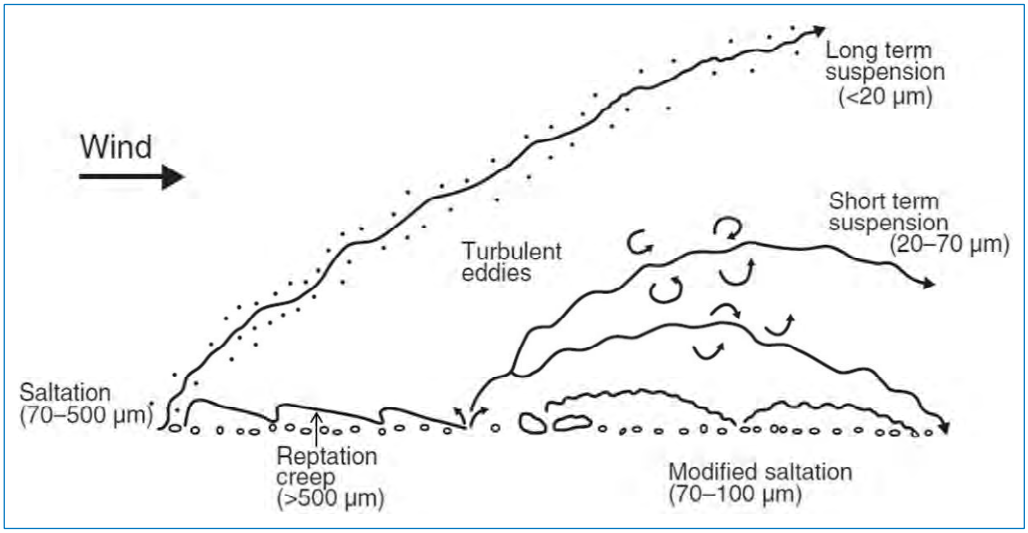

Figure 8-1: Modes for the wind erosion of particles (Nickling and McKenna Neuman, 2009)

9 IMPACT ASSESSMENT

9.1 In-stack concentration limits

A comparison between the estimated in-stack concentrations for the MSP stacks and the standards of concentration set out in the POEO Clean Air Regulation indicates that the MSP would comply with the relevant limits (**Table 9.1**).

Table 9.1: Comparison to Emission Standards

Stack	Estimated Emission Concentration (mg/Nm³)			Limit (mg/Nm³)	
	Combustion	Product Loss	Total	EPL	POEO Group 6
NO_x					
Leucoxene Hygiene Baghouse	-	-	-	-	-
Leucoxene Dryer	107	-	107	350	-
Ilmenite Hygiene Baghouse	-	-	-	-	-
Ilmenite Dryer	86	-	86	350	-
Ilmenite Kiln	500	-	500	-	500
Zircon/Rutile Hygiene Baghouse	-	-	-	-	-
Zircon Dryer	40	-	40	-	350
Rutile Dryer	15	-	15	-	350
Particulate Matter					
Leucoxene Hygiene Baghouse	-	30	30	100	-
Leucoxene Dryer	6	70	76	100	-
Ilmenite Hygiene Baghouse	-	27	27	100	-
Ilmenite Dryer	5	44	49	100	-
Ilmenite Kiln	14	36	50	-	50
Zircon/Rutile Hygiene Baghouse	-	5	5	-	50
Zircon Dryer	2	44	46	-	50
Rutile Dryer	1	16	17	-	50

9.2 Predicted ground level concentrations – MSP only

Dispersion model predictions have been made for the MSP. Contour plots of particulate concentrations show the areas that are predicted to be affected by dust at different levels. It is important to note that the isopleth figures are presented to provide a visual representation of the predicted impacts. To produce the isopleths it is necessary to make interpolations, and as a result the isopleths will not always match exactly with predicted impacts at any specific location. The actual predicted particulate concentrations/levels at nearby receivers are presented in tabular form.

9.2.1 PM_{10}

Figure 9-1 and **Figure 9-2** show contour plots for the predicted GLCs for MSP only maximum 24-hour and annual average PM_{10} concentrations. The 24-hour PM_{10} contours presented in **Figure 9-1** do not represent a single worst case day, but rather represent the potential worst case 24-hour PM_{10} concentration that could be reached at any particular location across the entire modelling year.

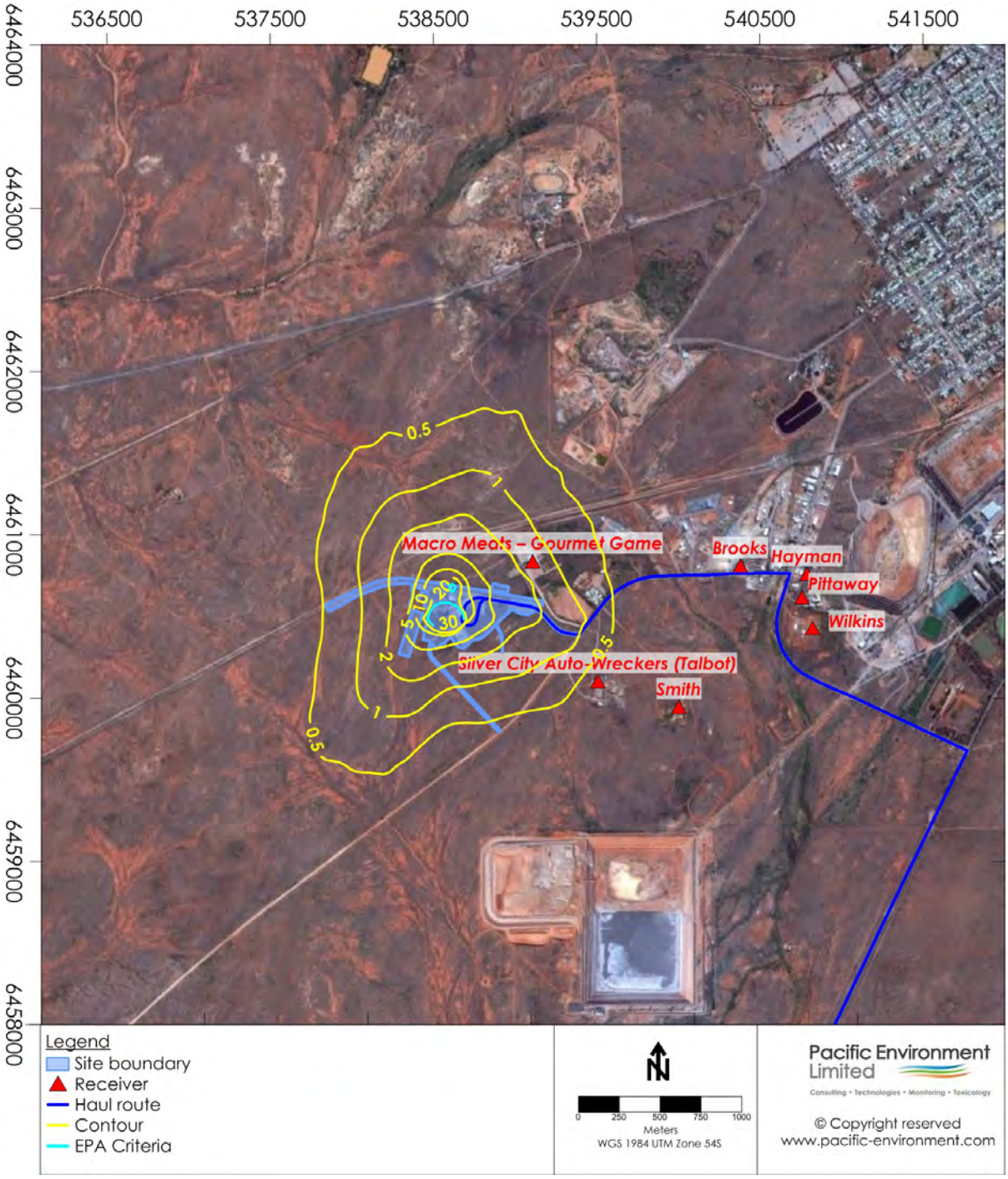

Figure 9-1: Predicted MSP 24-hour PM_{10} Concentration

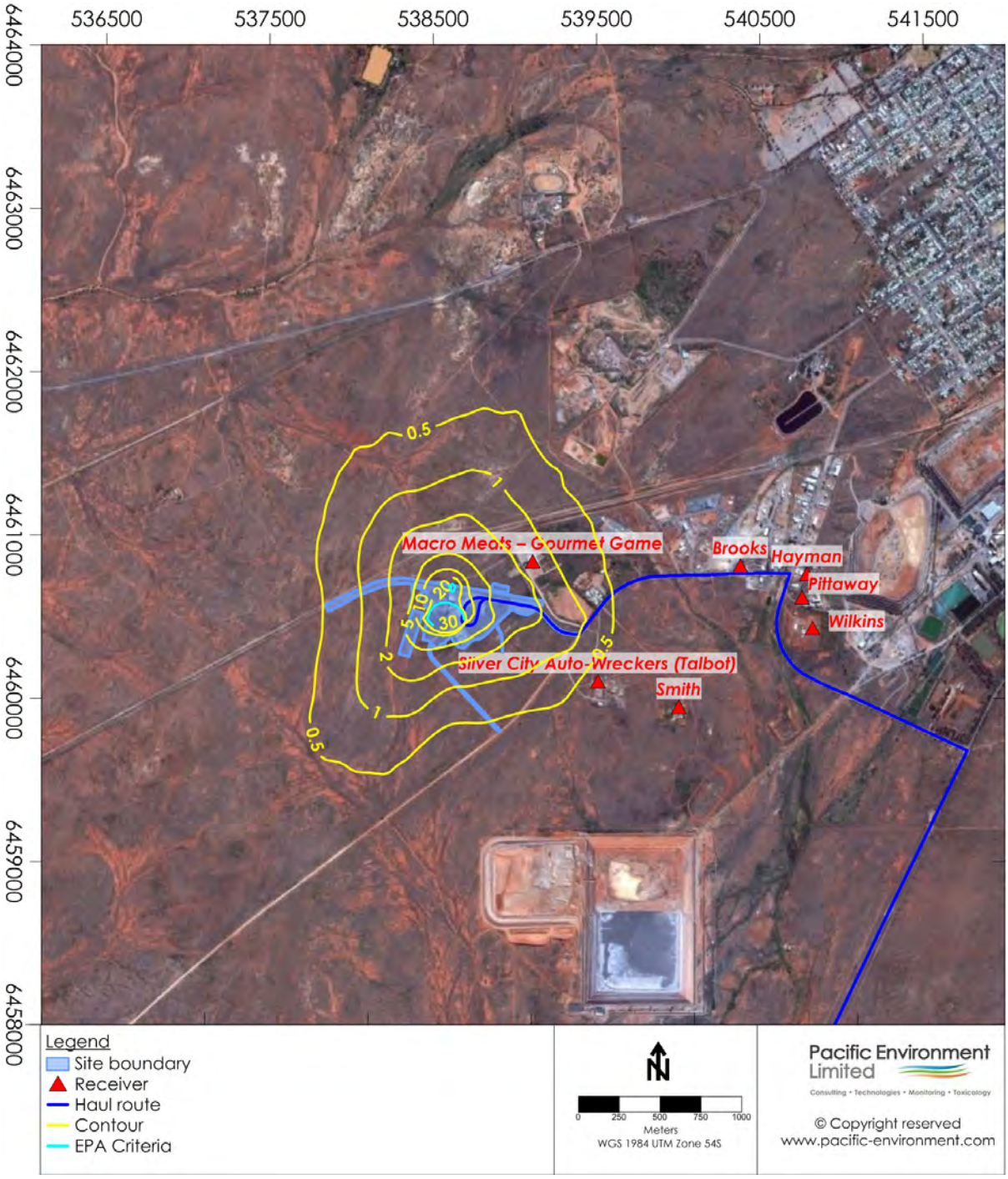

Figure 9-2: Predicted MSP Annual PM_{10} Concentration

A summary of the predicted GLCs at each of the individual receivers is provided in **Table 9.2**. None of the nearby receivers are predicted to experience PM_{10} levels above the impact assessment criterion due to the project alone.

Table 9.2: Maximum Predicted MSP PM_{10} Concentrations (µg/m³)

Discrete Receiver	24-hour PM_{10} Concentration (µg/m³)	Annual PM_{10} Concentration (µg/m³)
	Assessment criteria = 50 µg/m³	*Assessment criteria = 30 µg/m³*
Smith	2.4	0.2
Silver City Auto-Wreckers (Talbot)	4.2	0.4
Macro Meats – Gourmet Game	14.6	1.5
Brooks	2.4	0.2
Hayman	1.5	0.1
Pittaway	2.7	0.1
Wilkins	2.2	0.1

The predicted GLCs presented in **Table 9.2** include contributions from both fugitive and stack sources. The modelling of particle emissions from the stacks was based on an estimated percentage of product loss and an assumed control efficiency (refer to **Section** 8). The resulting in stack concentrations are lower than the allowable EPL and POEO Clean Air Regulation limit.

If modelling of particle emissions from the MSP stacks was based on the allowable EPL and POEO Clean Air Regulation limit (i.e. in-stack concentration of 100 mg/m³ for existing stacks and 50 mg/m³ for future stacks), compliance at each of the individual receivers identified in **Figure 9-2** would also be achieved. This is primarily because the dominant contributor to the predicted GLCs are the fugitive sources (approximately 60%), compared to the stacks contribution of approximately 40%.

9.2.2 $PM_{2.5}$

There are no particulate size distribution data available to estimate the $PM_{2.5}$ sub fraction of PM_{10}, however, a comparison of the predictions presented in **Table 9.2** for PM_{10} against the advisory reporting standards for $PM_{2.5}$, indicate that there would be no exceedances of the $PM_{2.5}$ reporting standards based on the PM_{10} GLCs.

9.2.3 NO_2

Figure 9-3 and **Figure 9-4** show contour plots for the predicted GLCs for maximum 1-hour and annual average NO_2 concentrations.

The 1-hour contours presented do not represent a single worst case hour, but rather represent the potential worst case 1-hour NO_2 concentration that could be reached at any particular location across the entire modelling year.

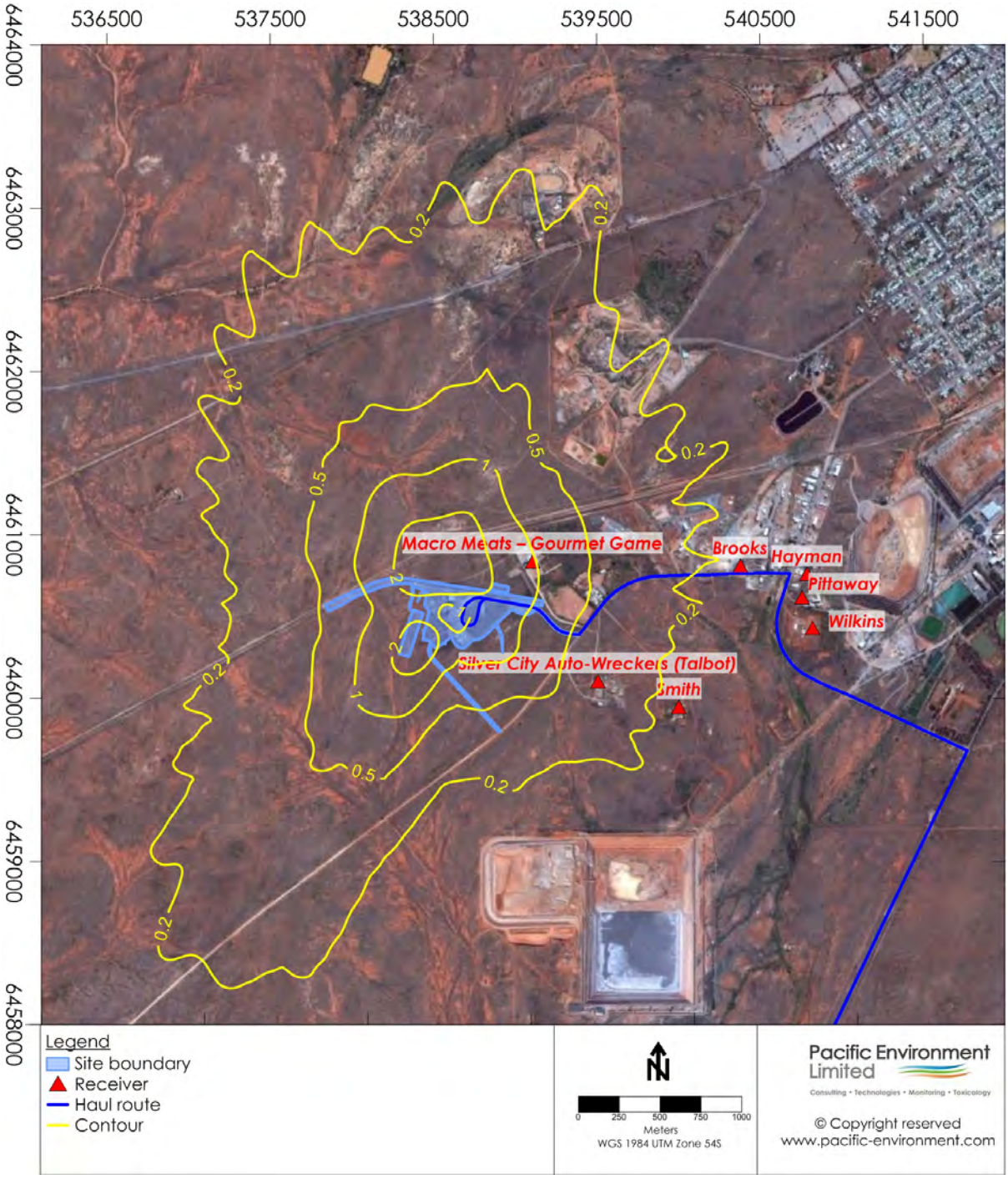

Figure 9-3: Predicted MSP 1-hour NO_2 Concentration

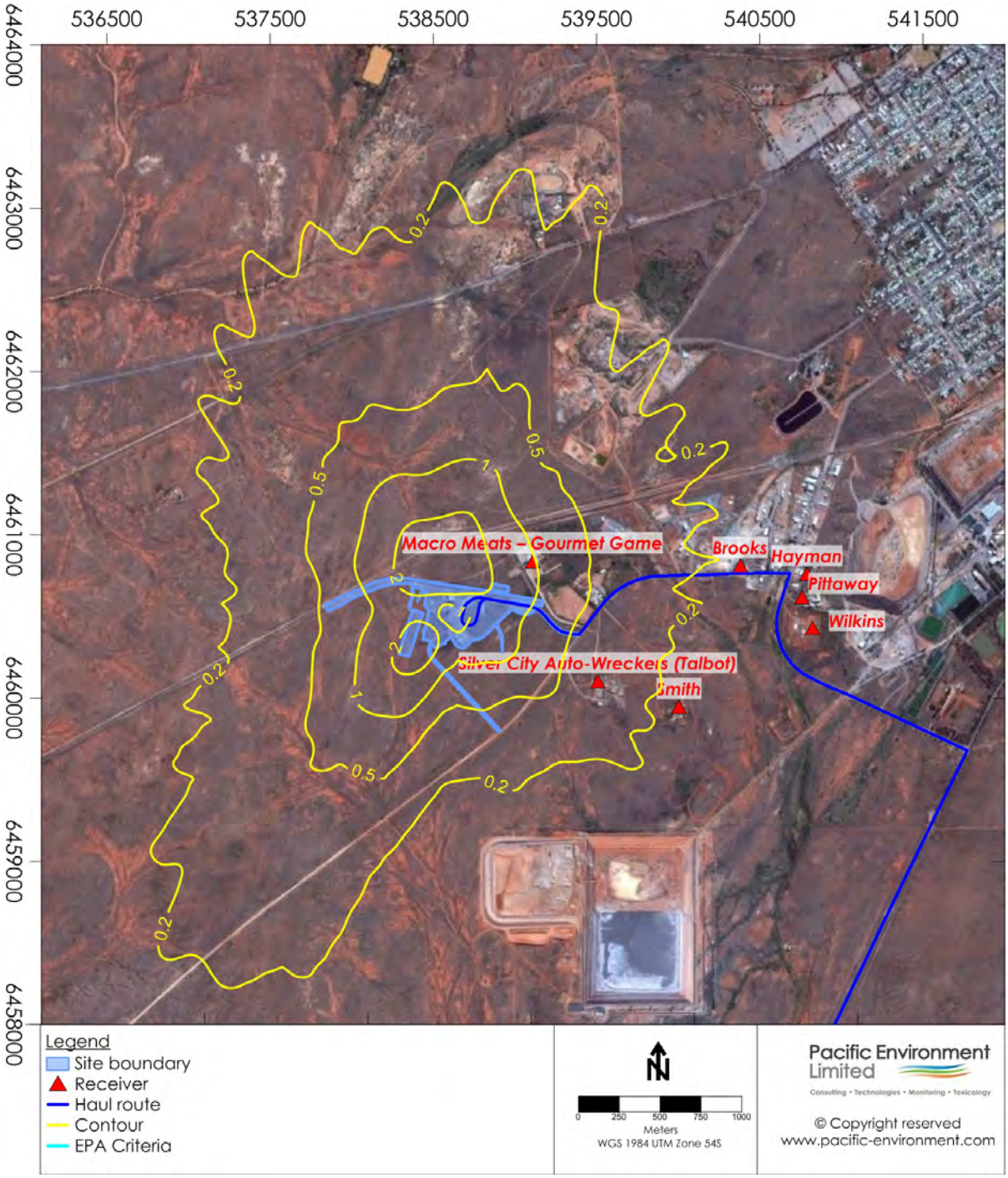

Figure 9-4: Predicted MSP Annual NO_2 Concentration

A summary of the predicted NO_2 GLCs at each of the individual receivers is provided in **Table 9.3**. None of the nearby receivers are predicted to experience NO_2 levels above the impact assessment criterion. It is noted that 100% conversion of the NO_x to NO_2 has been conservatively assumed.

Table 9.3: Predicted Incremental NO_2 Concentrations (µg/m³)

Discrete Receiver	1-hour NO_2 Concentration (µg/m³)	Annual NO_2 Concentration (µg/m³)
	Assessment criteria = 246 µg/m³	*Assessment criteria = 62 µg/m³*
Smith	17.3	0.2
Silver City Auto-Wreckers (Talbot)	22.6	0.3
Macro Meats – Gourmet Game	77.1	1.0
Brooks	27.5	0.2
Hayman	11.8	0.1
Pittaway	21.1	0.1
Wilkins	12.2	0.1

The predicted GLCs presented in **Table 9.3** are based on emission rates derived from National Pollutant Inventory emission factors, resulting in in-stack concentrations lower than the allowable EPL and POEO Clean Air Regulation limit. However, based on the low predicted GLCs presented in **Table 9.3** (noting that 100% conversion of NO_x is assumed) it is expected that compliance would also be achieved at the individual receivers identified in **Table 9.3** if the modelling of NO_2 emissions from the stacks was based on the allowable limits (i.e. in stack concentration of 350 mg/m³).

9.2.4 TSP and dust deposition

A summary of the predicted annual GLCs for TSP and dust deposition at each of the individual receivers is provided in **Table 9.4**. The predicted incremental increases at each of the residences are minor when compared to the relevant impact assessment criterion.

Table 9.4: Predicted Incremental TSP and Dust Deposition – Approved Operations

Discrete Receiver	Annual TSP Concentration (µg/m³)	Annual Dust Deposition
	Assessment criteria = 90 µg/m³	*Assessment criteria = 2 g/m²/month*
Smith	0.5	0.1
Silver City Auto-Wreckers (Talbot)	1.4	0.1
Macro Meats – Gourmet Game	5.7	0.5
Brooks	0.4	0.0
Hayman	0.3	0.0
Pittaway	0.3	0.0
Wilkins	0.3	0.0

9.2.5 Chromium (VI)

CSIRO conducted a study to determine if hexavalent chromium emissions would be released from the kiln (**Pacific Air Environment, 2001**). The study determined that in the likely temperature range of roasting (600-800ºC) the maximum level of Cr (VI) emission was no greater than 0.1 ppb and significantly lower under predominant conditions for roasting. A modelling assessment for Cr (VI) emissions presented in the original air quality impact assessment (**Pacific Air Environment, 2001**) found that maximum GLCs of Cr (VI) would be well below the safe cancer risk limit. As there is no change proposed to the ilmenite kiln stack, these findings are still considered relevant.

9.3 Cumulative impacts

9.3.1 Other developments

The following existing/approved developments are located in the MSP area:

- Perilya South Operation;
- Rasp Mine; and
- Broken Hill Solar Plant.

The implication of these existing/approved developments is discussed below.

Perilya South Operation

The Perilya South Operation is a lead-zinc underground mine that mines ore at a rate of up to 5 million tonnes per annum. The Perilya South Operation is located approximately 1.5 km to the south-east of the MSP (at its closest point).

No air quality assessments are available for the Perilya South Operation.

Perilya South Operation air quality impacts in the vicinity of the MSP are captured by the MSP monitoring program (**Section 6.2**). Consideration of potential cumulative air quality impacts of the Perilya South Operation have been considered using the background air quality levels estimated from the MSP monitoring program.

Rasp Mine

The Rasp Mine is located approximately 4 km to the north-east of the MSP and was granted Project Approval (07-0018) by the Minister for Planning in January 2011. The Rasp Mine is an underground lead-zinc-silver mine that includes:

- establishing an underground mine at the Rasp Mine to extract 8.45 million tonnes of lead-zinc-silver ore;
- processing 750,000 tonnes of ore per year at the surface for up to 12 years;
- constructing and/or extending associated infrastructure, plant, equipment and activities; and
- transporting concentrate by rail to a smelter and/or port.

The Environmental Assessment prepared for Rasp Mine included an assessment of the potential air quality impacts of the Rasp Mine and concluded (Environ, 2010):

> *Predictions indicate that, provided the comprehensive dust controls documented within this report are implemented, Project-related incremental particulate concentrations and dust deposition will be within DECC* [EPA] *air quality criteria at all surrounding non-project related residences. ...*

PAEHolmes (2011) assessed the potential air quality impacts associated with a modification to the Rasp Mine Project Approval (07-0018) and concluded:

> *In view of the above, it is anticipated that the proposed relocation of the Rasp underground mine ventilation shaft will not cause any significant change to the conclusions made within either the EA or PPR.*

Rasp Mine air quality impacts in the vicinity of the MSP are captured by the MSP monitoring program (**Section 6.2**). Consideration of potential cumulative air quality impacts of the Rasp Mine have been considered using the background air quality levels estimated from the MSP monitoring program.

Broken Hill Solar Plant

The Broken Hill Solar Plant was granted Project Approval (MP10_0202) by the Planning Assessment Commission in March 2013 and includes:

- a photovoltaic array incorporating rows of solar panels mounted on a fixed steel frame and a series of central inverters and transformers;
- aboveground and underground electrical conduits and cabling to connect the arrays to the inverters and transformers;
- marshalling switchgear to collect the power from the PV arrays;
- a diversion of the existing aboveground transmission line and placing it underground;
- construction of an aboveground transmission line to connect the solar plant to the existing Broken Hill sub station;
- internal access tracks, upgrades to existing roads, fencing and landscaping;
- site office, operations and maintenance office buildings; and
- temporary construction facilities such as a site compound and equipment laydown area.

The Broken Hill Solar Plant is located approximately 800 m to the west of the MSP and is not operational at this stage.

The Environmental Assessment prepared for the Broken Hill Solar Plant (SKM, 2012) assessed the potential air quality impacts of the Broken Hill Solar Plant and concluded:

> *The operation of the project would involve distribution of electricity generated by solar energy and would not generate any air emissions. …*
>
> *Operational maintenance activities would involve up to four vehicles travelling to and from the site. The impacts of this on air quality and climate would be negligible.*

Given the predicted air quality impacts for the Broken Hill Solar Plant, it has not been considered further in this cumulative assessment.

9.3.2 Cumulative annual average

The addition of annual average predicted GLCs of PM_{10} at each of the sensitive receivers (**Table 9.2**) to a background of 12.1 µg/m^3 (refer **Section 6.2**) would not result in any exceedances of the annual average assessment criterion. Similarly, the minor MSP only predictions of TSP and dust deposition would be unlikely to result in any additional exceedances of the impact assessment criteria.

9.3.3 Cumulative PM_{10} – 24 hour

There are no available continuous 24-hour PM_{10} data for the area. HVAS data are available every sixth day, however, this is insufficient to provide a representative background for each day of the model simulation. A statistical approach (using a Monte Carlo Simulation) is presented to investigate the potential for cumulative 24-hour PM_{10} impacts. The approach takes the available background monitoring data from the HVAS and randomly generates a daily background 24-hour PM_{10}. This random daily background concentration is randomly added to model predictions for each day of the year.

The process assumes that a randomly selected background value from the real dataset would have a chance equal to that of any other background value from the dataset of occurring on the given future day when the MSP is operational. With sufficient repetition, this would yield a good statistical estimate of the combined and independent effects of varying background and MSP contributions to total 24-hour PM10. The Monte Carlo Simulation is run using the Oracle Crystal Ball software (version 11.1.1.2) which allows sufficient repetition (250,000 times) to generate a probability distribution of cumulative 24-hour PM10 concentrations, in this case the number of days over the 24 hour PM10 impact assessment criterion.

The results from the analysis are shown in **Figure 9-5** for the worst impacted assessment location (i.e. Macro Meats – Gourmet Game). The plots show the cumulative 24-hour PM_{10} concentration compared with the existing background, and demonstrate that there is a very small risk that cumulative 24-hour PM_{10} concentrations would result in any additional days over 50 µg/m³ than would occur anyway due to background in the absence of the MSP.

9.3.4 Cumulative NO_2 – approved operations

There are no monitoring data for NO_2 in Broken Hill. An analysis of ambient NO_2 levels across the entire EPA monitoring network indicates that the recorded maximum 1 hour NO_2 concentration during 2011 was less than 50% of the ambient air quality impact assessment criteria. The 70th percentile of the maximum 1 hour NO_2 concentration during 2011 was approximately 20% of the ambient air quality impact assessment criteria.

Ambient levels of NO_2 in Broken Hill are expected to be significantly less than areas of NSW where the highest impacts occur (i.e. metropolitan areas). Regardless, the addition of an incremental increase in 1-hour NO_2 from the MSP that is less than 30% of the impact assessment criteria (at the closest residence) would not result in cumulative impacts at sensitive receivers. It is noted the 1-hour modelling results are presented based on an assumption of 100% atmospheric transformation of NO_x to NO_2. For 1-hour concentrations at nearby receivers, there would be insufficient time for significant conversion and the percentage of NO_2 would more likely be in the range of 5-10% of NO_x.

Similarly, cumulative annual average impacts from NO_2 would be negligible considering the minor incremental increase in GLCs predicted in **Section 9.2.3**.

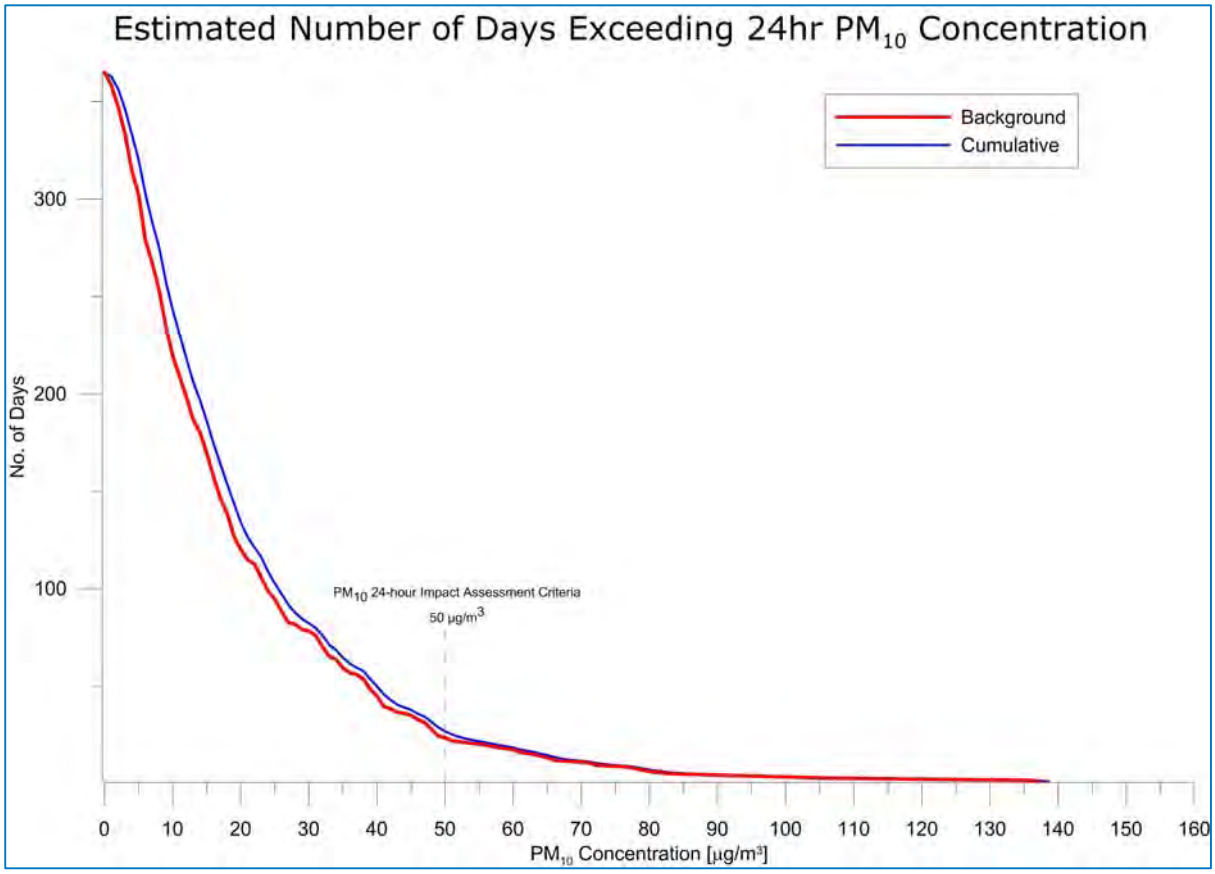

Figure 9-5: Predicted Number of Days Over 24-Hour PM_{10} Concentration at Closest Receiver (Macro Meats – Gourmet Game)

10 CONCLUSION

Pacific Environment has completed this Air Quality Assessment for the proposed Modification.

Emissions estimates have been made for the operations of the MSP and dispersion model predictions have been made to assess against air quality impact assessment criteria.

A total of eight stacks would be required for the MSP at full development, including the four existing stacks associated with the leucoxene and ilmenite circuits. PM_{10} emissions from product handling (hygiene stacks) and product drying and roasting (dryer and kiln stacks) and emissions of NO_x and PM_{10} have been estimated for the combustion of LPG fuel in the dryers and kiln.

Finally, fugitive dust emissions have also been considered for material handling and estimates of emissions for the key dust generating activities have been made.

Dispersion model predictions indicate that dust deposition and GLC of TSP, PM_{10} and NO_x are not predicted to exceed ambient air quality criteria at any of the nearby receivers, either due to the MSP alone or cumulatively. It can be inferred from the modelling results for PM_{10} that GLC of $PM_{2.5}$ would not exceed the advisory reporting standards due to the MSP.

The estimated in-stack concentrations for all stacks comply with the relevant limits in the EPL and POEO Clean Air Regulation.

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Appendix A ESTIMATION OF DUST EMISSIONS

Mineral Separation Plant – Fugitive Emissions

The dust emission inventories have been prepared using the operational description of the proposed MSP. Estimated emissions are presented for all significant dust generating activities associated with raw material, waste and product handling.

The relevant emission factors used for the study are described below. Activities have been modelled for 24-hours per day.

LOADING AND UNLOADING RAW MATERIAL

Each tonne of material loaded/unloaded will generate a quantity of particulate matter with an equivalent aerodynamic diameter of 10 micrometres (µm) or less PM_{10} that will depend on the wind speed and the moisture content. **Equation 1** shows the relationship between these variables.

Equation 1

$$E = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) (kg|t)$$

Where,

k = 0.74 for total suspended particulate matter (TSP), 0.35 for PM_{10} and 0.053 for particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$)

U = wind speed (metres per second [m/s])

M = moisture content (percent [%]) (for 0.25 <= M <=4.8)

kg/t = kilograms per tonne

The mean wind speed has been taken to be 2 m/s and a moisture content of 6%.

DELIVERY OF RAW MATERIAL – HAULING ON UNSEALED SURFACES

The emission estimate of wheel generated dust is based the United States Environment Protection Agency (US EPA) AP42 emission factor for unpaved surfaces at industrial sites shown in **Equation 2**.

Equation 2

$$E = 0.2819 \times \left[k \times \left(\frac{s}{12}\right)^{a} \times \left(\frac{W \times 1.1023}{3}\right)^{b} \right] (kg|VKT)$$

Where:

k = 4.9 for TSP, 1.5 for PM_{10} and 0.15 for $PM_{2.5}$

a = 0.7 for TSP and 0.9 for PM_{10} and $PM_{2.5}$

b = 0.45 for TSP, PM_{10} and $PM_{2.5}$

s = silt content of road surface (%)

W = mean vehicle weight (t)

kg/VKT = kilograms per vehicle kilometres travelled

The adopted silt content (s) was 5%. The mean vehicle weight used in the emissions estimates is based on the approved 35 truck movements per day and the amount of material delivered.

FRONT END LOADER – LOADING TRAINS AND ON STOCKPILES

Emissions from front end loaders (FEL) have been calculated using the US EPA emission factor for dozers given in **Equation 3** (US EPA, 1985 and updates).

Equation 3

$$E = k \times \frac{s^a}{M^b} (kg/hr)$$

Where:

k = 2.6 for TSP, 0.3375 for PM_{10} and 0.273 for $PM_{2.5}$

a = 1.2 for TSP and $PM_{2.5}$ and 1.5 for PM_{10}

b = 1.3 for TSP and $PM_{2.5}$ and 1.4 for PM_{10}

s = silt content (assumed to be 8%)

M = moisture content (assumed to be 6%)

FELs are assumed to operate for 70% of the year

kg/hr = kilograms per hour

WIND EROSION

The default US EPA (1985 and updates) emission factor of 0.1 kilograms per hectare per hour (kg/ha/hr) (TSP) and 0.05 kg/ha/hr (PM_{10}) has been used for wind erosion.

Figure A-1: Location of Modelled Sources for Approved Operations

Table A.1: Approved Operations Fugitive Emissions Inventory

ACTIVITY	PM_{10} emission for Revised Production Scenario (kg/yr)	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Hauling - Access Road	2,282	856,640	t/y	0.0107	kg/t	67	t/load	100	Vehicle gross mass (t)	1.1	km/return trip	0.648898	kg/VKT	5	% silt content	75	% control
Hauling - Internal tip truck	583	328,360	t/y	0.0071	kg/t	64	t/load	100	Vehicle gross mass (t)	0.7	km/return trip	0.648898	kg/VKT	5	% silt content	75	% control
Unloading at Mineral Concentrate Stockpiles	147	1,185,000	t/y	0.0001	kg/t	1.03	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %							0	% control
Loading - Leucoxene Feed	37	300,000	t/y	0.0001	kg/t	1.03	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %							0	% control
Loading - Ilmenite Feed	116	935,000	t/y	0.0001	kg/t	1.03	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %							0	% control
Loading - rutile/zircon feed	28	230,000	t/y	0.0001	kg/t	1.03	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %							0	% control
Loading - Trucks with Rejects	24	192,000	t/y	0.0001	kg/t	1.03	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %							0	% Control
FEL - Loading Trains	3,812	6,132	h/y	0.6216	kg/h	8	silt content in %	6	moisture content in %							0	% control
FEL - at Mineral Concentrate Storage Pile	3,812	6,132	h/y	0.6216	kg/h	8	silt content in %	6	moisture content in %							0	% control
FEL - at Mineral Concentrate Storage Pile	3,812	6,132	h/y	0.6216	kg/h	8	silt content in %	6	moisture content in %							0	% control
Unloading - Coal Storage	181	187,767	t/y	0.0010	kg/t	8.00	average of (wind speed/2.2)^1.3 in m/s	6	moisture content in %							0	% control
Stockpiles - Mineral Concentrate Stockpile 1	45	0.103	ha	0.05	kg/ha/hr	8760	h/y									0	% Control
Stockpiles - Mineral Concentrate Stockpile 2	32	0.074	ha	0.05	kg/ha/hr	8760	h/y									0	% Control
Stockpiles - Mineral Concentrate Stockpile 3	46	0.105	ha	0.05	kg/ha/hr	8760	h/y									0	% Control
Stockpiles - Mineral Concentrate Stockpile 4	33	0.074	ha	0.05	kg/ha/hr	8760	h/y									0	% Control
Stockpiles - Additional Mineral Concentrate Stockpile	613	1.4	ha	0.05	kg/ha/hr	8760	h/y									0	% Control
Stockpiles - Product stockpile	116	0.264	ha	0.05	kg/ha/hr	8760	h/y									0	% Control
Stockpiles - Reject stockpile	14	0.032	ha	0.05	kg/ha/hr	8760	h/y									0	% Control

Notes: kg/yr = kilograms per year
km = kilometre
ha = hectare
t/y = tonnes per year

Appendix B

MSP Noise Assessment

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MURRAY-DARLING BASIN OPERATIONS MODIFICATION

NOISE ASSESSMENT

TG430-01F02 (REV 6) NOISE ASSESSMENT.DOCX

8 NOVEMBER 2013

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30 1982-2012 ACOUSTIC ENGINEERING EXCELLENCE

DOCUMENT CONTROL

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29/10/13	Revise for RS and EPA comments	-	5	WC	MCH	MCH
8/11/13	Final	-	6	WC	MCH	MCH

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1 INTRODUCTION

Renzo Tonin & Associates was engaged by Cristal Mining Australia Limited (Cristal Mining) to conduct an assessment examining the potential noise impacts associated with a proposed modification to Cristal Mining's mineral sand mining and processing operations located in the Murray-Darling Basin in western New South Wales (NSW), which are collectively known as the Murray-Darling Basin Operations (MDBO).

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

1.1 Currently Approved MDBO

The following currently approved operations form Cristal Mining's MDBO (Figure 1.1):

- Broken Hill Mineral Separation Plant (MSP);
- Ginkgo Mine; and
- Snapper Mine.

An overview of the currently approved MDBO is provided below.

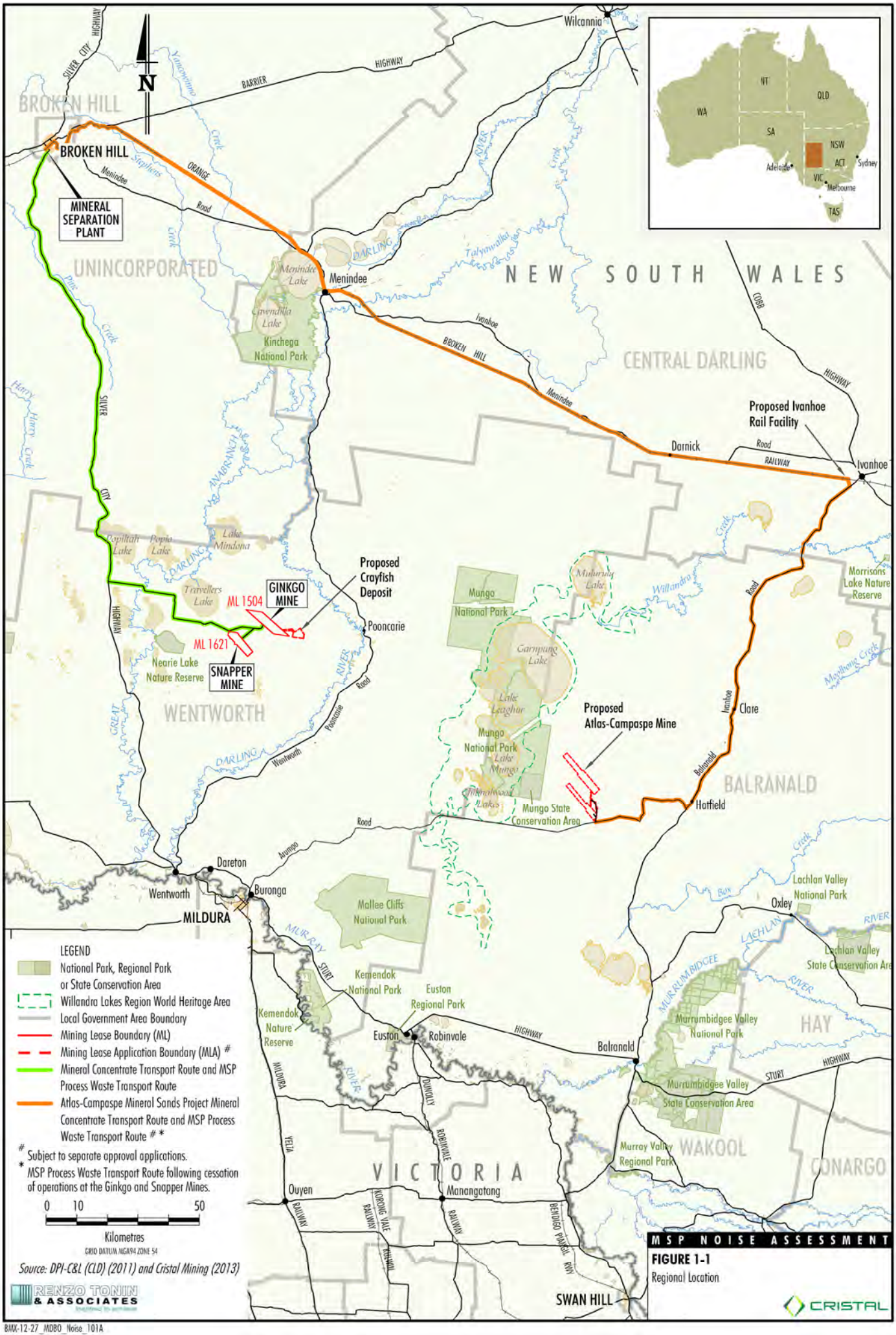
Broken Hill Mineral Separation Plant

The MSP is a mineral concentrate processing plant located on the south-western outskirts of Broken Hill and is currently approved under Development Consent (DA 345-11-01) to:

- have an operational life of approximately 19 years (i.e. to 2025);
- receive up to approximately 735,000 tonnes per annum (tpa) of mineral concentrate/heavy mineral concentrate (HMC) (combined) via road haulage from the Ginkgo and Snapper Mines (Figure 1.1);
- process up to 650,000 tpa of mineral concentrate or HMC (combined) from the Ginkgo and Snapper Mines;
- transport up to 300,000 tpa (combined) MSP process waste to the Ginkgo and Snapper Mines for disposal; and
- rail to market up to 3,200 tonnes of mineral products per train from the MSP to South Australia.

Ginkgo Mine

The Ginkgo Mine is a mineral sands mining operation located approximately 85 kilometres (km) north of Wentworth and approximately 170 km south of Broken Hill in western NSW (Figure 1.1).



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Mineral concentrate from the Ginkgo Mine is currently transported via road haulage to the MSP for processing. MSP process waste is transported back to the Ginkgo Mine for disposal.

Snapper Mine

The Snapper Mine is a mineral sands mining operation located approximately 10 km to the west of the Ginkgo Mine (Figure 1.1).

Mineral concentrate from the Snapper Mine is currently transported via road haulage to the MSP for processing. MSP process waste is transported back to the Ginkgo Mine for disposal.

1.2 Atlas-Campaspe Mineral Sands Project

Cristal Mining has lodged a separate application to develop the Atlas-Campaspe Mineral Sands Project, which consists of a mineral sands mining operation and associated rail load out facility (Figure 1.1).

Mineral concentrate from the Atlas-Campaspe Mineral Sands Project is proposed to be transported via rail to the MSP for processing. Waste associated with the processing of mineral concentrate from the proposed Atlas-Campaspe Mineral Sands Project would be transported to the Ginkgo and Snapper Mines, and following cessation of the Ginkgo and Snapper Mines, would be transported to the Atlas-Campaspe Mineral Sands Project.

Accordingly, the proposed Atlas-Campaspe Mineral Sands Project would be an additional component of the MDBO.

1.3 Overview of the MDBO Modification

The MDBO Modification (the Modification) is required in order to allow for mineral concentrates produced at the proposed Atlas-Campaspe Mineral Sands Project (subject to separate approval) to be processed at the MSP.

The Modification would involve the following key components:

- **MSP Processing Rate Increase -** proposed increase in the currently approved rate of mineral concentrate received and processed at the MSP due to the proposed development of the Atlas-Campaspe Mineral Sands Project.
- **MSP Process Waste Disposal Increase -** proposed increase in the rate of MSP process waste transported and disposed at the Ginkgo and Snapper Mines due to the proposed development of the Atlas-Campaspe Mineral Sands Project.

1.4 Scope of the Noise Assessment

The key potential noise impacts of the Modification are associated with the increased processing, handling and transport of mineral concentrate, product and waste at the MSP. Accordingly, this noise assessment considers the potential noise impacts associated with modified operations at the MSP.

As described in the main text of the Environmental Assessment (EA) prepared for the Modification, no change to the approved mining fleets at the Ginkgo and Snapper Mines is proposed due to the Modification, and as such, no additional noise impacts at receiver locations is expected.

There would be no change to the approved number of rail movements from the MSP and no change in the number of locomotives per train. As such, the Modification would not change the currently approved noise emissions associated with the transport of mineral product by rail.

2 MODIFICATION DESCRIPTION

2.1 General Description

The main activities associated with the Modification potentially relevant to noise impacts include:

- increased mineral concentrate receival at the MSP via rail from the proposed Atlas-Campaspe Mineral Sands Project;
- increased processing rate at the MSP;
- increased MSP project life (to match the proposed life of the Atlas-Campaspe Mineral Sands Project);
- increased transport of MSP product via rail (using trains with increased length to accommodate the increase in the rate of MSP product);
- increased transport of MSP waste via haulage truck to the Ginkgo and Snapper Mines; and
- increased MSP mobile fleet to accommodate the increased handling, processing and transport of mineral concentrate, MSP product and MSP waste.

A detailed description of the MDBO is provided in Section 2 in the Main Report of the EA.

2.2 MSP Operations

The MSP General Arrangement is presented in Figure 2.1.

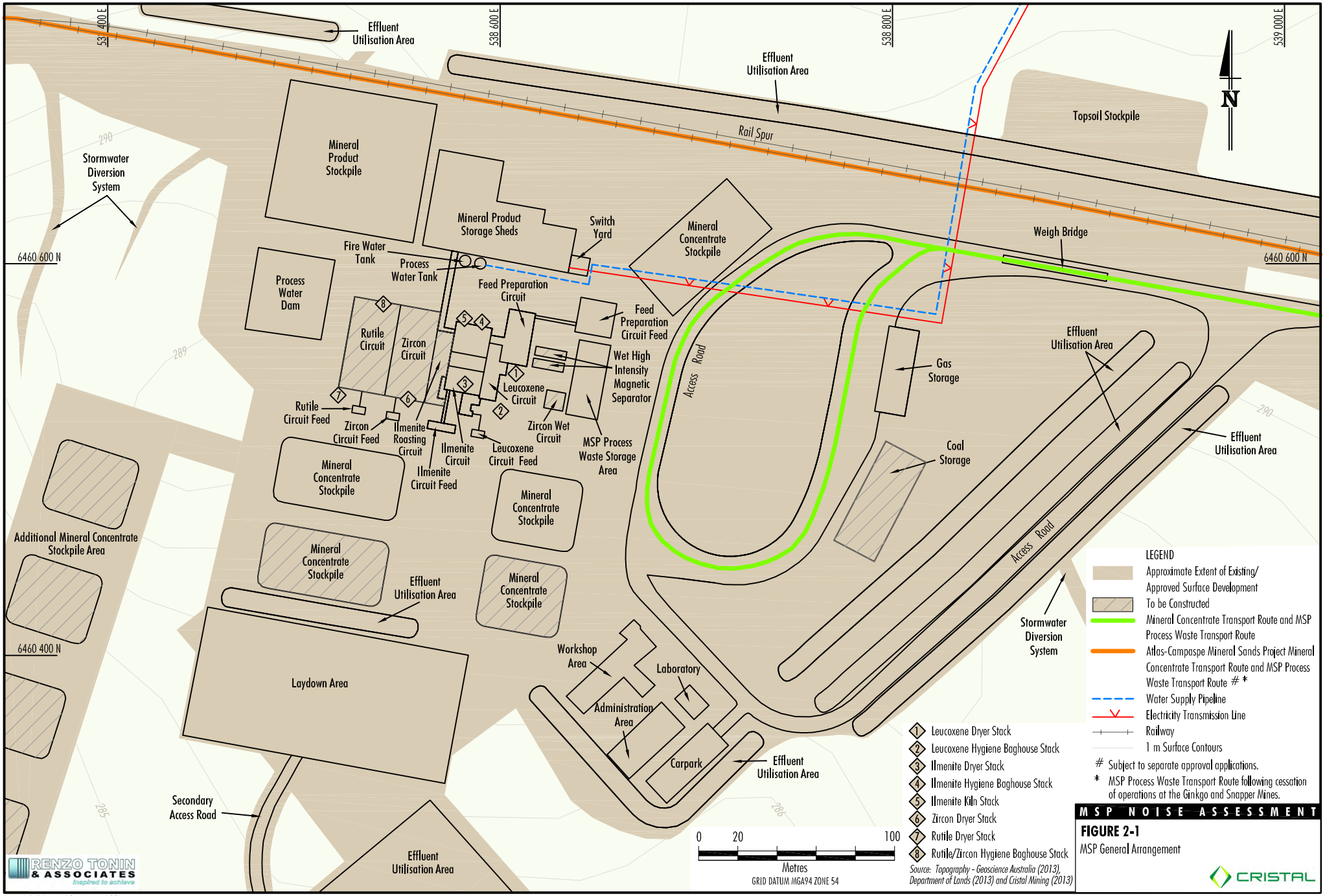
The MSP operations would continue to operate 24 hours per day, seven days per week for the Modification.

The Modification proposes to increase the mineral concentrate processing rate at the MSP from approximately 650,000 tpa to approximately 1,200,000 tpa to accommodate the development of the Atlas-Campaspe Mineral Sands Project. In addition, the operational life of the MSP would increase from approximately 19 years (i.e. 2025) to approximately 26 years (i.e. 2032) to match the proposed life of the Atlas-Campaspe Mineral Sands Project.

Mineral concentrate would continue to be stockpiled and fed by front end loader to the mineral separation circuits for processing.

The following processing circuits are approved for the MSP:

- feed preparation circuit;
- leucoxene circuit;
- ilmenite circuit;
- ilmenite roasting circuit;
- zircon circuit;
- zircon wet circuit; and
- rutile circuit.



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Following processing, mineral product would continue to be stored in storage sheds located to the north of the MSP site and handled by front end loaders.

2.3 Mineral Concentrate Transport

There would be no change to the transportation of mineral concentrate from the Ginkgo and Snapper Mines via the approved mineral concentrate transport route to the MSP.

As a component of the Modification, additional mineral concentrates from the Atlas-Campaspe Mineral Sands Project would be transported via rail on the Orange-Broken Hill Railway to the existing rail spur at the MSP. The rail containers used to transport the Atlas-Campaspe Mineral Sands Project mineral concentrates would be unloaded and the mineral concentrate transported to the mineral concentrate stockpiles and tipped directly onto the mineral concentrate stockpiles.

Up to three trains per week would be required to transport the maximum of approximately 450,000 tpa of mineral concentrates from the Atlas-Campaspe Mineral Sands Project to the MSP.

2.4 Mineral Product Transport

Mineral product generated from processing mineral concentrates at the MSP would continue to be transported via rail on the Peterborough-Broken Hill Railway to South Australia.

To accommodate the proposed increase in the annual rate of product material from 3,200 tpa to 6,400 tpa, and maintain the currently approved number of train movements, the length of the mineral product trains would increase in length from approximately 50 wagons to 100 wagons. However, no additional locomotives would be required for these mineral product trains of increased length for the Modification.

As there would be no change to the approved number of rail movements from the MSP and no change in the number of locomotives per train, the Modification would not change the currently approved noise emissions associated with the transport of mineral product by rail.

2.5 MSP Process Waste

Additional MSP process waste would be generated from the processing of Atlas-Campaspe Mineral Sands Project mineral concentrates.

This additional MSP process waste would be combined with the existing/approved MSP process wastes produced at the MSP and would be transported to the Ginkgo and Snapper Mines in accordance with existing/approved operations until cessation of these operations. No increase in total haulage truck movements would be required for the Modification, as the MSP process waste would be backloaded into the empty haulage trucks transporting mineral concentrate from the Ginkgo and Snapper Mines to the MSP.

Once operations at the Ginkgo and Snapper Mines have ceased, the MSP process waste would be loaded into containers at the MSP for transport via the Atlas-Campaspe Minerals Sands Project mineral concentrate and MSP process waste transport route to the Atlas-Campaspe Mine (Figure 1.1). Potential noise impacts associated with the transport of MSP process waste to the Atlas-Campaspe Mine were described and assessed in the Environmental Impact Statement prepared for the Atlas-Campaspe Minerals Sands Project.

3 ACOUSTIC ENVIRONMENT

3.1 Background Noise

Background noise varies over the course of any 24 hour period, typically from a minimum at 3.00 am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW *Industrial Noise Policy* (INP) (Environment Protection Authority [EPA] 2000) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The INP defines these periods as follows:

- **Day** is defined as 7.00 am to 6.00 pm, Monday to Saturday and 8.00 am to 6.00 pm Sundays & Public Holidays.
- **Evening** is defined as 6.00 pm to 10.00 pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10.00 pm to 7.00 am, Monday to Saturday and 10.00 pm to 8.00 am Sundays & Public Holidays.

Noise impacts at the receiver locations are assessed against noise goals established from the existing noise environment of the area without the subject premise in operation.

Rating background levels (RBLs) for the day, evening and night were established for the original noise assessment prepared by Pacific Air & Environment (PAE) (reference: Job 1416) for the MSP Environmental Impact Statement (EIS) in November 2001. The day, evening and night RBLs (i.e. the background noise levels prior to the commencement of operations at the MSP) were determined to be 30 A-weighted decibels (dB[A]).

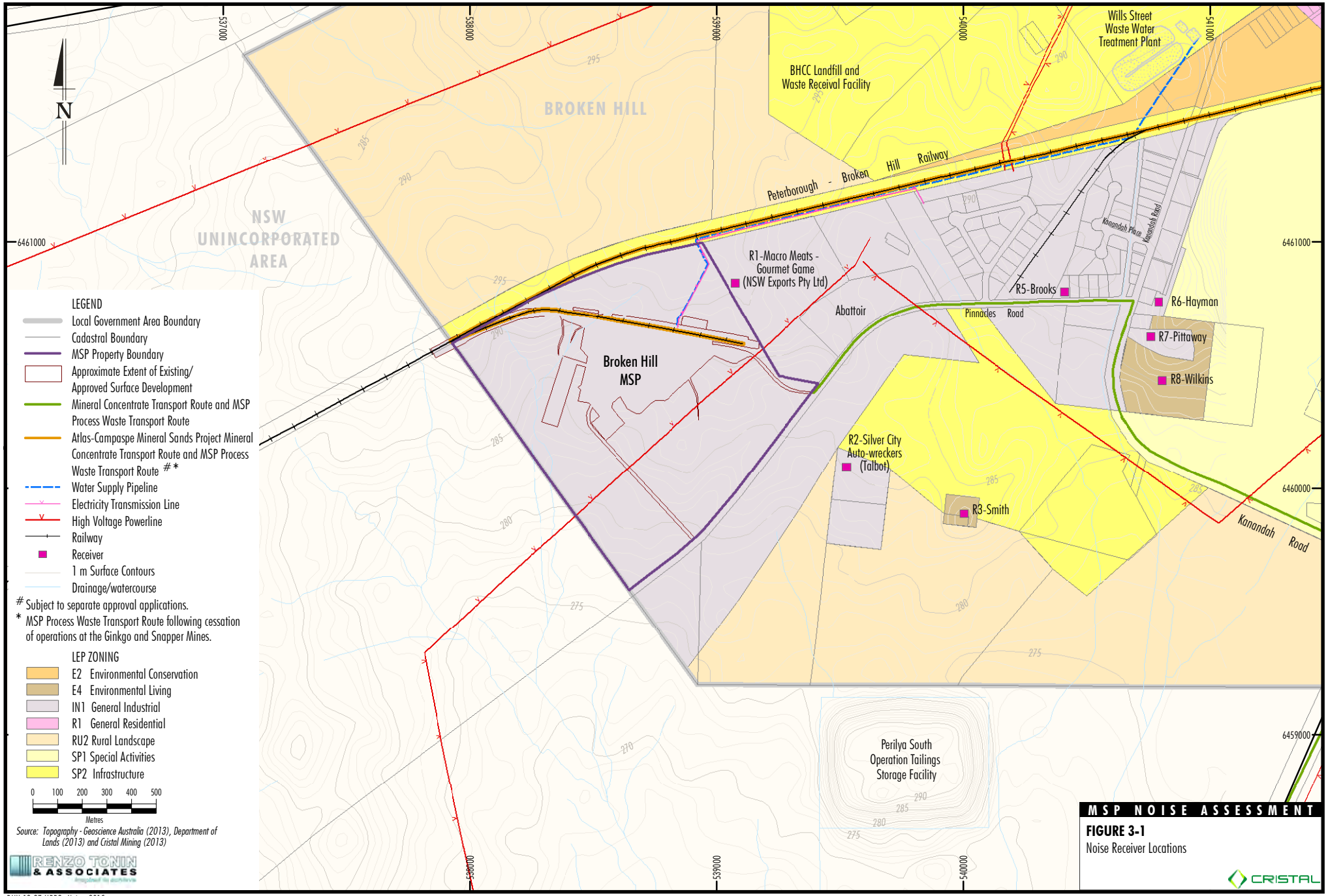
Given that the approved MSP is currently operational (and would contribute to the noise environment of the area) it is appropriate to adopt the RBLs determined by PAE in 2001 as being representative of the noise environment of the area without the MSP in operation.

As such, for this assessment 30 dB(A) was adopted as the background noise level for relevant receiver locations surrounding the MSP.

3.2 Potentially Affected Receiver Locations

The nearest affected residential and industrial locations are identified as (Figure 3.1):

- **Location R1 – Macro Meats – Gourmet Game (NSW Exports Pty Ltd) (Caretaker residence)**
  Located 50 metres (m) east from the MSP boundary at closest point. This property located within Broken Hill City Council's industrial zone (IN1). The abattoir is not currently operational.



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- **Location R2 – Silver City Auto-Wreckers (Talbot)**

  Located 250 m south-east from the MSP boundary at the closest point. This property is located within Broken Hill City Council's industrial zone (IN1). This property is currently an automobile wrecking yard with isolated residence.

- **Location R3 – Smith**

  Located 700 m south from the MSP boundary at the closest point. This property is located within Broken Hill City Council's environmental living zone (E4). This property is classified as a residential receiver.

- **Location R5 – Brooks**

  Located 1,200 m east from the MSP boundary at the closest point. This property is located within Broken Hill City Council's industrial zone (IN1). This property is currently a vacant isolated residence within the Kanandah industrial area.

- **Location R6 – Hayman**

  Located 1,500 m east from the MSP boundary at the closest point. This property is located within Broken Hill City Council's industrial zone (IN1). This property is a caretaker's residence on Kanandah Road at Pinnacles Road intersection.

- **Location R7 – Pittaway**

  Located 1,500 m east from the MSP boundary at the closest point. This property is located within Broken Hill City Council's industrial zone (IN1). This property is an isolated residence on Kanandah Road south of Pinnacles Road intersection.

- **Location R8 – Wilkins**

  Located 1,500 m east from the MSP boundary at the closest point. This property is located within Broken Hill City Council's environmental living zone (E4). This property is an isolated residence on Kanandah Road south of Pinnacles Road intersection and south of Location R7 Pittaway.

4 METEOROLOGY

Certain meteorological conditions may increase noise levels by focusing sound-wave propagation paths at a single point. Such refraction of sound waves will occur during temperature inversions (atmospheric conditions where temperatures increase with height above ground level) and where there is a wind gradient (that is, wind velocities increasing with height) with wind direction from the source to the receiver.

Temperature inversions occurring within the lowest 50 to 100 m of atmosphere can affect noise levels measured on the ground. Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to the cooling of the air in contact with the ground. This is especially prevalent on cloudless nights with little wind. Air that is somewhat removed from contact with the ground will not cool as much, resulting in warmer air aloft than nearer the ground.

Similarly, when significant wind exists, the conditions can significantly affect noise levels at receptor points downwind of a noise source. This would depend however, on the particular direction and the velocity of the wind at that time. It should also be noted that although wind can raise noise emission levels as perceived from a downstream assessment point, background noise also tends to increase as a result of increased wind activity. This often causes masking of potential increases in intrusive noise.

The NSW EPA's INP recommends that project noise criteria are to apply under weather conditions characteristic of an area. These conditions may include calm, wind and temperature inversions. In this regard, the increase in noise that results from atmospheric temperature inversions and wind effects may need to be assessed. The noise levels predicted under characteristic meteorological conditions for each receiver are then compared with the criteria, to establish whether the meteorological effect will cause a significant impact.

The NSW EPA's INP permits two approaches for assessing these effects: use of default parameters and use of site-specific parameters.

- With using default parameters, general meteorological values are used to predict noise levels, foregoing detailed analyses of site-specific meteorological data. This approach assumes that meteorological effects are conservative, in that it is likely to predict the upper range of increases in noise levels. Actual noise levels may be less than predicted.

- The use of site-specific parameters is a more detailed approach, which involves analysing site meteorological data to determine whether inversion and/or wind effects are significant features warranting assessment. Where assessment is warranted, default parameters are available for use in predicting noise or, where preferred, measured values may be used instead. The use of site-specific parameters provides a more accurate prediction of noise increases due to meteorological factors, however, is more costly especially if suitable site data is unavailable and long-term meteorological monitoring is required. Existing weather data may be used, provided the site is within a radius of 30 km of the collection point and in the same topographical basin.

For this assessment, the more detailed approach using site-specific parameters were conducted. Weather data was obtained from the Bureau of Meteorology at the nearest weather station (Broken Hill Airport AWS 47048, located approx. 5.2 km east of the MSP) over a one year period between 1st January 2011 and 31st December 2011.

4.1 Temperature Inversions

Appendix C of the INP describes the following procedure for assessing the increase in noise caused by temperature inversions:

1. Do an initial screening test to determine whether there is the potential for significant increases to noise levels due to inversions to warrant further assessment. That is, will the development operate during the night-time assessment period of 10.00 pm to 7.00 am, and if so, will the noise increase significantly (by more than 3 decibels as per Table D1 in Appendix D of INP)?

2. Determine extent of impact in terms of percent occurrence of inversions where there is the potential for inversions to increase noise levels for the locality being assessed. Where inversions are predicted for more than 30 percent (%) of the total night-time (or approx. 2 nights per week) during winter (June, July and August), these are considered to be significant and should be accounted for in the noise assessment.

3. Predict noise levels using default or site-specific parameters to determine the increase in noise levels expected due to inversions. The default parameters are:

    - non-arid areas (mean rainfall $\geq$ 500 millimetres per annum [mm pa]); 3 degrees Celsius (^{o}C)/100 m temperature inversion strength and 2 metres per second (m/s) at 10 m height drainage-flow wind from source to receiver where applicable.

    - arid and semi-arid areas (mean rainfall < 500 mm pa); 8^{o}C/100 m temperature inversion strength and 1 m/s at 10 m height drainage-flow wind from source to receiver where applicable.

4. Assess impact to determine whether the increased noise levels due to inversions will affect receivers in the vicinity of the development. The predicted increased noise levels are compared with the project's noise criteria to determine if any exceedances or noise impacts are expected.

Assessment of impacts from temperature inversions is confined to the night-time period of 10.00 pm to 7.00 am, as this is the time likely to have the greatest impact. As the MSP operates at night-time, there is potential for noise impact due to inversions, and further consideration of these effects is required.

Following the procedure above, the likelihood of temperature inversion occurrence was determined based on Pasquill-Gifford stability classes for the night-time periods in the weather data. A summary of the likelihood of temperature inversions for night-time are presented in Table 4.1 below:

Table 4.1 – Seasonal Night-time Temperature Inversion (TI) Likelihood, %

Season	Pasquill-Gifford Stability Class							TI Likelihood (F+G)
	A	B	C	D	E	F	G	
Summer	0.0	1.0	2.7	35.3	36.2	16.9	7.9	24.8
Autumn	0.0	0.0	1.1	31.4	36.6	22.0	8.9	30.9
Winter	0.0	0.0	0.0	21.4	36.0	28.0	14.6	42.6
Spring	0.0	0.0	0.1	23.9	33.8	26.9	15.2	42.1

The results above indicate that the combination of F and G class temperature inversions are above the 30% occurrence threshold nominated in the INP for the night-time period, and therefore, temperature inversions will need to be considered in the assessment for the night-time period. In accordance with Section 5.2 of the INP, temperature inversions are only assessable during the night-time period.

As the MSP is located within an arid/semi-arid area, as defined in the INP, 8°C/100 m strength G class temperature inversions are assessable. No drainage flow has been assessed, as drainage flow is not considered to be a feature relevant to any receiver.

4.2 Wind Effects

Gradient wind differs from the drainage-flow wind associated with temperature inversions. Drainage-flow wind is the localised drainage of cold air under the influence of the local topography, and travels in one direction only (direction of decreasing altitude). Gradient wind is the regional wind determined by synoptic factors (high and low-pressure systems), and may originate from any direction.

Unlike temperature inversions, gradient winds may cause impacts during any assessment period, (day, evening, night), and not just the night period.

The INP specifies a procedure for assessing the significance of wind effects, and a default wind speed to be used in the assessment where these effects are found to be significant. The procedure requires that wind effects be assessed where wind is a feature of the area. Wind is considered to be a feature where source-to-receiver wind speeds (at 10 m height) of 0.5 to 3 m/s occur for 30% of the time or more in any assessment period (day, evening, night) in any season. Winds with velocities less than 0.5 m/s (calm conditions) and greater than 3 m/s (at 10 m height), are not included in the calculations of wind occurrence.

Therefore, there are two ways to assess wind effects:

- Use available wind data or wind roses to determine the frequency of occurrence and wind speed, taking into account the various components of wind that are relevant.
- Simply assume that wind is a feature of the area (foregoing the need to use wind data or wind roses) and apply a 'maximum impact' scenario by using the default 3 m/s wind at 10 m height.

Where there is 30% or more occurrence of wind speeds between 0.5 m/s and 3 m/s (source-to-receiver component), then the highest wind speed is used (below 3 m/s) instead of the default. Where there is less than a 30% occurrence of wind between 0.5 m/s and 3 m/s (source-to-receiver component), wind is not included in the noise-prediction calculations.

Analysis of the wind data was undertaken using the EPA's Noise Enhancement Wind Analysis (NEWA) program to determine if wind is a 'feature' of the area as defined by the INP. The program determines whether there are prevailing source-to-receiver wind conditions. The results of the analysis are presented in Table 4.2 below:

Table 4.2 – Percentage of Wind Records (up to 3 m/s) from MSP to Receiver, %

Location	Summer			Autumn			Winter			Spring		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
R1	3.2	1.7	6.9	4.2	6.8	9.5	4.8	10.6	16.8	2.2	7.4	13.3
R2	2.5	2.2	0.9	2.4	4.9	5.9	4.5	9.2	11.4	2	5.2	5.1
R3	2.6	1.9	0.9	2.3	4.9	6.3	4.7	9	11.6	1.8	5.2	5
R5	3.3	2.2	4.4	3.5	4.6	8.3	4.4	10.3	14.3	2.6	5.5	8.4
R6	2.8	1.9	4.4	3.3	4.6	8.2	4.5	10.3	14.4	2.7	4.9	7.5
R7	2.9	1.9	3.5	3.5	4.9	7.8	4.8	10.9	13.6	2.5	5.8	6.8
R8	2.7	1.7	2.5	3.5	4.6	7.5	4.5	10.6	13.3	2.1	5.5	5.7

The results above indicate that there is less than a 30% occurrence of winds between 0.5 m/s and 3 m/s (source-to-receiver component) for all receivers. Therefore, there are no prevailing wind conditions for any receiver, and in accordance with the INP, wind effects are not assessed further in this assessment.

5 CRITERIA

5.1 Operational Noise

Operational noise from the MSP is assessed in accordance with the INP. The INP is used as a guide by the EPA for setting statutory limits in licences for scheduled noise sources.

The INP has two components:

- Controlling intrusive noise impacts in the short term for residences.
- Maintaining noise level amenity for particular land uses for residences and other land uses.

5.1.1 Intrusive Noise Impacts

According to the INP, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor) does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). The intrusiveness criterion is summarised as follows:

- $L_{Aeq,15minute} \leq$ RBL plus 5 dB(A)

5.1.2 Protecting Noise Amenity

The Amenity Criteria are determined in accordance with Chapter 2 of the INP. The INP recommends base acceptable noise levels for various receivers, including residential, commercial, industrial receivers and sensitive receivers such as schools, hospitals, churches and parks.

To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the policy, the applicable parts of which are reproduced in Table 5.1 below.

Table 5.1 – Applicable Amenity Criteria

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended $L_{Aeq(Period)}$ Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
Industrial premises	All	When in use	70	75

Note: Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.

On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

5.1.3 Industrial Receiver Locations

Receiver R1 (Macro Meats – Gourmet Game (NSW Exports Pty Ltd), R2 (Silver City Auto-wreckers [Talbot]), R5 (Brooks), R6 (Hayman) and R7 (Pittaway) are located within the Broken Hill City Council's industrial zone *IN1 General Industrial* (Figure 3.1), as defined in the *Broken Hill Local Environment Plan 2013*. It is noted that an objective of the *Broken Hill Local Environment Plan 2013* is to support and protect industrial land for industrial uses.

In regard to receivers located within an industrial zone, the INP states:

> *"Industrial - an area defined as an industrial zone on an LEP. For isolated residences within an industrial zone the industrial amenity criteria would usually apply."*

Furthermore, in regard to receivers located within an industrial zone, the INP Application Notes state:

> *"The INP does not require that intrusive noise be assessed at industrial or commercial premises. For industrial/commercial receivers, only the amenity criteria apply. Amenity noise levels should be assessed at the most affected point on or within the property boundary. This approach also applies to other non-residential receivers, such as educational facilities, hospitals and places of worship."*

Accordingly, the relevant noise criteria for receivers located within the zone *IN1 General Industrial* is the amenity criteria for industrial premises, as shown in Table 5.1.

5.1.4 Residential Receivers

Receivers R3 (Smith) and R8 (Wilkins) are located within the zone *E4 Environmental Living* (Figure 3.1), as defined in the *Broken Hill Local Environment Plan 2013*. Home occupations are permitted in the zone *E4 Environmental Living*, and accordingly, R3 and R8 have been considered as residential receivers.

5.1.5 Project Noise Goals

The applicable industrial noise criteria for receivers surrounding the MSP are provided in Table 5.2 below.

Table 5.2 – Applicable Industrial Noise Criteria for the MSP

Receiver Location	Receiver Type	Intrusiveness Criteria, $L_{Aeq,15min}$, dB(A)			Amenity Criteria, $L_{Aeq,period}$, dB(A)		
		Day	Evening	Night	Day	Evening	Night
R1 – Macro Meats – Gourmet Game (NSW Exports Pty Ltd)	Industrial	N/A	N/A	N/A	70 (When in use)		
R2 – Silver City Auto-wreckers (Talbot)	Industrial	N/A	N/A	N/A	70 (When in use)		
R3 – Smith	Residential	35	35	35	50	45	40
R5 – Brooks	Industrial	N/A	N/A	N/A	70 (When in use)		
R6 – Hayman	Industrial	N/A	N/A	N/A	70 (When in use)		
R7 – Pittaway	Industrial	N/A	N/A	N/A	70 (When in use)		
R8 – Wilkins	Residential	35	35	35	50	45	40

Notes:
1. *Receiver locations have been categorised as 'Rural" for Location R3.*
2. *Intrusiveness criteria only applicable for residential receiver locations.*
3. *Amenity criterion applicable to industrial type premises.*
4. *Receiver locations R1, R2, R5, R6, and R7 are located within the Broken Hill LEP IN1 General Industrial Zone.*

5.1.6 Sleep Disturbance

Guidance for assessing sleep disturbance resulting from short-duration high-level noises which occur between 10:00 pm and 7:00 am can be taken from the EPA's "Noise Guide for Local Government" (NGLG):

> *"Currently, there is no definitive guideline to indicate a noise level that causes sleep disturbance and more research is needed to better define this relationship. Where likely disturbance to sleep is being assessed, a screening test can be applied that indicates the potential for this to occur. For example, this could be where the subject noise exceeds the background noise level by more than 15 dB(A). The most appropriate descriptors for a source relating to sleep disturbance would be LA1 (1 minute) (the level exceeded for 1% of the specified time period of 1 minute) or LAmax (the maximum level during the specified time period) with measurement outside the bedroom window."*

The EPA's noise policy (as described in the INP Application Notes) with respect to sleep disturbance states:

> *"Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*

Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, the EPA recognised that current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:

- *how often high noise events will occur*
- *time of day (normally between 10pm and 7am)*
- *whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*

The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. The EPA will accept analysis based on either LA1, (1 minute) or LA, (Max).”

The policy states that a sleep disturbance criterion of $L_{A1,1minute} \leq L_{A90,15minute} + 15$ dB(A), should be used as a first step ‘guide’ as it is ‘not ideal’ and ‘where it is not met, a more detailed analysis is required’. That detailed analysis includes a reference to the research material contained in the NSW Road Noise Policy in the assessment of the subject proposal.

The NSW Road Noise Policy contains a summary of the findings of world-wide research undertaken on sleep disturbance from noise up until the time when this publication was produced. It summarises all of the research with the following statement:

“From the research on sleep disturbance to date it can be concluded that:

- *maximum internal noise levels below 50-55dB(A) are unlikely to awaken people from sleep*
- *one or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and wellbeing significantly.”*

Therefore, from the above research a 50-55 dB(A) maximum internal noise level would be equivalent to approximately 65-70 dB(A) maximum noise level outside a bedroom window. These external noise limits are in line with the noise limits described by Griefahn [Acoustics Australia vol 20 No 2 August 1992 pp 43-47] and the NSW Road Noise Policy which address sleep disturbance.

In summary, the sleep arousal criteria described in policies described above are used for the purpose of noise impact assessment for this study, however due consideration is also given to the NSW Road Noise Policy research findings in setting an appropriate 'upper' limit.

The sleep arousal criteria described in the NSW policies and research referred to above is used for the purpose of noise impact assessment for this study and is summarised in Table 5.3 below.

Table 5.3 – Sleep Arousal Criteria

Receiver Location	Night-time L_{A90}	$L_{A1,1minute}$ Sleep Disturbance Criteria (Outdoors)	
		Night RBL + 15 dB(A)	Upper Limit
R3 – Smith	30 dB(A)	45	$L_{A1} \leq$ 65 dB(A
R8 – Wilkins	30 dB(A)	45	$L_{A1} \leq$ 65 dB(A

6 EXISTING MONITORING AND MANAGEMENT

6.1 Development Consent and Environment Protection Licence Noise Limits

Operations at the MSP are currently required to comply with the noise limits in Development Consent (DA 345-11-01) and Environment Protection Licence (EPL) 12314.

Condition 3.6(a), Schedule 2 of Development Consent (DA 345-11-01) and Condition L5.1 of EPL 12314 both specify that noise from the MSP premises must not exceed 35 dB(A) $L_{Aeq(15minute)}$ during the day, evening or night at relevant receiver locations.

6.2 Noise Management and Monitoring

Noise Management and Monitoring at the MSP is conducted in accordance with the existing MSP Noise Management Plan (NMP).

As described in the NMP, a combination of attended and unattended monitoring is conducted to determine compliance with the noise limits specified in the Development Consent (DA 345-11-01) and EPL 12314.

6.3 Complaints

No noise related complaints have been received since operations at the MSP commenced in 2005.

7 NOISE SOURCES

7.1 Noise Modelling Scenarios

Two operational scenarios have been developed for the purpose of noise modelling, which are representative of the operations during the daytime/evening period and night-time period, respectively.

The main difference between the daytime/evening scenario and night-time scenario is:

- The loading of production material to trains using front end loaders would occur during the daytime/evening period (consistent with current operations).
- The unloading of trains transporting mineral concentrate from the proposed Atlas-Campaspe Mineral Sands Project would occur during the night-time.

7.1.1 Daytime/evening Scenario

The daytime/evening scenario includes the following key operational activities:

- Unloading haulage trucks transporting mineral concentrate from the Ginkgo and Snapper Mines at the MSP.
- Loading mineral concentrate from stockpiles to the MSP using a front end loader.
- Processing of mineral concentrate in the processing circuits in the MSP. Note that this includes the zircon, rutile and ilmenite kiln/roaster circuits, which are currently approved but not constructed.
- Loading product material to trains using two front end loaders.
- Removing container lids of the rail wagons transporting product material using an integrated tool carrier.

7.1.2 Night-time Scenario

The night-time scenario includes the following key operational activities:

- Unloading haulage trucks transporting mineral concentrate from the Ginkgo and Snapper Mines at the MSP.
- Loading mineral concentrate from stockpiles to the MSP using a front end loader.
- Processing of mineral concentrate in the processing circuits in the MSP, including the zircon, rutile and ilmenite kiln/roaster circuits, which are currently approved but not constructed.
- Unloading containers transporting mineral concentrate from the proposed Atlas-Campaspe Mineral Sands Project from trains using a reach stacker, and placing the containers on a tip truck.

- Transporting the containers via tip truck for unloading at the mineral concentrate stockpile area.

7.2 Mobile and Fixed Equipment Sound Power Levels

Attended noise monitoring was undertaken by Renzo Tonin & Associates on Wednesday 25 September 2013, for key existing mobile and fixed equipment currently operational at the MSP, including:

- existing processing circuits and associated auxiliary equipment (e.g. fans, pumps and screen);
- front end loaders (during loading operations);
- road trains; and
- integrated tool carrier (removing product train container lids).

The equipment used for the noise measurements was a Brüel & Kjær Type 2250 precision sound level analyser which is a Class 1 instrument having an accuracy suitable for field and laboratory use. The instrument was calibrated prior and subsequent to measurements using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

All instrumentation complies with AS IEC 61672.1 2004 “Electroacoustics - Sound Level Meters” and carries current NATA certification (or if less than 2 years old, manufacturers certification).

Measurements were conducted at close proximity to each item of plant and the sound power level (SWL) was determined based on distance correction to the measured noise levels. Where relevant, the results of the SWL monitoring have been incorporated in the noise modelling conducted for the Modification.

For other equipment, SWLs have been determined based on manufacturer’s specifications, or other available information including Renzo Tonin & Associates database of noise levels and previous studies.

Modifying factor adjustments, as per Section 4 of the INP, has been considered for all plant and equipment at the MSP site. Noise from all sources, individually and in combination were determined not to exhibit tonal, low-frequency, impulsive, and/or intermittent characteristics. Therefore no modifying factors corrections are required.

A summary of mobile and fixed equipment included in the noise modelling for the Modification, and relevant SWLs, is provided in Table 7.1. A summary of $L_{A,1minute}$ plant noise levels used for the sleep disturbance assessment are provided in Table 7.2.

Table 7.1 – Plant Sound Power Levels, dB(A)

Plant	Sound Power Level (per Item)	Modelling Scenario[5]	
		Daytime/Evening	Night-time
Processing Plant			
Top Floor Vent Openings x 4	77[1]	✓	✓
Screen	89[2]	✓	✓
Pump	93[2]	✓	✓
Fan 1	92[2]	✓	✓
Fan 2	87[2]	✓	✓
Fan 3	87[2]	✓	✓
Fan 4	86[2]	✓	✓
Fan 5	88[2]	✓	✓
Wet Plant Opening	79[1]	✓	✓
New fans x 3 (enclosed)	85[3]	✓	✓
Conveyor 1	83 per metre[4]	✓	✓
Conveyor 2	83 per metre[4]	✓	✓
Conveyor 3	83 per metre[4]	✓	✓
Conveyor 4	83 per metre[4]	✓	✓
Mobile Plant			
Road train	105[1]	✓	✓
FEL	107[1]/104[2]	✓ (3)	✓ (1)
Light Vehicle	88[2]	✓ (4)	✓ (2)
Integrated Tool Carrier	105[1]	✓	-
Reach Stacker	106[3]	-	✓
Tip Truck	105[4]	-	✓ (2)

Notes: 1. *From attended noise monitoring at MSP on 25/09/13.*
2. *From attended noise monitoring at the MSP on 25/09/13 as adjusted for additional attenuation.*
3. *From Renzo Tonin & Associates noise database.*
4. *From EIS study.*
5. *Numbers in brackets denote number of items.*

Table 7.2 – Plant $L_{A1,1minute}$ Levels, dB(A)

Plant	$L_{A1,\ 1min}$
Road Train	112
FEL	112
Light Vehicle	91
Reach Stacker	111
Tip Truck	113
Shunting	114

7.3 Reasonable and Feasible Mitigation Measures

Cristal Mining currently implements the following noise mitigation measures at the MSP:

- The processing circuits are enclosed within a building.
- External conveyors and conveyor drives are enclosed.
- Scheduling of operations to avoid potential maximum noise generating activities occurring during the night (i.e. loading of product trains, which requires two front end loaders and an integrated tool carrier does not occur during the night-time period)
- Road trains transporting mineral concentrate do not idle when not in use.
- Use of infrastructure to shield/screen noise from mobile plant (i.e. front end loaders shielded by mineral concentrate stockpiles and buildings).
- All equipment is regularly maintained and serviced.

In addition to the above, the following noise mitigation measures would be implemented:

- The front end loader operating during the night-time (i.e. for loading mineral concentrates from stockpiles to the MSP) would be retrofitted with a noise suppression kit (e.g. engine compartment lining and/or exhaust silencer) once the MSP receives trains from the Atlas-Campaspe Mineral Sands Project.
- Cladding/enclosures would be installed around existing external auxiliary equipment to the processing circuits that were identified during the on-site SWL monitoring to be noise generating (i.e. five external fans, one external pump and one external screening table).
- If the approved zircon, rutile and ilmenite kiln/roaster processing circuits are constructed at the MSP, these circuits would be fully enclosed within a building, and external auxiliary equipment (e.g. conveyors and fans) would also be enclosed.

Cristal Mining considers the noise mitigation measures described above to be reasonable and feasible for the Modification. As such, these noise mitigation measures have been included in the operational noise modelling conducted for the Modification.

Cristal also considered the implementation of additional mitigation measures, however, these additional mitigation measures were not considered to be reasonable/feasible, as described below:

- Construction of bunds and/or acoustic barriers: The effect of bunds/acoustic barriers would be limited due to the effect of the most adverse noise-enhancing weather conditions (i.e. F and G class temperature inversions) on noise propagation. Given the limited benefit, Cristal does not consider the construction costs associated with bunds and/or acoustic barriers to be reasonable for the MSP. Notwithstanding, Cristal currently uses existing infrastructure (e.g. stockpiles and buildings) to shield noise from mobile plant operating at the MSP, and in addition the processing plant and associated conveyors are currently enclosed.

- Scheduling the unloading of trains from the Atlas-Campaspe Mineral Sands Project for the daytime/evening only: This activity has been scheduled for the night-time as it generates less noise than the loading of mineral product trains (scheduled for the daytime/evening). Due to the constraint of the single rail spur at the MSP it is not feasible for both the unloading of trains from the Atlas-Campaspe Mineral Sands Project and the loading of mineral product trains to occur during the daytime/evening only.

8 PREDICTED LEVELS

Noise emissions were predicted by modelling the noise sources, receiver locations, topographical features of the intervening area, and possible noise control treatments using SoundPLAN (version 7.2) noise prediction computer program. SoundPLAN is an internationally recognised environmental noise prediction computer program that can be used to model transportation noise, construction noise and general industry noise. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

The noise prediction models takes into account:

- location of noise sources and receiver locations;
- height of sources and receivers;
- separation distances between sources and receivers;
- ground type between sources and receivers;
- attenuation from barriers (natural and purpose built); and
- meteorological effects.

8.1 Intrusive Noise

Based on the scenarios and sound power levels presented in Section 7, the worst case 15 minute period was modelled for the day, evening and night period. For each scenario all processing plant and mobile plant items were assumed to be operating continuously and concurrently, except the road trains and tip trucks. The SWLs (Table 7.1) of the road trains and tip trucks have been time-corrected in the noise model as follows:

- The road trains would enter the MSP and park in the loading/unloading area and exit the MSP after being unloaded. Up to 3 road trains in a worst case 15 minute period have been modelled and time corrected for travelling along the path from site entrance/exit to loading/unloading area and back, at a speed of 40 kilometres per hour.
- The tip trucks will be loaded with containers using the reach stacker, then transport containers to the stockpile area to be unloaded and return to the reach stacker to repeat the process. As a conservative estimate the tip trucks have been modelled to operate at the SWL in Table 7.1 for 50% of the worst cast 15 minute period.

Table 8.1 below presents the predicted noise levels from the MSP compared to the intrusiveness noise criteria (relevant to residential receiver locations only).

Table 8.1 – MSP Intrusiveness Noise Impact Assessment, dB(A) $L_{Aeq,15minute}$

Receiver Location	Intrusiveness Criteria			Predicted Noise Levels				Comply? (Yes/No)
	Day	Eve	Night	Day	Eve	Night	Night with TI	
R3 – Smith	*35*	*35*	*35*	35	35	35	**39**	No
R8 – Wilkins	*35*	*35*	*35*	29	29	28	33	Yes

Notes: Bold denotes exceedance of criteria
TI = Temperature Inversion

A summary of the results presented in Table 8.1 is provided below:

- During the day and evening, noise emissions from the modified MSP operations are predicted to comply with the intrusive criteria of 35 dB(A) $L_{Aeq,15minute}$ at receivers R3 and R8 under all assessable meteorological conditions.
- During the night under calm meteorological conditions, noise emissions from the modified MSP operations are predicted to comply with the intrusive criteria of 35 dB(A) $L_{Aeq,15minute}$ at receivers R3 and R8.
- During the night under adverse meteorological conditions (i.e. G class temperature inversions) noise emissions from the modified MSP operations are predicted to:
  - comply with the intrusive noise criteria of 35 dB(A) $L_{Aeq,15minute}$ at receiver R8; and
  - result in a moderate (i.e. 4 dB[A]) exceedance the intrusive noise criteria of 35 dB(A) $L_{Aeq,15minute}$ at receiver R8.

Based on the summary above, one receiver (R3) is predicted to be within the Noise Management Zone for the modified MSP. Therefore, in addition to the noise mitigation measures included in the predictive modelling, noise management procedures for this receiver predicted to be within the Noise Management Zone would include:

- Prompt response to community concerns or complaints.
- Attended noise monitoring at this receiver location.
- Refinement of on-site noise mitigation measures and operating procedures as required (and where possible).
- Implementation of reasonable and feasible acoustical mitigation (which may include measures such as enhanced glazing, insulation and/or air conditions) at this receiver location upon request from the relevant landowner, where noise monitoring shows noise levels which are 3 to 5 dB(A) above 35 dB(A) $L_{Aeq,15minute}$.

8.2 Amenity Noise

For a conservative and worse case assessment, all processing plant and mobile plant items in each scenario were assumed to operate continuously and concurrently for the duration of the relevant day, evening or night periods. Table 8.2 below presents the predicted noise levels from the MSP compared to the amenity noise criteria (relevant for both residential and industrial receiver locations).

Table 8.2 – MSP Amenity Noise Impact Assessment, dB(A) $L_{Aeq,period}$

Receiver Location	Amenity Noise Criteria			Predicted Noise Levels				Comply? (Yes/No)
	Day	Eve	Night	Day	Eve	Night	Night with TI	
R1 – Macro Meats – Gourmet Game (NSW Exports Pty Ltd)	*70 (When in use)*			46	46	44	47	Yes
R2 – Silver City Auto-wreckers (Talbot)	*70 (When in use)*			41	41	41	45	Yes
R3 – Smith	*50*	*45*	*9*	35	35	35	39	Yes
R5 – Brooks	*70 (When in use)*			30	30	29	34	Yes
R6 – Hayman	*70 (When in use)*			28	28	27	32	Yes
R7 – Pittaway	*70 (When in use)*			29	29	29	34	Yes
R8 – Wilkins	*50*	*45*		29	29	28	33	Yes

Results presented in Table 8.2 above, indicate that the noise emissions from the MSP will comply with the amenity noise criteria for all periods at all receiver locations.

8.3 Sleep Disturbance

Table 8.3 below presents the predicted noise levels from the MSP compared to the sleep disturbance criteria (relevant to residential receiver locations only).

Table 8.3 – MSP Sleep Arousal Assessment, dB(A) $L_{A1,1minute}$

Receiver Location	$L_{A1,1minute}$ Sleep Disturbance Criteria (Outdoors)		Predicted Noise Levels		Comply? (Yes/No)
	Night RBL + 15 dB(A)	Upper Limit	Night	Night with TI	
R3 – Smith	45	$L_{A1} \leq 65$ dB(A)	44	48	Yes
R8 – Wilkins	45	$L_{A1} \leq 65$ dB(A)	38	42	Yes

Results presented in Table 8.3 above, indicate that the $L_{A1,1minute}$ noise emissions from the MSP will exceed the Night RBL + 15 dB(A) criteria marginally by 3 dB(A) at receiver location R3 during adverse weather conditions (i.e. G class temperature inversions) but is well within the upper limit of 65 dB(A). At receiver location R8 the predicted $L_{A1,1minute}$ noise level is within both criteria.

It should be noted that R3 is predicted to be in the Noise Management Zone for the modified MSP, and therefore, the additional mitigation/management measures afforded to this receiver would also manage potential sleep disturbance impacts.

8.4 Cumulative Impacts

The following existing/approved developments are located in the MSP area:

- Perilya South Operations;
- Rasp Mine; and
- Broken Hill Solar Plant.

The implication of these existing/approved developments is discussed below.

Perilya South Operation

The Perilya South Operation is a lead-zinc underground mine that mines ore at a rate of up to 5 million tonnes per annum. The Perilya South Operation is located approximately 1.5 km to the south-east of the MSP (at its closest point).

No noise assessments are available for the Perilya South Operation. In addition EPL 2688 for the Perilya South Operation does not contain noise limits. Accordingly, potential cumulative impacts from the Perilya South Operations and modified MSP operations can not be quantified.

Notwithstanding, it is expected that the Perilya South Operations would be required to comply with intrusive noise criteria at all relevant residential receivers, and on this basis, would not result in an exceedance of the amenity criteria at any residential receiver relevant to the MSP.

Rasp Mine

The Rasp Mine is located approximately 4 km to the north-east of the MSP and was granted Project Approval (07-0018) by the Minister for Planning in January 2011. The Rasp Mine is an underground lead-zinc-silver mine that includes:

- establishing an underground mine at the Rasp Mine to extract 8.45 million tonnes of lead-zinc-silver ore;
- processing 750,000 tonnes of ore per year at the surface for up to 12 years;
- constructing and/or extending associated infrastructure, plant, equipment and activities; and

- transporting concentrate by rail to a smelter and/or port.

The Environmental Assessment (Broken Hill Operations Pty Ltd, 2010) prepared for Rasp Mine included an assessment of the potential noise impacts. Review of Broken Hill Operations Pty Ltd (2010) indicates that predicted noise levels from the Rasp Mine would be well below 35 dB(A) $L_{Aeq,15minute}$ at all residential receivers relevant to the MSP, and accordingly no exceedance of amenity criteria at any residential receiver relevant to the MSP is predicted.

Broken Hill Solar Plant

The Broken Hill Solar Plant was granted Project Approval (MP10_0202) by the Planning Assessment Commission in March 2013 and includes:

- a photovoltaic array incorporating rows of solar panels mounted on a fixed steel frame and a series of central inverters and transformers;
- aboveground and underground electrical conduits and cabling to connect the arrays to the inverters and transformers;
- marshalling switchgear to collect the power from the PV arrays;
- a diversion of the existing aboveground transmission line and placing it underground;
- construction of an aboveground transmission line to connect the solar plant to the existing Broken Hill sub station;
- internal access tracks, upgrades to existing roads, fencing and landscaping;
- site office, operations and maintenance office buildings; and
- temporary construction facilities such as a site compound and equipment laydown area.

The Broken Hill Solar Plant is located approximately 800 m to the west of the MSP and is not operational at this stage.

The Environmental Assessment prepared for the Broken Hill Solar Plant (SKM, 2012) assessed the potential noise impacts of the Broken Hill Solar Plant and concluded that potential noise impacts would be negligible. Accordingly, potential cumulative noise impacts from the Broken Hill Solar Plant have not been considered further.

9 RECOMMENDATIONS

In addition to the current measures implemented at the MSP, the following noise mitigation and management measures are recommended for the Modification.

9.1 Physical Mitigation

9.1.1 Processing Plant

Existing external auxiliary equipment identified to be noise generating should be acoustically treated with cladding/enclosures.

In addition, if the approved zircon, rutile and ilmenite kiln/roaster circuits are constructed at the MSP, these circuits will need to be fully enclosed within a building. External auxiliary equipment associated with these circuits should be acoustically treated with enclosures.

Mechanical plant should have their noise specifications and their proposed locations checked prior to their installation on site.

9.1.2 Mobile Plant

The front end loader operating during the night-time should be retrofitted with a noise suppression kit.

In addition, the following mitigation measures should be considered for the mobile fleet of the MSP:

- ensure equipment is well maintained and has quality mufflers installed;
- alternative reverse alarm, such as 'quackers' or equivalent non-tonal reversing beepers should be installed on mobile fleet where feasible and reasonable; and
- noisy plant equipment should be located as far as possible from noise sensitive areas, optimising attenuation effects from topography, natural and purpose built barriers and buildings and material stockpiles.

9.2 Management and Monitoring Measures

The existing management measures described in the MSP Noise Management Plan should be maintained, and updated as necessary, for the Modification.

9.2.1 General Management Measures

The following general management measures should be considered as part of the operation of the MSP:

- Perform very noisy work during the less sensitive time periods where possible.
- Equipment should be operated in the correct manner including replacement of engine covers, repair of defective silencing equipment, tightening of rattling components, and repair of leakages in compressed air lines.

- Limit equipment in use to only the equipment that is necessary. Any equipment not in use for extended periods should be switched off. For example, heavy vehicles should switch engines off whilst being unloaded.
- Implement quieter work practices by educating staff on noise sensitive issues and the need to make as little noise as possible.
- Take complaints seriously and deal with them expeditiously. The person responsible for liaising with the community should be adequately trained and experienced in such matters.

9.2.2 Monitoring

It is recommended that attended noise monitoring be conducted at receiver location R3 to reflect the predicted exceedances of the intrusive noise criteria at this location.

10 CONCLUSION

Renzo Tonin & Associates has completed an assessment of the potential noise impacts associated with a proposed modification to Cristal Mining's mineral sand mining and processing operations located in the Murray-Darling Basin in accordance with the INP.

This noise assessment has assessed the potential changes in noise impacts associated with the modified MSP operations. The key potential noise impacts of the Modification are associated with the increased processing, handling and transport of mineral concentrate, product and waste at the MSP.

Noise impact from the proposed modification upon the potentially most affected surrounding receivers have been quantified and compared to the relevant noise limits as specified in the INP.

Results of the noise modelling indicate that, with the implementation of reasonable and feasible noise mitigation measures, residual noise emissions from the modified MSP operations would comply with intrusive noise limits at all receivers for all periods, with the exception of a moderate (i.e. 4 dB[A]) exceedance predicted at one receiver location during the most adverse weather conditions (i.e. G class temperature inversion). Additional noise mitigation measures would be afforded to the receiver

Noise emissions are predicted to comply with the applicable amenity criteria at all residential and industrial receivers.

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30 percent (%) of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated.
Background Noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for 90% of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0 dB The faintest sound we can hear 30 dB A quiet library or in a quiet location in the country 45 dB Typical office space. Ambience in the city at night 60 dB CBD mall at lunch time 70 dB The sound of a car passing on the street 80 dB Loud music played at home 90 dB The sound of a truck passing on the street 100 dB The sound of a rock band 115 dB Limit of sound permitted in industry 120 dB Deafening
dB(A):	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the “A” filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
Lmax	The maximum sound pressure level measured over a given period.
Lmin	The minimum sound pressure level measured over a given period.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
Leq	The “equivalent noise level” is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound Absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.